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A Qualitative Evaluation of Attitudes towards Extractions amongst Primary Care Orthodontists in Great Britain.

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Abstract:	Introduction: The need to extract permanent teeth, as part of orthodontic treatment, has been keenly debated over many decades. Changes in the frequency of extraction have been well documented; however, we continue to lack an understanding of what influences clinicians' decisions as to whether to extract permanent teeth. Methods: Purposive sampling was undertaken to obtain representative views from primary care practitioners across Great Britain with a range of experience, representing both genders and a wide geographical distribution. Twenty participants (9 female, 11 male) took part in in-depth, qualitative, one-to-one interviews based on a piloted topic guide. Interviews were carried out via video conferencing software with audio-recording and verbatim transcription. Thematic analysis was performed with discussion and agreement to identify the main themes. Results: Five main themes were identified: (1) Patient-related factors, such as age and features of the malocclusion; (2) Operator factors, including level of experience; (3) Setting, with regards to geographical location and method of remuneration; (4) Mechanical approaches, including variations in appliance systems; and (5) Self-directed ongoing education, including both formal Continuing Professional Development and informal learning from peers. These factors variously acted as barriers, enablers or both in relation to non-extraction treatment. Conclusions: Five key influences on extraction decisions among orthodontists in Great Britain were identified. Extraction choices appear to be influenced by a range of inter-related factors, which appear to evolve over time and with increased experience.

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Highlights

- Extraction choices appear to be influenced by a range of inter-related factors.
- Decisions evolve over time and with increased experience.
- Clinical and non-clinical factors can be attributed to changes in attitudes.

Factors influencing extraction decisions amongst Primary Care Orthodontists in Great Britain: A qualitative study.

ABSTRACT

Introduction: The need to extract permanent teeth, as part of orthodontic treatment, has been keenly debated over many decades. Changes in the frequency of extraction have been well documented; however, we continue to lack an understanding of what influences clinicians' decisions as to whether to extract permanent teeth.

Methods: Purposive sampling was undertaken to obtain representative views from primary care practitioners across Great Britain with a range of experience, representing both genders and a wide geographical distribution. Twenty participants (9 female, 11 male) took part in in-depth, qualitative, one-to-one interviews based on a piloted topic guide. Interviews were carried out via video conferencing software with audio-recording and verbatim transcription. Thematic analysis was performed with discussion and agreement to identify the main themes.

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231 words

INTRODUCTION

The decision to extract teeth as part of an orthodontic treatment plan typically involves an assessment of space requirements, which may be founded on a formal space analysis[1]. Although quantitative evidence points to changes in extraction frequency over time, the range and impact of factors affecting these decisions remains largely unexplored[2].

In response to a recent survey of British Orthodontic Society members, 95.6% of the 208 respondents reported a decrease in the prescription of extractions as part of orthodontic treatment[2]. Various factors were cited to account for this, including facial (69.7%) and smile (61.1%) aesthetics, and increased use of techniques, such as interproximal reduction (49%). This decrease in extraction prescription was also accompanied by a growing predilection for removal of second, rather than first premolars.

Prior to this, declining prescription of orthodontic extraction was noted in North America. In a 40-year review of extraction frequencies at the University of North Carolina[3], an overall rate of extractions of 30% was reported in 1953, increasing to 76% in 1968, prior to a marked decline to 28% in 1993. Following on from this work, Jackson *et al*.[4] reported that the rate of all first premolar extractions at the University of North Carolina varied less markedly between the years 2000 (16.5%) and 2011 (12.4%) with the lowest rate recorded in 2006 (8.9%).

The earlier findings reflect changes in philosophical approaches to orthodontic treatment[3], sparked by the reticence of Edward Angle to extract permanent teeth in the early twentieth Century, to increased prescription of extractions with the use of Begg appliances following concerns over relapse of non-extraction cases[5]. While a recent decline in the prescription of extractions is recognized and known to be influenced by a range of interwoven variables, there remains a lack of evidence to explain the factors affecting extraction choices among orthodontists.

Qualitative research is increasingly recognised as a powerful approach to investigating individual attitudes, beliefs and behaviours, providing more depth and flexibility than quantative methods. We aimed to evaluate the factors affecting extraction choices among orthodontists in a primary care setting using qualitative techniques. The objectives were to explore the clinical and non-clinical factors affecting extraction choices; and explore the impact of different influences on extraction choices.

