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Extraction of premolars for orthodontic reasons on the decline? A cross-sectional survey of BOS members

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Abstract

Objective: To obtain the opinion of British Orthodontic Society (BOS) members in relation to possible patterns of prescription of orthodontic extractions over the past 5-10 years and to relate any changes identified to treatment objectives, facial and smile aesthetics, and treatment strategies and adjuncts.

Design: Cross-sectional questionnaire

Setting: On-line survey of BOS members

Methods: A 14-item on-line questionnaire was sent to orthodontic practitioners for completion. The questionnaire covered demographics, possible changes in frequency of prescribed extractions with specific information concerning the effect of patient age, and the influence of other factors including alternative approaches to space creation, evolving treatment mechanics, smile and facial aesthetics, and retention protocols.

Results: Two hundred and eight responses were obtained with 95.6% (n=199) reporting reduced extraction prescription over the last 5-10 years. Overall, 29.9% and 35.5% felt that their threshold for extractions had increased by more than 2mm in adolescents and adults, respectively. Facial (n= 145; 69.7%) and smile (n= 127; 61.1%) aesthetics, and increased use of inter-proximal reduction (n= 102; 49%) were the factors most frequently reported as having either a moderate or major influence on this trend. Based on ordinal logistical regression analyses, no significant relationship was found between threshold for extractions and work setting (P= 0.675; O.R. 0.51; 95% CI: 0.39, 1.85) or level of orthodontic experience (P= 0.15; O.R. 1.02; 95% CI: 0.15, 1.05), although a higher threshold for extractions was more likely among users of conventional than self-ligating brackets (P= 0.001; O.R. 4.74; 95% CI: 1.95, 11.5).

Conclusions: A reduced tendency to prescribe orthodontic extractions over the past 5-10 years among British Orthodontic Society members was identified. Comparative clinical research exploring the relative merits of extraction and non-extraction approaches could be timely.

Introduction

The decision to extract as part of orthodontic treatment has unquestionably been the most contested, and indeed occasionally acrimonious, debate within the specialty over the past century (Angle 1907). While Angle contended that it was possible to accommodate a full complement of teeth, this belief was debated intensely (Dewel 1964). Moreover, in the mid-20th Century, Angle's supporters drew attention to both the instability and aesthetic implications of a non-extraction approach, prompting a shift towards the increased prescription of mid-arch extractions as part of orthodontic treatment (Tweed 1945; Begg 1954).

This trend towards an increased prescription of extractions has now reversed, however, with a decline in premolar extractions over the past 30 years. Proffit (1994) highlighted that the proportion of orthodontic patients who had extractions at the University of North Carolina peaked at 76% in 1968, before dropping to 28% in 1993. One of the major changes was the reduced prescription of first premolar extractions, which was ascribed to the development of bonded fixed appliance systems, wider acceptance of fixed retention, and the implications of extraction-based treatment on facial appearance. Within the same university setting, Jackson et al. (2017) noted a further reduction in extraction frequency, to as low as 25% after 2006 and this was intuitively linked to pre-treatment characteristics, such as higher levels of crowding, increased overjet, Class II relationships and reduced overbite. A decline in the prevalence of extraction was also shown in a Brazilian university-based study, from 86% of patients in 1973 to 46% in 2007; again there was a reduction in extraction of first premolars (Janson et al. 2014). This trend was linked to the purported association between extraction and temporomandibular joint dysfunction, and to the increased usage of growth modification, inter-proximal enamel reduction and maxillary expansion.

While the frequency of premolar extractions has fluctuated over time, the rationale has altered little. Notwithstanding this, a 40% increase in the severity of dental crowding in the human population over the last 100,000 years has been inferred based on objective data being attributed to progressive reduction in jaw size and decreased inter-proximal wear due to dietary changes (Peck, 2017). It has therefore been argued that extractions are an 'essential compensatory method' with 15% to 25% of patients in Europe and North America likely to require extractions to reposition the remaining teeth in the most stable position (Peck 2017). Removal of premolars continue to represent a predictable means of providing space to achieve treatment outcomes, including relief of crowding and overjet correction (Kirschen et al. 2000). Clearly, however, a range of extraneous factors have influenced premolar extraction rates, including patient acceptance, as well as technological improvements that have been purported to reduce the need for removal of teeth. Notwithstanding these factors, relatively little is known about changes in the perceived need for premolar extraction for adolescent and adult patients among UK specialists in orthodontics, or indeed concerning the influence of specific clinical factors and technological advances.

