

# American Journal of Orthodontics & Dentofacial Orthopedics

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

--Manuscript Draft--

<b>Manuscript Number:</b>	AJODO-D-21-00980R3
<b>Article Type:</b>	Original Article
<b>Keywords:</b>	Orthodontic extractions; Non-extraction; qualitative research; Treatment planning
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<b>Abstract:</b>	<p><b>Introduction:</b> 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.</p> <p><b>Methods:</b> 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.</p> <p><b>Results:</b> 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.</p> <p><b>Conclusions:</b> 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.</p>

Reviewers' comments:

The number of females and males at the OVERALL summary of participants is still wrong! You said 20 participants, being 10 female and 10 male at table 1.

If you look carefully at your results (first paragraph) lines 4 and 5, you will see the following sentence:

"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)".

Did I have missed the point here? What is correct: the text or the table?

I already have suggested you to correct the number of participants since it seems wrong to me at table 1. Please clarification is needed .

Thanks

**Response: Apologies for the oversight. We have now found the issue and corrected. Many thanks for spotting this.**

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

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### **Funding:**

Funding was granted by the British Orthodontic Society Foundation.

## 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.

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.

231 words

1           **INTRODUCTION**  
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5           The decision to extract teeth as part of an orthodontic treatment plan typically involves an  
6           assessment of space requirements, which may be founded on a formal space analysis<sup>1</sup>.  
7           Although quantitative evidence points to changes in extraction frequency over time, the  
8           range and impact of factors affecting these decisions remains largely unexplored<sup>2</sup>.  
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10  
11           In response to a recent survey of British Orthodontic Society members, 95.6% of the 208  
12           respondents reported a decrease in the prescription of extractions as part of orthodontic  
13           treatment<sup>2</sup>. Various factors were cited to account for this, including facial (69.7%) and smile  
14           (61.1%) aesthetics, and increased use of techniques, such as interproximal reduction (49%).  
15           This decrease in extraction prescription was also accompanied by a growing predilection for  
16           removal of second, rather than first premolars.  
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19  
20           Prior to this, declining prescription of orthodontic extraction was noted in North America.  
21           In a 40-year review of extraction frequencies at the University of North Carolina<sup>3</sup>, an overall  
22           rate of extractions of 30% was reported in 1953, increasing to 76% in 1968, prior to a  
23           marked decline to 28% in 1993. Following on from this work, Jackson *et al.*<sup>4</sup> reported that  
24           the rate of all first premolar extractions at the University of North Carolina varied less  
25           markedly between the years 2000 (16.5%) and 2011 (12.4%) with the lowest rate recorded  
26           in 2006 (8.9%).  
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31           The earlier findings reflect changes in philosophical approaches to orthodontic treatment<sup>3</sup>,  
32           sparked by the reticence of Edward Angle to extract permanent teeth in the early twentieth  
33           Century, to increased prescription of extractions with the use of Begg appliances following  
34           concerns over relapse of non-extraction cases<sup>5</sup>. While a recent decline in the prescription of  
35           extractions is recognized and known to be influenced by a range of interwoven variables,  
36           there remains a lack of evidence to explain the factors affecting extraction choices among  
37           orthodontists.  
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41           Qualitative research is increasingly recognised as a powerful approach to investigating  
42           individual attitudes, beliefs and behaviours, providing more depth and flexibility than  
43           quantative methods. We aimed to evaluate the factors affecting extraction choices among  
44           orthodontists in a primary care setting using qualitative techniques. The objectives were to  
45           explore the clinical and non-clinical factors affecting extraction choices; and explore the  
46           impact of different influences on extraction choices.  
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51           **METHODS**  
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54           A qualitative study design involving in-depth, one-to-one participant interviews was used.  
55           This approach was selected as qualitative methods permit more granular investigation of  
56           complex situations, behavior, and experiences, such as decision-making. Ethical approval for  
57           this study was granted by the XXXXXX Research Ethics Committee (XXXXX2408a).  
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1 A purposive sampling matrix was developed to obtain representative views from primary  
2 care specialist orthodontists across Great Britain with recruitment of up to 30 participants  
3 anticipated at the outset. The following inclusion criteria were applied: Male or  
4 female; previously having attended a UK orthodontic training programme leading to award  
5 of Membership in Orthodontics (MOrth) or Membership in Dental Orthopedics  
6 (MDO); practicing orthodontics in a primary care setting in England, Wales or  
7 Scotland. Those practicing orthodontics solely in a secondary care setting or in any other  
8 geographical location were excluded to minimize confounding. Participants were invited to  
9 take part through an e-mailed invitation circulated to current members of the British  
10 Orthodontic Society's Orthodontic Specialists Group and Consultant Orthodontist Group. A  
11 gift voucher to the value of £15 was offered to participants as a gesture of thanks for  
12 participation.  
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16 A topic guide was developed and piloted prior to recruitment. The topic guide facilitated  
17 discussion based around the aims and objectives of the research and was based on  
18 predetermined topics to allow in-depth exploration further informed by participant  
19 responses. Simple language was used, and leading questions were avoided. Neutrality of the  
20 interviewer was maintained to avoid the interviewer influencing the nature of responses  
21 and participants were asked to clarify points where necessary.  
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25 Areas of interest that were explored included changes to extraction tendency over time and  
26 factors affecting this including: biological and mechanical factors (inviting an open  
27 discussion around areas such as, envelope of tooth movement, stability, approaches to  
28 space creation, treatment time, retention protocols, treatment mechanics, and risks of  
29 extraction and non-extraction approaches); non-clinical factors including the effect of  
30 marketing and medico-legal implications; and patient preferences. Participants were  
31 encouraged to talk freely without interruption; however, probing questions were used to  
32 seek clarity or further detail where appropriate.  
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37 Participant interviews were carried out by one researcher (L.R.) who had undergone formal  
38 training in qualitative research. In light of the COVID-19 pandemic, interviews took place  
39 using online video calling software (Zoom Video Communications Inc., 2016) to comply with  
40 social distancing and travel restrictions, whilst allowing recognition of non-verbal cues.  
41 Audio recording of the interviews took place digitally and the recordings were transcribed  
42 verbatim. The audio transcripts were checked for accuracy following transcription.  
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46 A subgroup of the research team met regularly to review the use of the topic guide and to  
47 evaluate the level of data saturation, as well as to consider the course and scope of further  
48 interviews (LR, KG-B, PSF). The topic guide was adapted throughout the interviews to aid  
49 with both flow and clarity with further participants recruited on an iterative basis.  
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53 Familiarisation with transcripts was undertaken in the first instance with initial codes and  
54 themes being generated as part of analyses involving both thematic and framework  
55 approaches<sup>6</sup>. Data were entered into Microsoft Excel enabling comparison within and across  
56 emergent themes. The analysis was continually adapted based on developing themes,  
57 further discussion and agreement in relation to interpretation.  
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## RESULTS

Twenty participants (p<sup>1</sup>-p<sup>20</sup>) 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<sup>P1</sup>)

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 [2<sup>nd</sup> premolar] out we might be able to do that in a much shorter time.'* (M, <10 y experience, Wales<sup>P3</sup>)

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:



1 *'Even sometimes if they're borderline cases with regard to extraction versus non-*  
2 *extraction, we will sometimes obviously take the decision to extract the sixes in order*  
3 *to get rid of a tooth of long-term poor prognosis.'* (M, >10 y experience, Wales<sup>P12</sup>)  
4