METHODS

A qualitative study design involving in-depth, one-to-one participant interviews was used. This approach was selected as qualitative methods permit more granular investigation of complex situations, behavior, and experiences, such as decision-making. Ethical approval for this study was granted by the XXXXXX Research Ethics Committee (XXXXX2408a).

A purposive sampling matrix was developed to obtain representative views from primary care specialist orthodontists across Great Britain with recruitment of up to 30 participants anticipated at the outset. The following inclusion criteria were applied: Male or female; previously having attended a UK orthodontic training programme leading to award of Membership in Orthodontics (MOrth) or Membership in Dental Orthopedics (MDO); practicing orthodontics in a primary care setting in England, Wales or Scotland. Those practicing orthodontics solely in a secondary care setting or in any other geographical location were excluded to minimize confounding. Participants were invited to take part through an e-mailed invitation circulated to current members of the British Orthodontic Society's Orthodontic Specialists Group and Consultant Orthodontist Group. A gift voucher to the value of £15 was offered to participants as a gesture of thanks for participation.

A topic guide was developed and piloted prior to recruitment. The topic guide facilitated discussion based around the aims and objectives of the research and was based on predetermined topics to allow in-depth exploration further informed by participant responses. Simple language was used, and leading questions were avoided. Neutrality of the interviewer was maintained to avoid the interviewer influencing the nature of responses and participants were asked to clarify points where necessary.

Areas of interest that were explored included changes to extraction tendency over time and factors affecting this including: biological and mechanical factors (inviting an open discussion around areas such as, envelope of tooth movement, stability, approaches to space creation, treatment time, retention protocols, treatment mechanics, and risks of extraction and non-extraction approaches); non-clinical factors including the effect of marketing and medico-legal implications; and patient preferences. Participants were encouraged to talk freely without interruption; however, probing questions were used to seek clarity or further detail where appropriate.

Participant interviews were carried out by one researcher (L.R.) who had undergone formal training in qualitative research. In light of the COVID-19 pandemic, interviews took place using online video calling software (Zoom Video Communications Inc., 2016) to comply with social distancing and travel restrictions, whilst allowing recognition of non-verbal cues. Audio recording of the interviews took place digitally and the recordings were transcribed verbatim. The audio transcripts were checked for accuracy following transcription.

A subgroup of the research team met regularly to review the use of the topic guide and to evaluate the level of data saturation, as well as to consider the course and scope of further interviews (LR, KG-B, PSF). The topic guide was adapted throughout the interviews to aid with both flow and clarity with further participants recruited on an iterative basis.

Familiarisation with transcripts was undertaken in the first instance with initial codes and themes being generated as part of analyses involving both thematic and framework approaches[6]. Data were entered into Microsoft Excel enabling comparison within and across emergent themes. The analysis was continually adapted based on developing themes, further discussion and agreement in relation to interpretation.

RESULTS

Twenty participants ([p1-p20]) were interviewed including 9 females (F) and 11 males (M) with a range of experience from 1 to 32 (mean 15.2) years following award of the Membership in Orthodontics (Royal College of Surgeons) examination (Tables 1 and 2). Four participants worked in both primary and secondary care settings simultaneously. The mean interview duration was 34 minutes with a range from 21 to 50 minutes.

Five main themes and associated sub-themes concerning the decision about whether or not to prescribe extractions as part of orthodontic treatment were identified (Figure 1). These were: (1) Patient-related factors; (2) Operator factors; (3) Setting; (4) Mechanical approaches; and (5) Self-directed ongoing education (formal and informal). These comprised of both enablers of non-extraction treatment, barriers to non-extraction treatment and factors which could act both as an enabler of and a barrier to non-extraction treatment. The most salient themes identified are outlined below.