The aim of the present study was to obtain the opinions of British Orthodontic Society members regarding any changes in their tendency to prescribe orthodontic extractions in recent years. The specific research questions were:

- What percentage of BOS members judge that the proportion of orthodontic patients they refer for extraction has changed?
- If the proportion of patients treated with extraction has changed, are there any identifiable patterns relating to treatment objectives, facial and smile aesthetics, and treatment strategies and adjuncts?

Methods

Ethical approval was obtained from the Queen Mary Research Ethics Committee (QMREC2052a) for an on-line questionnaire-based survey. Following initial piloting with 8 orthodontic specialists and trainees who provided written feedback on the design, the survey was modified and a 14-item online questionnaire was developed. This was distributed through the British Orthodontic Society mailing lists, with the exception of the trainee database, in February 2018 to obtain data from all Society members involved in independent practice (specialist and non-specialist members). The questionnaire was compatible with mobile devices and

was designed for online, electronic completion (www.ole.co.uk). Accompanying explanatory information was given and respondents were advised that the survey should take less than 10 minutes to complete. Two reminder emails were sent following the initial email with a minimum period of 3 weeks allowed for completion before the survey was closed.

Initial questions included details of demographics (age, gender); years since qualification and geographical region of practice. Respondents were then asked if they had changed the proportion of patients they treated with extractions in the last 5 to 10 years. If they reported that this was unchanged, the survey was complete. If they reported a change in extraction frequency, they were asked specific follow-up questions in relation to tooth type and patient maturity; use of alternative methods of creating space; and factors influencing tendency to suggest extractions as part of an orthodontic treatment plan. The degree of influence associated of the following factors were considered:

- facial and smile aesthetics,
- temporo-mandibular joint (TMJ) health,
- appliance and anchorage systems,
- use of inter-proximal reduction (IPR) and reliance on transverse expansion and incisor proclination,
- periodontal and treatment duration implications,
- and retention and stability.

Further information in relation to answers could be given in free text boxes.

Data were entered into a Microsoft Excel ™ spreadsheet for analysis. Descriptive statistics were obtained including means (and SD) for continuous variables and frequencies (%) depending on the nature of the responses. Ordinal logistical regression analysis was used to investigate the association between estimated threshold space requirement prompting extractions according to clinical setting (private and mixed vs. public sector), level of operator experience in orthodontics (in years), and bracket type (conventional or self-ligating brackets; SLB). Statistical analysis was undertaken with software (SPSS, Version 22, New York, USA) with a threshold level of statistical significance of $P< 0.05$.

Results

A total of 208 responses from approximately 1,250 members were obtained giving an estimated response of 16%. The majority of respondents (n= 183; 88%) worked in specialist practice, 30.3% (n= 63) were hospital-based Consultants and one-quarter worked in private practice settings (n= 53; 25.5%; Table 1). The mean duration of orthodontic experience was 22.4 years. The majority of respondents used a conventional pre-adjusted edgewise appliance routinely (n= 187; 89.9%), with 9.1% (n= 19) using self-ligating brackets most commonly. Most respondents trained with the pre-adjusted edgewise appliance (n= 178; 86%), although some trained with standard edgewise (n=21; 10.1%) and Begg (n=3; 1.4%) systems.

Overall, 95.6% (n=199) reported reduced extraction prescription over the last 5-10 years, with the majority reporting a decrease in both adults and adolescents (n=154; 74%). Overall, 29.9% felt that their threshold for extractions had increased by more than 2mm in the last 5-10 years in adolescents; the corresponding figure in adult patients was 35.1%. Among the possible factors explaining the reduced prescription of extractions, facial (n= 145; 69.7%) and smile (n= 127; 61.1%) aesthetics, and increased use of inter-proximal reduction (n= 102; 49%) were most frequently reported as having either a moderate or major influence (Table 2).