5 Some facial soft tissue features were felt to be enablers of non-extraction treatment,  
6 including retrusive soft tissues and bimaxillary retroclination with competent lips. By  
7 contrast, bimaxillary proclination and incompetent lips prompted an increased extraction  
8 tendency. In the presence of a retrusive soft tissue pattern, non-extraction treatment was  
9 favored even if this meant accepting a compromised occlusal outcome placing the emphasis  
10 on an overall evaluation of esthetic outcomes encompassing both facial and occlusal  
11 features:  
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14  
15 *'If I've got an unfavourable facial profile, I may decide not to extract and accept a*  
16 *quarter two canine relationship.'* (M, >10 y experience, England<sup>P7</sup>)  
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20 Patient age seemed to dictate differences in both extraction frequency and pattern. This  
21 predominantly resulted from differences in the likely rate of space closure, growth potential  
22 and more nuanced treatment objectives with non-extraction based approaches favored in  
23 adults:  
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26  
27 *'With adults I'd be much more likely if I had a patient come in with crowded lower*  
28 *incisors, I'd be much more likely to extract near to the site of the crowding rather than*  
29 *remotely. So, for example, take a lower incisor out. Particularly if there's a bit of*  
30 *recession on one of them rather than going for 4's and bringing things back.'* (M, >10 y  
31 *experience, England<sup>P4</sup>)*  
32  
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34  
35 *'With adults I'd be far more likely to accept an overjet so that is something I do slightly*  
36 *differently but that's simply because you've lost the potential for growth at that age.'*  
37 *(M, >10 y experience, England<sup>P4</sup>)*  
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## 40 41 2. Operator Factors 42

43 A reduction in the frequency of prescription of extractions in recent years was  
44 acknowledged. Participants largely believed themselves to make extraction decisions  
45 reflecting the wider community of practicing orthodontists nationally and noted a reduced  
46 tendency to extract compared to older colleagues:  
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50 *'I think that a generation older than me, many of whom have probably now retired,*  
51 *would certainly be very much more extraction-ist. I think probably those that came*  
52 *five, ten, fifteen years after me are extracting less.'* (M, >10 y experience, Scotland<sup>P6</sup>)  
53  
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55 In addition to observing treatment planned by the treating clinician, managing patients that  
56 have undergone a transfer of care was revealed to reinforce treatment planning decisions in  
57 subsequent cases. This was associated with self-appraisal concerning adverse effects and  
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1 sub-optimal outcomes. However, this was typically found to cement beliefs around pre-  
2 conceived extraction tendencies rather than in changing treatment philosophy:

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4 *'Of the cases that I took over pretty much all of them were four fours [4 x first*  
5 *premolars]. Four fours extraction cases. And I think I learnt a lot from that ... there*  
6 *were so many unnecessary extractions going on.'* (M, <10 y experience, England<sup>P8</sup>)  
7

8  
9 Observation of patients during the retention phase was also recognized as influencing  
10 extraction tendency over time. More recently qualified participants struggled to make  
11 conclusions as to whether review of retention impacted their decisions. However,  
12 observation of relapse in non-extraction cases appeared to promote extraction-based  
13 treatment for participants who had been qualified long enough to observe and reflect on  
14 patients in retention:  
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18 *'I went through a big non-extraction phase and then was finding relapse left, right*  
19 *and centre so I went back to extractions.'* (M, >10 y experience, England<sup>P2</sup>)  
20