1. *Patient-related factors*

Patient-related factors were identified covering a range of potential influences, including dental health, soft tissue factors, age, and features of the malocclusion. The degree of crowding, incisor inclination, overbite and overjet were all features of a malocclusion that participants felt influenced their extraction choices. The presence of a deep overbite or mild to moderate crowding, individually or in combination, promoted non-extraction approaches, although there was acceptance of the individual nature of these decisions:

> *'Overbite or anterior overbites, or high angle cases, it would all affect [extraction choices] … if it was a deep bite, you'd try not to take any teeth out, if you possibly could. If it was a high angle or anterior open bite … you'd be more erring on the side of taking teeth out.' (F, >10 y experience, England[P1])*

Where space creation was required, it was believed that extractions are more efficient than alternatives such as distalization. The potential lack of compliance associated with some means of distalization (e.g., headgear), therefore, caused some clinicians to gravitate towards extractions:

> *'So sometimes you have to say to people we can spend 24 months but you have to wear head gear… and I am not going to be in a position to be able to monitor that. Whereas, if you have that five [2nd premolar] out we might be able to do that in a much shorter time.' (M, <10 y experience, Wales[P3])*

Poor prognosis, carious and restored teeth were acknowledged to influence the decision to extract as well as the specific extraction pattern. Extraction of poor prognosis teeth in adolescents, to improve the long-term health of the dentition and reduce the future restorative burden was suggested, irrespective of specific orthodontic requirements:

'*Even sometimes if they're borderline cases with regard to extraction versus non-extraction, we will sometimes obviously take the decision to extract the sixes in order to get rid of a tooth of long-term poor prognosis.' (M, >10 y experience, Wales[P12])*

Some facial soft tissue features were felt to be enablers of non-extraction treatment, including retrusive soft tissues and bimaxillary retroclination with competent lips. By contrast, bimaxillary proclination and incompetent lips prompted an increased extraction tendency. In the presence of a retrusive soft tissue pattern, non-extraction treatment was favored even if this meant accepting a compromised occlusal outcome placing the emphasis on an overall evaluation of esthetic outcomes encompassing both facial and occlusal features:

'If I've got an unfavourable facial profile, I may decide not to extract and accept a quarter two canine relationship.' (M, >10 y experience, England[P7])

Patient age seemed to dictate differences in both extraction frequency and pattern. This predominantly resulted from differences in the likely rate of space closure, growth potential and more nuanced treatment objectives with non-extraction based approaches favored in adults:

'With adults I'd be much more likely if I had a patient came in with crowded lower incisors, I'd be much more likely to extract near to the site of the crowding rather than remotely. So, for example, take a lower incisor out. Particularly if there's a bit of recession on one of them rather than going for 4's and bringing things back.' (M, >10 y experience, England[P4])

'With adults I'd be far more likely to accept an overjet so that is something I do slightly differently but that's simply because you've lost the potential for growth at that age.' (M, >10 y experience, England[P4])

2. <u>Operator Factors</u>

A reduction in the frequency of prescription of extractions in recent years was acknowledged. Participants largely believed themselves to make extraction decisions reflecting the wider community of practicing orthodontists nationally and noted a reduced tendency to extract compared to older colleagues:

'I think that a generation older than me, many of whom have probably now retired, would certainly be very much more extraction-ist. I think probably those that came five, ten, fifteen years after me are extracting less.' (M, >10 y experience, Scotland[P6])

In addition to observing treatment planned by the treating clinician, managing patients that have undergone a transfer of care was revealed to reinforce treatment planning decisions in subsequent cases. This was associated with self-appraisal concerning adverse effects and

sub-optimal outcomes. However, this was typically found to cement beliefs around pre-conceived extraction tendencies rather than in changing treatment philosophy:

> *'Of the cases that I took over pretty much all of them were four fours [4 x first premolars]. Four fours extraction cases. And I think I learnt a lot from that … there were so many unnecessary extractions going on.' (M, <10 y experience, England[P8])*

Observation of patients during the retention phase was also recognized as influencing extraction tendency over time. More recently qualified participants struggled to make conclusions as to whether review of retention impacted their decisions. However, observation of relapse in non-extraction cases appeared to promote extraction-based treatment for participants who had been qualified long enough to observe and reflect on patients in retention:

> *'I went through a big non-extraction phase and then was finding relapse left, right and centre so I went back to extractions.' (M, >10 y experience, England[P2])*

3. *Setting*

Geographical region of practice was found to have a bearing on extraction frequency. Locally, both lower socio-economic areas and regions without water fluoridation were associated with an increase rate of enforced extractions. Differences in international approaches to managing malocclusion were also highlighted with participants citing instances of treating transfer cases from North America, mainland Europe and Asia who had undergone early expansion with the aim of preventing later extractions:

> *'I definitely feel like different parts of the world approach treatment plans differently. I've had a few patients come from abroad and they're all into expansion, non-extraction, start them off when they're 6 with an upper removable appliance which just expand.' (F, <10 y experience, England[P11])*