These findings were mirrored in the responses in relation to the treatment of moderate Class I crowding (4-7mm) in adolescents, with the majority (n= 148; 71.2%) less likely to prescribe removal of 4 first premolars. Similarly, the use of interproximal reduction (IPR) (n= 131; 63%), expansion (n= 115; 55.3%), incisor advancement (n= 130; 62.5%) and a combination of arch lengthening and IPR (n= 110; 52.9%) were all considered more likely approaches than 5 to 10 years previously. Distal movement of posterior teeth with temporary anchorage devices was reported to have some effect, with 26.4% (n= 55) relating their use to changes in extraction frequency (Table 3).

These findings were also reflected in adults based on an identical scenario. The majority of respondents (n= 142; 68.3%) were again less likely to prescribe 4 first premolar extractions. Moreover; 44.7% of respondents also felt that extraction of second premolars was less likely than previously in adult patients. Reliance on interproximal reduction in isolation as a mechanism of space creation was more common in adults than in adolescents (n= 131; 63%), although similar usage of expansion (n= 144; 69.2%) and incisor advancement (n= 133; 63.9%) as in adolescents was reported. Increased use of a combination of arch lengthening and IPR (n= 127; 61.1%) was marginally more prevalent than in adolescents (52.9%). Distal movement of molars, utilising temporary anchorage devices, again appeared to have less bearing on extraction decisions, with 26.4% (n= 55) citing an association.

In terms of threshold levels of crowding which might be treated without extractions, only 3 respondents (1.7%) were comfortable treating 8mm or more without extractions; this figure increased to 13% (n= 22) for 6-8mm, 45.6% (n=77) for 4-6mm, while 39.6% (n=67) were unhappy to suggest non-extraction approaches for crowding of more than 4mm (Table 4; Figure 1). Ordinal logistical regression analyses did not find any significant relationship between threshold for extractions and setting (private and mixed vs. public sector) or level of orthodontic experience. An association was found between bracket type and the threshold amount of crowding before choosing to extract with practitioners using a conventional bracket nearly 5 times more likely to select a higher threshold of crowding before extracting (P= 0.001; O.R. 4.74, 95% CI: 1.95, 11.5). The confidence limits for this probability were wide, however, due to the small numbers of respondents using self-ligating brackets routinely.

Discussion

This is the first survey of U.K. based orthodontists evaluating perceived extraction frequency and the factors thought to influence changes in the prescription of orthodontic extractions. A clear trend towards a reduced reported proportion of orthodontic patients treated with extractions emerged and this mirrors previous data from international surveys, based on archived data in the U.S. and Brazil (Proffit 1994; Janson et al. 2014; Jackson et al. 2017). This pattern appeared to apply both to adolescents and adults and was also reflected in a shift away from removal of first premolars, which may lead to more prolonged space closure and possible retraction of the anterior segments, depending on the presenting features of the malocclusion and treatment mechanics utilised.

It is difficult to identify specific reasons for declining extractions with a potential myriad of non-treatment related, extraneous factors including direct marketing to patients, perceived anxiety and discomfort related to extractions and unproven side effects of extractions being possible contributors. Nevertheless, the data do suggest an increasing reliance on the use of inter-proximal reduction both in adult and adolescent patients. This pattern may reflect evidence highlighting the compatibility of IPR with dental and periodontal health based on 10-year follow-up (Zachrisson et al. 2007). Clearly, however, there are potential risks associated with this procedure and due care and attention is required in order to avoid introduction of inter-proximal ledges, which may risk plaque accumulation and sensitivity.

A growing acceptance of incisor advancement also appeared to emerge from the data, suggesting that arch lengthening may be viewed as a more acceptable alternative to reduction in tooth substance in the management of tooth size-arch length discrepancy. This philosophy appears to contradict traditional teaching in relation to the avoidance of lower incisor advancement in view of the risk of relapse (Mills 1968). Moreover, while limited incisal proclination is typically compatible with periodontal health (Allais and Melsen 2003), in susceptible patients with vulnerable biotype this may risk undermining of periodontal support (Melson and Allais 2005). Interestingly, the association between lower incisor proclination and instability has remained unchallenged in recent years. Nevertheless, the growing acceptance of incisor proclination does not appear to have been reflected in an increased reliance on bonded retainers. This implies that non-extraction based approaches may be favoured despite the potential increased risk of instability. This observation corroborates findings from a survey of U.S. orthodontists which illustrated that clinical decision-making is influenced by a range of factors, including clinical experience and research findings (Madhavji et al. 2011). In a separate survey, U.S. orthodontists also alluded to changes in practice based on bracket choice with a reduced

