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IN BRIEF

- There is no good evidence that orthodontics cures or causes temporomandibular joint dysfunction
- Extracting teeth does not inevitably result in an altered profile
- There is a need for better quality research in many of the controversial areas in orthodontics

Orthodontics. Part 7: Fact and fantasy in orthodontics

P. Williams[1], D. Roberts-Harry[2] and J. Sandy[3]

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Clinical research has previously lacked good methodology and much opinion was based on anecdote which is widely regarded as the weakest form of clinical evidence. There are few randomised control trials in orthodontics which support or refute areas of dogma. The number of randomised control trials is increasing significantly. There is currently however no good evidence that orthodontics causes or cures temporomandibular joint dysfunction, that appropriate extractions in orthodontics ruin patients' profiles, or that the orthodontist is able to significantly influence facial growth with appliances.

[1]Specialist Registrar in Orthodontics, [3]Professor of Orthodontics, Division of Child Dental Health, University of Bristol Dental School, Lower Maudlin Street, Bristol BS1 2LY; [2]*Consultant Orthodontist, Orthodontic Department, Leeds Dental Institute, Clarendon Way, Leeds LS2 9LU
*Correspondence to: D. Roberts-Harry
E-mail: robertsharry@btinternet.com

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Orthodontics, like other fields of medicine and dentistry has its fair share of controversies. Some of these controversies have haunted the profession since its inception and some individuals may be reluctant to change their treatment philosophies in the light of new clinical evidence.

Orthodontics has evolved from many years of clinical experience, in which the opinions of respected individuals during the birth of the speciality have determined how orthodontics should be practised. A problem with this form of teaching is that it is based on anecdotal experience rather than sound scientific evidence. New research often highlights inadequacies in these fundamental teachings, eventually leading to a change in clinical practice. A trend is emerging towards evidence-based rather than opinion-based decisions as more and more structured research is published.

EVIDENCE-BASED DECISIONS

Evidence-based dentistry can be defined as: 'the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients'.[1] The 'gold standard' is strong evidence from at least one published systematic review of multiple well-designed randomised controlled trials. Meta-analysis is a form of systematic review looking at all the relevant literature whether good, bad or indifferent and producing a single estimate of the clinical effectiveness. The advantage of meta-analysis is that it summarises the available evidence and because of its systematic nature it can be appraised rapidly and applied to patient care.[2]

There are various levels of evidence beneath the 'gold standard', of which the weakest is anecdotal evidence. In the field of orthodontics there are few well-designed randomised controlled trials which lend themselves to a systematic review. Currently there are two such reviews, namely the change of intercanine width following orthodontic treatment and the treatment of posterior crossbites.[3,4]

Recently, media attention has focused on views made by a small number of orthodontists and general dental practitioners on the adverse effects of conventional orthodontic treatment. Much of this has centred on the role of extracting teeth as part of orthodontic therapy to align teeth, retract protrusive incisors and to camouflage dentally any skeletal disharmonies between the mandible and the maxillae.

Summary of evidence-based dentistry

- Anecdotal evidence is the weakest form of evidence
- 'Gold standard' is a randomised controlled trial
- Orthodontics has little 'gold standard' evidence

ORTHODONTICS AND TEMPOROMANDIBULAR DYSFUNCTION

Relatively recently, orthodontists have been concerned about the possibility of a link between the orthodontic treatment they provide and temporomandibular dysfunction (TMD) which is a

Temporomandibular joint problems are not caused or cured by orthodontic treatment

Litigation forced orthodontists into generating objective scientific research into the effects of orthodontic treatment

common finding in the population. Longitudinal studies show that the prevalence of signs and symptoms of TMD increases with age and that the prevalence of signs is greater than the prevalence of symptoms. It has a variable incidence in an adolescent population between 5–35%.[5]