### 21 3. Setting

22  
23 Geographical region of practice was found to have a bearing on extraction frequency.  
24 Locally, both lower socio-economic areas and regions without water fluoridation were  
25 associated with an increase rate of enforced extractions. Differences in international  
26 approaches to managing malocclusion were also highlighted with participants citing  
27 instances of treating transfer cases from North America, mainland Europe and Asia who had  
28 undergone early expansion with the aim of preventing later extractions:  
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33 *'I definitely feel like different parts of the world approach treatment plans differently.*  
34 *I've had a few patients come from abroad and they're all into expansion, non-*  
35 *extraction, start them off when they're 6 with **an upper removable appliance** which*  
36 *just expand.'* (F, <10 y experience, England<sup>P11</sup>)  
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39  
40 The need to achieve comprehensive correction in state-funded (UK National Health Service  
41 or NHS) patients was seen as a barrier to non-extraction treatment when compared to  
42 privately-funded treatment, where a limited objective treatment option without extractions  
43 may be offered and accepted. This effect was also related to age with adults being more  
44 accepting of compromise, whereas comprehensive correction with or without extractions  
45 was considered preferable for adolescent patients in both NHS and private settings.  
46 However, it was agreed that due to the use of the Index of Orthodontic Treatment Need  
47 (IOTN) to determine NHS-funded treatment for adolescents, those that opted to be treated  
48 privately may have milder malocclusions and are therefore less likely to require extractions  
49 even when aiming for comprehensive correction:  
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54 *'Often for children that don't qualify on the NHS they're going down the private route*  
55 *so they are quite mild malocclusions. So, you wouldn't often be extracting in those*  
56 *cases anyway.'* (F, <10 y experience, England<sup>P16</sup>)  
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1 The ethical consideration of extraction versus non-extraction treatment was clear-cut to  
2 participants. Ideas such as the “daughter/son test” were cited as well as the feeling of an  
3 ethical obligation not to offer one modality as a state-funded option and another privately  
4 when both could be offered within a state-funded system:  
5

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

#### 12 4. Mechanical Approaches

13 Historical evolution in appliance systems were said to influence extraction tendency over  
14 time, particularly with transition from edgewise and Begg appliances to Straight-Wire. The  
15 variety of systems available was felt to offer options to suit the demands of particular  
16 patients with no single system or technique being viewed as a panacea:  
17

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

22 *‘I feel like the success of an orthodontic treatment depends on your treatment plan*  
23 *and then you just go to your toolbox and you see what appliance fits that plan.’ (F,*  
24 *<10 y experience, England<sup>P11</sup>)*

25 The increased use of functional appliances was associated with a significant decrease in  
26 extraction frequency. The ability to achieve sagittal correction, in particular, was seen as an  
27 enabler of non-extraction treatment and compliance was reportedly enhanced with  
28 functional appliances compared to headgear:  
29

30 *‘We can do more functional treatments and try and avoid camouflage extractions.’*  
31 *(M, <10 y experience, England<sup>P8</sup>)*

32 The influence of self-ligating fixed appliance systems was found to divide opinion. For some,  
33 the possibility of increased expansion resulted in decreased extraction tendency, although  
34 this was not suggested uniformly:  
35

36 *‘I think many of my generation were influenced by the strong drive with self-ligation*  
37 *that we had in the early 2000s to not take out teeth.’ (M, >10 y experience,*  
38 *Scotland<sup>P6</sup>)*

39 *‘I’ve used a fair amount of Damon appliances over the years and I will try more non-*  
40 *extraction with those because I think you get more of the width increase. So with a*  
41 *Damon case might think more non-extraction.’ (M, >10 y experience, England<sup>P2</sup>)*