propensity to extract with self-ligating brackets (Prettyman et al. 2012). This did not appear to be borne out in the present study, although relatively few practitioners (9.1%) reported preferred use of self-ligation. However, the impact of research data highlighting comparable arch form changes with conventional and self-ligating systems may account for this change in approach (Fleming et al. 2013; Scott et al. 2008).

The management of hypothetical cases was explored in relation to possible threshold levels of space requiring extractions: only 14.7% of respondents were comfortable advocating non-extraction approaches for children and 16.9% for adults with crowding in excess of 6mm of space requirement. The case presented may be somewhat arbitrary, but the data remains informative, with broadly similar results observed in adolescent and adult cases. This is perhaps unsurprising, although it would be intuitive to expect a reduced frequency of extractions in adults in view of the associated challenges associated with space closure and the propensity for reopening of extraction space in adults. Furthermore, removal of both first and second premolars was marginally less commonplace in adults than in adolescents. This also reflects a general shift away from first premolar extractions, which was uniformly reported in previous studies (Proffit 1994; Janson et al. 2014; Jackson et al. 2017). The present survey was based on practitioners' recollection rather than on objective data, but appears to suggest that these findings are mirrored in this U.K. sample, comprising of both hospital- and practice- based practitioners. No specific extraction trend in relation to extractions was noted with respect to place of work. This may reflect the relatively low sample size, with examples of divergent approaches based on settings and remuneration observed in other areas of healthcare (Brocklehurst et al. 2013; Rashidian et al. 2015).

The results of the present survey suggests that orthodontists in the U.K. are gravitating increasingly towards non-extraction based approaches. It is well-known that the level of evidence concerning the decision to extract is fraught with issues, including baseline confounding factors such as differences in relation to facial appearance, space conditions and other occlusal factors. The majority of research studies are non-randomised and these issues have been mitigated with statistical approaches including discriminant analysis (Paquette et al. 1992; Luppanapornlarp and Johnston 1993; Beit et al. 2017). Clearly, random allocation to treatment interventions is predicated on equipoise; the present study may suggest that equipoise in relation to extractions could exist in certain instances and implementation of focused selection criteria may facilitate random allocation in a comparison of extraction and non-extraction approaches. Alternatively, a prospective cohort study could be considered in view of possible reticence, both among practitioners and patients, to consider random allocation to extraction-based treatment. Clearly, known confounders would need to be recorded carefully with prolonged follow-up to ascertain the relative merits of either approach both in the short- and medium- term, particularly in view of the potential heightened risk of third molar impaction in subjects not undergoing mid-arch extractions (Brezulier et al. 2017).

The present study was limited by a relatively low response; nevertheless, on-line surveys are accepted as having much lower response rates than paper-based questionnaires (Nulty, 2008) and a reasonable number of responses was obtained, ensuring that the results are likely to be credible. Moreover, there is no reason to believe that non-response is associated with any form of bias pertaining to extraction prescription. Furthermore, a broad cross-section of opinion was obtained both in relation to geographic spread, level of experience and place of work. A further potential issue, which has already been highlighted, relates to the reliance on recall of extraction frequency and the present data could be complemented with objective quantification of extraction frequency, but this would almost certainly have reduced the percentage response further. The results from the present survey do, however, corroborate findings from comparable international analyses (Proffit 1994; Janson et al. 2014; Jackson et al. 2017) pointing to declining extraction frequency among U.K.-based clinicians, which cannot consistently be attributed to evolving treatment mechanics or adjuncts.