The need to achieve comprehensive correction in state-funded (UK National Health Service or NHS) patients was seen as a barrier to non-extraction treatment when compared to privately-funded treatment, where a limited objective treatment option without extractions may be offered and accepted. This effect was also related to age with adults being more accepting of compromise, whereas comprehensive correction with or without extractions was considered preferable for adolescent patients in both NHS and private settings. However, it was agreed that due to the use of the Index of Orthodontic Treatment Need (IOTN) to determine NHS-funded treatment for adolescents, those that opted to be treated privately may have milder malocclusions and are therefore less likely to require extractions even when aiming for comprehensive correction:

> *'Often for children that don't qualify on the NHS they're going down the private route so they are quite mild malocclusions. So, you wouldn't often be extracting in those cases anyway.' (F, <10 y experience, England[P16])*

The ethical consideration of extraction versus non-extraction treatment was clear-cut to participants. Ideas such as the "daughter/son test" were cited as well as the feeling of an ethical obligation not to offer one modality as a state-funded option and another privately when both could be offered within a state-funded system:

> *'If I can do it privately on a non-extraction basis or an extraction basis, I can do it on the NHS in the same way. I always try to look at the case and think, you know, were this my son, were this my big sister, wee brother, what do I think is the most appropriate treatment.' (M, >10 y experience, Scotland[P6])*

4. *Mechanical Approaches*

Historical evolution in appliance systems were said to influence extraction tendency over time, particularly with transition from edgewise and Begg appliances to Straight-Wire. The variety of systems available was felt to offer options to suit the demands of particular patients with no single system or technique being viewed as a panacea:

> *'When I was taught we were taught traditional Begg as well and edgewise and then Straight-Wire. So as a consequence, I think I've actually lived through the period of time where extractions and Begg was fairly common. 99% of the time as far as I can work out.' (M, >10 y experience, Wales[P3])*

> *'I feel like the success of an orthodontic treatment depends on your treatment plan and then you just go to your toolbox and you see what appliance fits that plan.' (F, <10 y experience, England[P11])*

The increased use of functional appliances was associated with a significant decrease in extraction frequency. The ability to achieve sagittal correction, in particular, was seen as an enabler of non-extraction treatment and compliance was reportedly enhanced with functional appliances compared to headgear:

> *'We can do more functional treatments and try and avoid camouflage extractions.' (M, <10 y experience, England[P8])*

The influence of self-ligating fixed appliance systems was found to divide opinion. For some, the possibility of increased expansion resulted in decreased extraction tendency, although this was not suggested uniformly:

> *'I think many of my generation were influenced by the strong drive with self-ligation that we had in the early 2000s to not take out teeth.' (M, >10 y experience, Scotland[P6])*

> *'I've used a fair amount of Damon appliances over the years and I will try more non-extraction with those because I think you get more of the width increase. So with a Damon case might think more non-extraction.' (M, >10 y experience, England[P2])*

5. *Self-directed ongoing education (formal and informal)*

Both the presentation of treated patients and high-quality research were understood to affect extraction tendency. For those more sceptical of marketing, the publication of high-quality research influenced treatment decisions more significantly. Conferences were also seen as an opportunity to hear from international speakers, particularly from North America with these presentations being influential and popular, although these did not necessarily translate into personal changes in extraction philosophy:

> *'A lot of the American stuff that comes across and ends up in our national conferences tends to be quite interesting. I think that people now make a bee line to those sorts of lectures.' (M, >10 y experience, Wales[P3])*

> *'Journals do [influence me] from proper peer reviewed highly respected trials showing the difference between [extraction] approaches, or the lack of difference between approaches and trying to look at the factors that should influence them.' (M, >10 y experience, Scotland[P6])*

Participants described how social media-based communication appeared to promote a non-extraction approach to treatment. The collaborative nature of discussion on social media platforms was reportedly useful in considering different approaches, but this was felt to risk disproportionately influencing less experienced practitioners who may question their own approach more readily. Some scepticism of "cherry-picked" cases posted on social media was identified with a feeling that these were typically not representative. Consequently, such platforms were given less credence among more experienced practitioners:

> *'On social media there are a lot of clinicians posting their cases, and it's almost like you're a hero if you've done it non-extraction which I think is absolutely ridiculous.' (F, <10 y experience, England[P11])*

DISCUSSION

In this qualitative study, several pivotal factors underpinning extraction choices were identified. The use of qualitative research methods in orthodontics is increasingly recognized given the inherent value in gaining deeper insight into complex and multi-faceted research questions[7-12]. Among the research topics examined with qualitative methods include orthodontic information on social media[8,9], patient perception of orthodontic appliances[10], compliance with removable retainers[11] and removable functional appliances[12]. Qualitative methods were uniquely valuable in the present study in offering insight into extraction decisions among orthodontic providers and therefore supplements data from previous quantitative surveys[2,13].