Most of the attempts at relating TMD to orthodontic treatment have been based on anecdotal evidence or retrospective studies, approaches that cannot demonstrate a cause and effect relationship between treatment and disease. An opinion held by a few was that occlusal interferences induced by orthodontic treatment would lead to TMD. This extended to the suggestion that orthodontic treatment is needed for those whose occlusion is not functionally optimal to prevent the development of TMD. A functional occlusion was defined as one in which intercuspal position should coincide with retruded contact position, there should not be any balancing side interferences and there should be anterior and canine guidance. Guidelines such as these are often referred to as treating to a 'functionally optimal occlusion' and were advocated by a group of 'functional orthodontists'. One viewpoint from a group of 'functional orthodontists' is that when premolar teeth are extracted for orthodontic treatment this leads to TMD because of over retracting the upper incisors during space closure, forcing the condyle into a posterior position. It is this posterior position of the condyle within the fossa, which is presumed to cause an anteriorly displaced disc and therefore TMD.[6] It was also believed that occlusal interferences would lead to TMD, as well as tooth wear, periodontal disease and instability of tooth position after orthodontic treatment if the position of the condyle was not 'rear most, mid most and upper most'. Roth demonstrated that the symptoms of TMD could be resolved once they were equilibrated with occlusal positioning splints.[7] However, these conclusions were reached after Roth had evaluated only nine patients post treatment and two of these acted as controls.

The debate concerning a relationship between orthodontic treatment and TMD came to a head in 1987 following a lawsuit, Brimm vs Malloy, in which it was claimed that orthodontic treatment had caused TMD in a patient. During the trial, the lack of good scientific evidence investigating the effects of orthodontic treatment and TMD was highlighted and prompted the formation of the American Association of Orthodontics Temporo Mandibular Joint Research Programme. This is perhaps the first time that orthodontists realised the lack of objective, scientific research into the effects of orthodontic treatment. Only recently has stronger evidence been forthcoming in assessing the role of orthodontic treatment with respect to TMD.

A number of studies have examined the position of the condyle and its relationship with TMD. They found that individuals with 'normal' joints (ie none have reported any signs or symptoms of TMD) had condyles that could be observed, randomly distributed, in anterior, centric and posterior positions in the glenoid fossa.[8] A posterior position of the condyle within the glenoid fossa cannot therefore be taken as proof of TMD.

When orthodontic treatment involves the extraction of upper first premolar teeth and the retraction of the upper incisors some have suggested that this predisposes the patient to TMD by posteriorly positioning the condyle. Some light has been shed on this position in a study of 42 patients with a Class II Division 1 malocclusion treated by the extraction of both upper first premolars and fixed appliances. Seventy per cent showed a forward movement of mandibular basal bone and the changes in condylar position did not correlate with incisor retraction (ie orthodontic treatment caused a transitory forward position of the condyle in the intercuspal position with a return to the pretreatment position after treatment). It was therefore concluded that orthodontic treatment involving the loss of premolar teeth did not cause TMD and this has been supported by the finding of other workers.[9,10]

The suggestion that orthodontic treatment causes a posteriorly positioned condyle, which in turn leads to TMD, appears to be ill founded. The clinical studies published so far conclude that orthodontic treatment has no role in worsening or causing TMD when treated patients are compared with untreated patients with or without a malocclusion.[11]

The final question that should be addressed is the need to treat our orthodontic cases to a 'functionally optimal occlusion'. There is little clinical evidence to suggest that such an occlusion has any benefits in terms of reducing the following:

- Tooth wear
- TMD
- Periodontal disease
- Instability of tooth position

Indeed intercuspal position rarely coincides with retruded contact position in a good occlusion and it has yet to be shown that canine guidance has an effect of preventing or curing TMD. A natural dentition with canine guidance will tend to become group functioning with time as the canines wear. Furthermore canine guidance does not seem to offer any protection against TMD.[12]

Although canine guidance is often advocated as the functioning mode of choice, it is often an unobtainable aim for a substantial proportion of orthodontic patients. A study investigating the frequency of group function and canine guidance patterns of occlusion as related to the Frankfort-mandibular plane angle found the following. It showed a positive relationship between canine guidance and low Frankfort-mandibular plane angles and of group function to high Frankfort-mandibular plane angles.[13] This would suggest that facial morphology may indicate which functional goal to aim for.