Conclusions

Based on the present subset of orthodontic practitioner members of the British Orthodontic Society the following can be concluded:

1. Members have a reduced tendency to prescribe orthodontic extractions over the past 5-10 years.
2. There is a growing reliance on inter-proximal reduction, but reduced extraction rates has not been accompanied by an increased use of fixed retention.
3. Further controlled clinical research exploring the relative merits of extraction and non-extraction approaches with prolonged follow-up and detailed evaluation of associated confounders could be considered.

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Table 1. Demographic characteristics of the respondents (n= 208).

Demographics	**n = (%)**
Female	91 (43.8%)
Male	115 (55.3%)
Prefer not to say	2 (1%)
Clinical Setting (1 or more per respondent)	
NHS Specialist Practice	43 (20.7%)
Mixed Specialist Practice	87 (41.8%)
Private Specialist Practice	53 (25.5%)
Hospital: Consultant	63 (30.3%)
Hospital: Non-Consultant	18 (7.9%)
Community Service	5 (2.2%)
General Dental Practice	25 (12%)
Other	1 (0.5%)
Geographic region	
Scotland	23 (11.1%)
Northern Ireland	7 (3.1%)
Wales	4 (1.8%)
North-East England	18 (8.7%)
North-West England	22 (10.6%)
Midlands (England)	40 (19.2%)
Greater London	26 (12.5%
South-West England	30 (15.4%)
South-East England	38 (18.3%)

Table 2. Degree of influence of various factors on extraction decisions

	No Influence	Minor Influence	Moderate Influence	Major Influence
Facial Aesthetics	9.1%	21.2%	43.3%	26.4%
Smile Aesthetics	8.7%	30.3%	40.4%	20.7%
TMJ Symptoms	80.8%	15.9%	2.4%	1%
Appliances Used	40.4%	27.9%	22.1%	9.6%
Increased use of IPR	13%	38%	34.1%	14.9%
Increased use of Transverse expansion	19.7%	42.3%	31.3%	6.7%
Periodontal Implications	35.1%	36.5%	23.6%	4.8%
Stability due to effect of extractions	39.4%	38.9%	16.8%	4.8%
Treatment duration	27.4%	41.8%	26.4%	4.3%
Change in mode of anchorage supplementation	30.8%	34.1%	26%	9.1%
Change in rate of usage of bonded retainers	40.9%	28.4%	21.6%	9.1%

Table 3. Change in approaches to managing moderate crowding in a Class I case compared to 5-10 years ago

	More likely than 5-10 years ago		**Less likely than 5-10 years ago**		**Unchanged**	
	Child	Adult	Child	Adult	Child	Adult
Extraction of all 1st premolars	1.9%	1.4%	71.2%	68.3%	26.9%	30.3%
Extraction of all 2nd premolars	33.2%	20.2%	38%	44.7%	28.8%	35.1%
Other extractions	10.6%	14.9%	16.3%	14.4%	73.1%	70.7%
Distal movement with TADs	26.4%	25%	10.1%	6.3%	63.5%	68.8%
Inter-proximal reduction	63%	74.5%	3.8%	0.5%	33.2%	25%
Transverse expansion	55.3%	54.8%	3.8%	2.9	40.9%	42.3%
Incisor proclination	62.5%	63.9%	5.8%	1.9%	31.7%	68.8%
Combination of IPR and arch lengthening	52.9%	61.1%	3.4%	1%	43.8%	38%

Table 4. Reported upper threshold for non-extraction approach to treatment.

Estimated space requirement prompting decision to extract	Respondents: n= (%)	
	Child patients	Adult patients
Above 8mm	3 (1.7%)	6 (3%)
Up to 6-8mm	22 (13%)	29 (13.9%)
Up to 4-6mm	77 (45.6%)	92 (44.2%)
Up to 4mm	67 (39.6%)	81 (38.9%)

Table 5. Ordinal logistic regression analysis of likelihood of suggesting extraction for low (0-4mm), moderate (4-6mm) or high (>6mm) space requirements.

Predictor	Odds Ratio	P	95% CI
Setting			
Setting: Private/Mixed practice vs NHS	0.51	0.675	0.39, 1.85
Appliance (Conventional vs SLB)	4.74	0.001	1.95, 11.50
Experience (years)	1.02	0.15	0.99, 1.05

Figure 1. Threshold level of crowding associated with decision to extract among child and adolescents and adults.