The identification of patient and operator influences on extraction choices was expected. Unsurprisingly, the extent of crowding was critical in deciding whether to extract and which

teeth to extract, with milder crowding enabling non-extraction treatment[14]. Use of a space analysis was reported to inform extraction decisions despite previous evidence that such bespoke approaches had little influence on treatment planning[15]; however, it is worth noting that this finding was related to whether or not a formal space analysis was used during specialist training. Skeletal presentation was also a consideration, with increased vertical proportions likely to promote extraction-based treatment[16]. Extracting more posteriorly in the arch was felt to promote an 'anti-wedge effect' as a result of molar mesial movement[17]. However, the presence or absence of third molars was regarded as less important than other features of the malocclusion, in keeping with previous evidence[14]. Similarly, while facial and smile esthetics were felt to be important in informing extraction choices by over 60% of orthodontists in a previous survey[2], the impact of these features subordinated to occlusal presentation in the present study.

The observation that patient age strongly affects extraction decision-making is intuitive given the inherent differences in treating adults and adolescents[2,13]. The reasons cited were numerous and inter-related, including decreased rate of space closure, less growth potential, and a willingness to occasionally accept limited objectives in adults. Patient preferences were also found to be particularly influential in borderline extraction or non-extraction cases. While orthodontic patients report sometimes being less involved in treatment planning decisions[18], the findings of the current study suggest that shared decision-making was a significant contributor to extraction decisions. This indicates a possible difference in experience of the decision-making process from patient and orthodontist perspectives and could help to influence future patient communication tools.

The participants referred to a general reduction in the prescription of orthodontic extractions, which reflects the findings from several studies based in the UK., U.S. and Brazil [2,3,4,13]. Operator experience was an important contributor with the impact of heuristic learning, from both active cases as well as treatment outcomes and stability recognized. An iterative, but inconsistent effect was identified reflecting the learning from both successful and unsuccessful treated cases. These findings echo the changes in attitudes over the twentieth century[19,20].

With regards to mechanical approaches, there was limited discussion regarding the effect of bracket ligation or the increased use of either temporary anchorage devices or fixed sagittal correctors. This mirrors a previous quantitative survey, in which the effect of the use of these techniques was marginal[2]. Notwithstanding this, an increasing recourse to inter-proximal reduction with both fixed appliance systems and aligners, especially in adults, was referred to. The declining recommendation of extractions as a means of addressing crowding may well be associated with a greater reliance on arch lengthening, which is known to be particularly unstable[21]. It is accepted, however, that non-compliance with removable retainers is prevalent[22] and that failure of bonded retainers is also problematic[11]. As such, the onus on long-term retention to mitigate this inherent instability, prompted by evolving extraction trends may be increasing.

The impact of scientific research on extraction decisions was limited, with an emphasis on the clinical presentation and treatment objectives. In previous studies, the lack of high-quality evidence as to the effectiveness of varying treatment modalities has also been

suggested to limit the agreement between orthodontists in relation to decision-making[23]. Attitudes towards, and understanding of, evidence-based practice in orthodontics is also known to be variable[24]. In keeping with the present study, contradictory research findings were cited as a barrier to the application of evidence-based practice. This uncertainty in the interpretation of published evidence may explain the emphasis on peer-to-peer learning on decision-making, which emerged in the present study.

In terms of limitations, although the use of focus groups rather than individual interviews may have provided opportunity for more discussion between participants, the open nature of group discussion may have introduced reluctance to provide unpopular or alternative opinions[25]. The intrinsic limitation of lack of generalizability beyond the cohort interviewed was mitigated by the recruitment of participants with a range of demographic characteristics, including gender, level of experience and geographical location, although generalizability is not an essential feature of qualitative research. A challenge associated with qualitative research is the ability to ensure data saturation. The interviews were therefore continued until no new themes emerged, which was felt to indicate attainment of adequate depth. Preconceptions of the interviewer based on the research topic was mitigated by the involvement of a non-dentally qualified qualitative researcher in discussions and data analysis. Although, the participants were made aware of the interviewer being an orthodontic trainee, this permitted more in-depth and focused discussion.