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3 5. Self-directed ongoing education (formal and informal)  
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5 Both the presentation of treated patients and high-quality research were understood to  
6 affect extraction tendency. For those more sceptical of marketing, the publication of high-  
7 quality research influenced treatment decisions more significantly. Conferences were also  
8 seen as an opportunity to hear from international speakers, particularly from North America  
9 with these presentations being influential and popular, although these did not necessarily  
10 translate into personal changes in extraction philosophy:  
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13  
14 *'A lot of the American stuff that comes across and ends up in our national*  
15 *conferences tends to be quite interesting. I think that people now make a bee line to*  
16 *those sorts of lectures.'* (M, >10 y experience, Wales<sup>P3</sup>)  
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19 *'Journals do [influence me] from proper peer reviewed highly respected trials*  
20 *showing the difference between [extraction] approaches, or the lack of difference*  
21 *between approaches and trying to look at the factors that should influence them.'*  
22 (M, >10 y experience, Scotland<sup>P6</sup>)  
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25 Participants described how social media-based communication appeared to promote a non-  
26 extraction approach to treatment. The collaborative nature of discussion on social media  
27 platforms was reportedly useful in considering different approaches, but this was felt to risk  
28 disproportionately influencing less experienced practitioners who may question their own  
29 approach more readily. Some scepticism of "cherry-picked" cases posted on social media  
30 was identified with a feeling that these were typically not representative. Consequently,  
31 such platforms were given less credence among more experienced practitioners:  
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35  
36 *'On social media there are a lot of clinicians posting their cases, and it's almost like*  
37 *you're a hero if you've done it non-extraction which I think is absolutely ridiculous.'*  
38 (F, <10 y experience, England<sup>P11</sup>)  
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42 **DISCUSSION**  
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45 In this qualitative study, several pivotal factors underpinning extraction choices were  
46 identified. The use of qualitative research methods in orthodontics is increasingly  
47 recognized given the inherent value in gaining deeper insight into complex and multi-  
48 faceted research questions<sup>7-12</sup>. Among the research topics examined with qualitative  
49 methods include orthodontic information on social media<sup>8,9</sup>, patient perception of  
50 orthodontic appliances<sup>10</sup>, compliance with removable retainers<sup>11</sup> and removable functional  
51 appliances<sup>12</sup>. Qualitative methods were uniquely valuable in the present study in offering  
52 insight into extraction decisions among orthodontic providers and therefore supplements  
53 data from previous quantitative surveys<sup>2,13</sup>.  
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57  
58 The identification of patient and operator influences on extraction choices was expected.  
59 Unsurprisingly, the extent of crowding was critical in deciding whether to extract and which  
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1 teeth to extract, with milder crowding enabling non-extraction treatment<sup>14</sup>. Use of a space  
2 analysis was reported to inform extraction decisions despite previous evidence that such  
3 bespoke approaches had little influence on treatment planning<sup>15</sup>; however, it is worth  
4 noting that this finding was related to whether or not a formal space analysis was used  
5 during specialist training. Skeletal presentation was also a consideration, with increased  
6 vertical proportions likely to promote extraction-based treatment<sup>16</sup>. Extracting more  
7 posteriorly in the arch was felt to promote an 'anti-wedge effect' as a result of molar mesial  
8 movement<sup>17</sup>. However, the presence or absence of third molars was regarded as less  
9 important than other features of the malocclusion, in keeping with previous  
10 evidence<sup>14</sup>. Similarly, while facial and smile esthetics were felt to be important in informing  
11 extraction choices by over 60% of orthodontists in a previous survey<sup>2</sup>, the impact of these  
12 features subordinated to occlusal presentation in the present study.  
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17 The observation that patient age strongly affects extraction decision-making is intuitive  