CONCLUSIONS

The following were found to affect extraction choices among orthodontic specialists: patient-related factors, operator factors, setting, mechanical approaches and self-directed ongoing education (both formal and informal). The extent of these influences on individual clinicians may be moderated by their level of experience, patient demographics and location of practice both in relation to geographical setting and method of remuneration.

REFERENCES

1. Kirschen RH, O'Higgins EA, Lee RT. The Royal London Space Planning: An integration of space analysis and treatment planning. Part I: assessing the space required to meet treatment objectives. Am J Orthod Dentofacial Orthop 2000;118:456-61.
2. Fleming PS, Cunningham S J, Benson PE, Jauhar P, Millett D. Extraction of premolars for orthodontic reasons on the decline? A cross- sectional survey of BOS members. J Orthod 2018;45(4):1-6.
3. Proffit WR. Forty-year review of extraction frequencies at a university orthodontic clinic. Angle Orthod 1994;64(6):407-414.
4. Jackson TH, Guez C, Lin FC, Proffit WR, Ko CC. Extraction frequencies at a university orthodontic clinic in the 21st century: demographic and diagnostic factors affecting the likelihood of extraction. Am J Orthod Dentofacial Orthop 2017;151:456–462.
5. Begg PR. Stone Age man's dentition. Am J Orthod 1954;40:298-312.
6. Braun V, Clarke V. Using thematic analysis in psychology. Qual Res Psychol 2006;3(2):77-101.

7. Almeida A B, Leite I, Silva G. Evidence in Orthodontics related to qualitative research. Dent Press J Orthod 2018;23(4):64–71.
8. Henzell RR, Knight MA, Morgaine KC, Antoun JS, Farella M. A qualitative analysis of orthodontic-related posts on Twitter. Angle Orthod 2014;84(2):203–207.
9. Guo J, Yan X, Li S, Van der Walt J, Guan G, Mei L. Quantitative and qualitative analyses of orthodontic-related videos on YouTube. Angle Orthod 2020;90(3):411-418.
10. Almeida AB, Leite I, Silva GA. Brazilian adolescents' perception of the orthodontic appliance: A qualitative study. Am J Orthod Dentofacial Orthop 2019;155:490–497.
11. Al-Moghrabi D, Colonio Salazar FB, Johal A, Fleming PS. Factors influencing adherence to vacuum-formed retainer wear: A qualitative study. J Orthod 2019;46(3):212-219.
12. El-Huni A, Colonio Salazar FB, Sharma PK, Fleming PS. Understanding factors influencing compliance with removable functional appliances: A qualitative study. Am J Orthod Dentofacial Orthop 2019;155(2):173-181.
13. Janson G, Maria FR, Bombonatti R. Frequency evaluation of different extraction protocols in orthodontic treatment during 35 years. Prog Orthod 2014;15(1):51.
14. Evrard A, Tepedino M, Cattaneo PM, Cornelis MA. Which factors influence orthodontists in their decision to extract? A questionnaire survey. J Clin Exp Dent 2019;11(5):432-438.
15. Al-Abdallah M, Sandler J, O'Brien K. Is the Royal London Space Analysis reliable and does it influence orthodontic treatment decisions? Eur J Orthod 2008;30:503-507.
16. Beit P, Konstantonis D, Papagiannis A, Eliades T. Vertical skeletal changes after extraction and non-extraction treatment in matched class I patients identified by a discriminant analysis: cephalometric appraisal and Procrustes superimposition. Prog Orthod 2017;18(1):44-54
17. Kojima K, Endo T, Shimooka S. Effects of maxillary second molar extraction on dentofacial morphology before and after anterior open-bite treatment: a cephalometric study. Odontology 2009;97(1):43-50.
18. Motamedi-Azari F, Ryan F, Jones E, Cunningham S. A cross-sectional study investigating patients' preferences regarding shared decision-making in adult orthodontic patients. Br Dent J 2020;228**:**869–874.
19. Angle EH. Letter to Morinosuke Chiwaki, Tokyo, September 17, 1902. The World of Edward Hartley Angle, MD, DDS: His letters, accounts and patents. 2nd ed. Boston: E. H. Angle Education and Research Foundation. 1902.
20. Tweed CH. Indications for the extraction of teeth in orthodontic procedure. Am J Orthod Oral Surg 1944;42:22-45.
21. Little RM, Riedel RA, Artun J. An evaluation of changes in the mandibular anterior alignment from 10 to 20 years post retention. Am J Orthod Dentofacial Orthop 1988;93:423-428.
22. Al-Moghrabi D, Johal A, O'Rourke N, Donos N, Pandis N, Gonzales-Marin C et al. Effects of fixed vs removable orthodontic retainers on stability and periodontal health: 4-year follow-up of a randomised controlled trial. Am J Orthod Dentofacial Orthop 2018;154(2):167-174.
23. Lee R, Macfarlane T, O'Brien K. Consistency of orthodontic treatment planning decisions. Clin Orthod Res 1999;2(2):79-84.

24. Madhavji A, Araujo EA, Kim KB, Buschang PH. Attitudes, awareness and barriers towards evidence-based practice in orthodontics. Am J Orthod Dentofacial Orthop 2011;140(3):309-16.
25. Bloor M, Frankland J, Thomas M, Robson K. Focus groups in social research. 1st ed. SAGE Publications Ltd; 2001.

LEGENDS

Table 1. Summary of participant demographics by region.
Table 2. Overview of individual participant data
Figure 1: Overview of themes and associated barriers and enablers in relation to extraction decisions among the respondents

Table 1. Summary of participant demographics by region.

Region	Participants	Mean number of years experience post-MOrth (Range)
England	15 (8 female, 7 male)	11.5 (1-32)
Scotland	2 (2 male)	22.5 (20-25)
Wales	3 (1 female, 2 male)	28.7 (24-32)
Overall	20 (11 female, 19 male)	15.2 (1-32)

Table 2. Overview of participant data.

Participant number	Gender	Years of experience post MOrth	Geographical region
1	F	>10	England
2	M	>10	England
3	M	>10	Wales
4	M	>10	England
5	M	>10	England
6	M	>10	Scotland
7	M	>10	England
8	M	<10	England
9	F	<10	England
10	F	<10	England
11	F	<10	England
12	M	>10	Wales
13	F	>10	Wales
14	F	<10	England
15	F	<10	England
16	F	<10	England
17	M	<10	England
18	M	<10	England
19	M	>10	Scotland
20	F	>10	England