18 given the inherent differences in treating adults and adolescents<sup>2,13</sup>. The reasons cited were  
19 numerous and inter-related, including decreased rate of space closure, less growth  
20 potential, and a willingness to occasionally accept limited objectives in adults. Patient  
21 preferences were also found to be particularly influential in borderline extraction or non-  
22 extraction cases. While orthodontic patients report sometimes being less involved in  
23 treatment planning decisions<sup>18</sup>, the findings of the current study suggest that shared  
24 decision-making was a significant contributor to extraction decisions. This indicates a  
25 possible difference in experience of the decision-making process from patient and  
26 orthodontist perspectives and could help to influence future patient communication tools.  
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31 The participants referred to a general reduction in the prescription of orthodontic  
32 extractions, which reflects the findings from several studies based in the UK., U.S. and Brazil  
33 <sup>2,3,4,13</sup>. Operator experience was an important contributor with the impact of heuristic  
34 learning, from both active cases as well as treatment outcomes and stability recognized. An  
35 iterative, but inconsistent effect was identified reflecting the learning from both successful  
36 and unsuccessful treated cases. These findings echo the changes in attitudes over the  
37 twentieth century<sup>19,20</sup>.  
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41 With regards to mechanical approaches, there was limited discussion regarding the effect of  
42 bracket ligation or the increased use of either temporary anchorage devices or fixed sagittal  
43 correctors. This mirrors a previous quantitative survey, in which the effect of the use of  
44 these techniques was marginal<sup>2</sup>. Notwithstanding this, an increasing recourse to inter-  
45 proximal reduction with both fixed appliance systems and aligners, especially in adults, was  
46 referred to. The declining recommendation of extractions as a means of addressing  
47 crowding may well be associated with a greater reliance on arch lengthening, which is  
48 known to be particularly unstable<sup>21</sup>. It is accepted, however, that non-compliance with  
49 removable retainers is prevalent<sup>22</sup> and that failure of bonded retainers is also problematic<sup>11</sup>.  
50 As such, the onus on long-term retention to mitigate this inherent instability, prompted by  
51 evolving extraction trends may be increasing.  
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57 The impact of scientific research on extraction decisions was limited, with an emphasis on  
58 the clinical presentation and treatment objectives. In previous studies, the lack of high-  
59 quality evidence as to the effectiveness of varying treatment modalities has also been  
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1 suggested to limit the agreement between orthodontists in relation to decision-  
2 making<sup>23</sup>. Attitudes towards, and understanding of, evidence-based practice in orthodontics  
3 is also known to be variable<sup>24</sup>. In keeping with the present study, contradictory research  
4 findings were cited as a barrier to the application of evidence-based practice. This  
5 uncertainty in the interpretation of published evidence may explain the emphasis on peer-  
6 to-peer learning on decision-making, which emerged in the present study.  
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9 In terms of limitations, although the use of focus groups rather than individual interviews  
10 may have provided opportunity for more discussion between participants, the open nature  
11 of group discussion may have introduced reluctance to provide unpopular or alternative  
12 opinions<sup>25</sup>. The intrinsic limitation of lack of generalizability beyond the cohort interviewed  
13 was mitigated by the recruitment of participants with a range of demographic  
14 characteristics, including gender, level of experience and geographical location, although  
15 generalizability is not an essential feature of qualitative research. A challenge associated  
16 with qualitative research is the ability to ensure data saturation. The interviews were  
17 therefore continued until no new themes emerged, which was felt to indicate attainment of  
18 adequate depth. Preconceptions of the interviewer based on the research topic was  
19 mitigated by the involvement of a non-dentally qualified qualitative researcher in  
20 discussions and data analysis. Although, the participants were made aware of the  
21 interviewer being an orthodontic trainee, this permitted more in-depth and focused  
22 discussion.  
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## 29 **CONCLUSIONS**