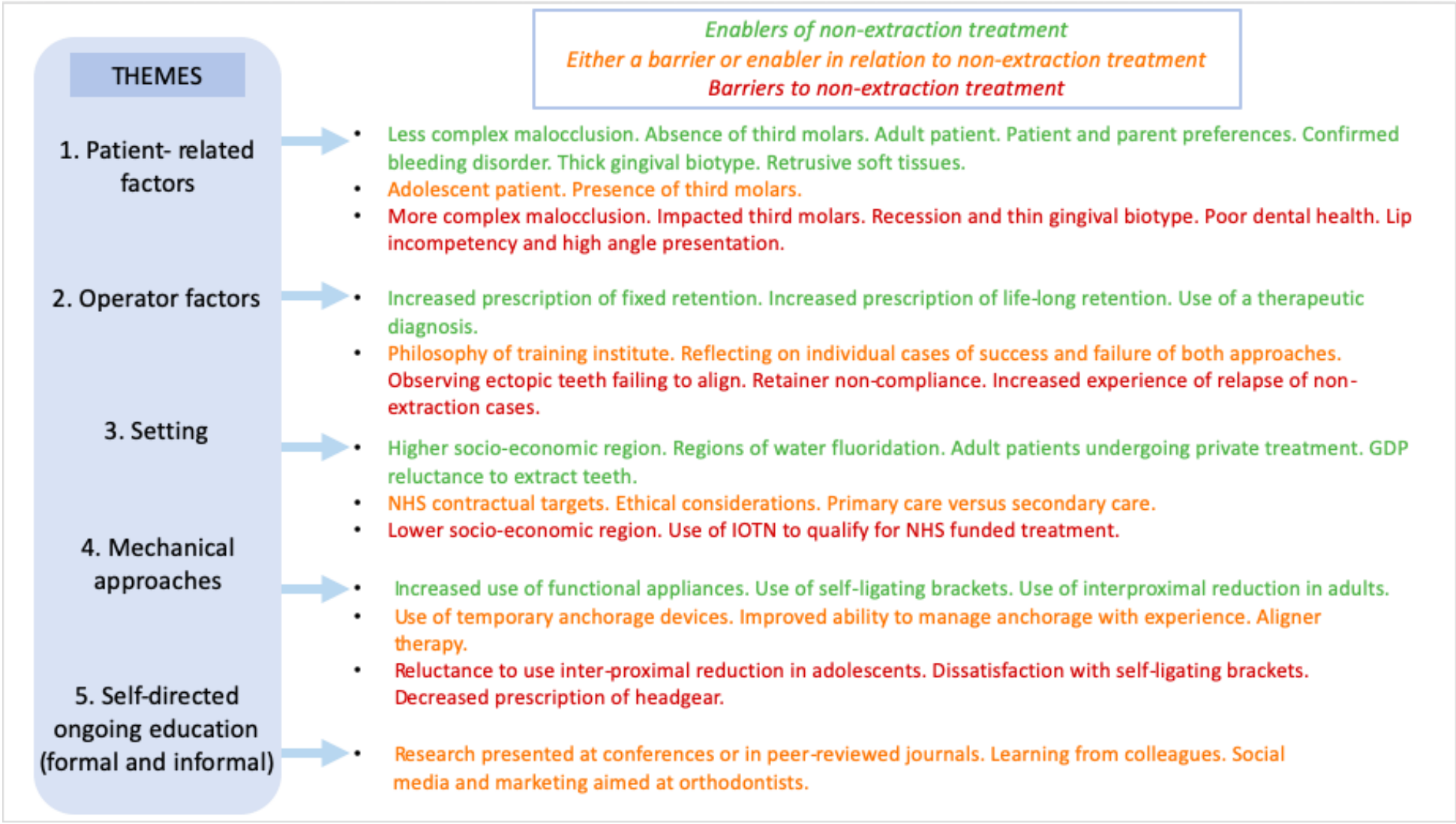

Figure 1: **Overview of themes and associated barriers and enablers in relation to extraction decisions among the respondents**

CRediT Author Statement

Libby Richardson: Formal analysis, Investigation, Writing- Original draft, Writing- Review & editing, Project administration
Declan Millett: Conceptualization, Methodology, Writing- Review & editing, Funding acquisition
Philip Benson: Conceptualization, Methodology, Writing- Review & editing, Funding acquisition
Susan Cunningham: Conceptualization, Methodology, Writing- Review & editing, Funding acquisition
Kara Gray-Burrows: Formal analysis, Writing- Review & editing
Padhraig Fleming: Conceptualization, Methodology, Formal analysis, Writing- Original draft, Writing- Review & editing, Supervision, Funding acquisition

Term	Definition	Initials
Conceptualization	Ideas; formulation or evolution of overarching research goals and aims	PF DM SC PB
Methodology	Development or design of methodology; creation of models	PF DM SC PB
Software	Programming, software development; designing computer programs; implementation of the computer code and supporting algorithms; testing of existing code components	
Validation	Verification, whether as a part of the activity or separate, of the overall replication/ reproducibility of results/experiments and other research outputs	
Formal analysis	Application of statistical, mathematical, computational, or other formal techniques to analyze or synthesize study data	PF LR KGB
Investigation	Conducting a research and investigation process, specifically performing the experiments, or data/evidence collection	LR
Resources	Provision of study materials, reagents, materials, patients, laboratory samples, animals, instrumentation, computing resources, or other analysis tools	

Term	Definition	Initials
Data Curation	Management activities to annotate (produce metadata), scrub data and maintain research data (including software code, where it is necessary for interpreting the data itself) for initial use and later reuse	
Writing - Original Draft	Preparation, creation and/or presentation of the published work, specifically writing the initial draft (including substantive translation)	PF LR
Writing - Review & Editing	Preparation, creation and/or presentation of the published work by those from the original research group, specifically critical review, commentary or revision – including pre-or postpublication stages	PF LR KGB SC PB DM
Visualization	Preparation, creation and/or presentation of the published work, specifically visualization/ data presentation	
Supervision	Oversight and leadership responsibility for the research activity planning and execution, including mentorship external to the core team	PF
Project administration	Management and coordination responsibility for the research activity planning and execution	
Funding acquisition	Acquisition of the financial support for the project leading to this publication	PF PB SC DM