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32 The following were found to affect extraction choices among orthodontic specialists:  
33 patient-related factors, operator factors, setting, mechanical approaches and self-directed  
34 ongoing education (both formal and informal). The extent of these influences on individual  
35 clinicians may be moderated by their level of experience, patient demographics and location  
36 of practice both in relation to geographical setting and method of remuneration.  
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## 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)
<b>Overall</b>	<b>20 (11 female, 19 male)</b>	<b>15.2 (1-32)</b>

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

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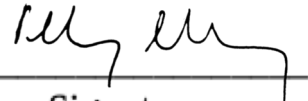
Figure 1: Overview of themes and associated barriers and enablers in relation to extraction decisions among the respondents

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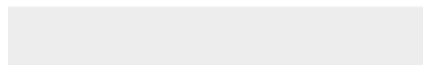
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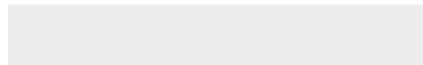
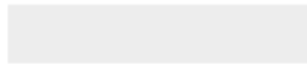






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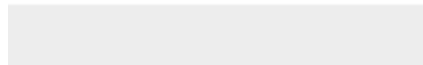
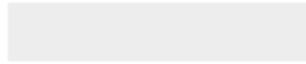
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## CRediT Author Statement

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
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