There are no clear occlusal objectives for orthodontic treatment although there are many occlusal goals which have been suggested. Occlusal goals are those directed at the relationship of the teeth both in static intercuspal position and during function. Andrews introduced his six keys to a normal occlusion as a means of obtaining a static intercuspal position that is seen as ideal.[14] A summary of these six keys is given below:

- Class I molar relationship
- Correct crown angulation
- Correct crown inclination
- No rotated teeth
- No interdental spaces
- Flat occlusal plane

In practice, orthodontically treated occlusions seldom achieve all occlusal keys because of differences in skeletal pattern and tooth size discrepancies.[15] It has however been shown that well intercuspated teeth may be more stable and less likely to relapse.[16]

There is a general agreement that intercuspal position should coincide with retruded contact position although there is a disagreement as to how closely they should coincide. The majority of the population have been shown to exhibit a discrepancy between the two positions with no ill effects. It seems sensible therefore to accept small discrepancies of approximately 1 mm or so of each other.

Summary of orthodontics and TMD
- Extracting teeth does not cause a posteriorly positioned condyle
- Orthodontics does not cause TMD

THE EXTRACTION VERSUS NON-EXTRACTION DEBATE

The extraction of teeth as part of orthodontic treatment continually causes controversy. Teeth are extracted for several reasons in orthodontics. The most common reason for extraction is the relief of crowding and the need to create space to gain good alignment of the teeth. The reduction of overbite and the correction of an increased overjet to obtain a Class I incisor relationship are also important issues to consider where extractions will be required.

Edward Angle was very influential during the 1890s in developing orthodontics as a speciality, with himself as the 'father of modern orthodontics'. He is credited with much of the development in the concept of occlusion in the natural dentition and a classification of malocclusion.

Angle believed in non-extraction orthodontic treatment and that every person had the potential for an ideal relationship of all 32 teeth. He was also concerned with the ideal facial aesthetics which he felt could be achieved when the dental arches had been expanded so that all the teeth were in ideal occlusion. Angle did not come to this expansion philosophy through clinical research but was convinced by the ideas of influential people of his time, namely Rousseau and Wolff. It was felt by Rousseau, a philosopher, that many of the ills of modern man were due to the environment we now live in and emphasised the 'perfectibility of man'. Therefore from an orthodontic perspective, a perfect occlusion could never be achieved by the extraction of teeth. In the early 1900s Wolff, a physiologist, demonstrated that remodelling of bone could occur in response to functional loading. Angle therefore reasoned that if teeth were placed in a proper occlusion, forces transmitted to the teeth would cause bone to grow around them. He went as far as describing his edgewise appliance as the 'bone growing appliance'. Any relapse seen in any of his treated cases was attributed to an inadequate occlusion.

It was not until the 1930s and the 1940s that this non-extraction rule advocated by Angle was challenged by Tweed and Begg. They both felt that a malocclusion was an inherited condition and dismissed the notion about the 'perfectibility of man'. Tweed argued about the poor long term stability of expanded dental arches and decided to retreat many of Angles cases by extracting four first premolars. He publicly demonstrated 100 consecutively treated patients claiming a more stable occlusion after extraction based treatment. An appliance system was created by Begg, which was designed to be used on extraction based treatments, which popularised this treatment approach.

The extraction debate has reopened recently, especially in North America, because of concerns of litigation if extraction based treatment philosophies are used. In recent years there has been a trend towards non-extraction treatment as studies have shown that even cases treated with the extraction of first premolars are not guaranteed a stable result.[17]

Summary of the extraction versus non-extraction debate
- Changing trends over the years in extraction/ non-extraction based treatment
- Arch expansion shows worst levels of relapse
- Extracting teeth does not guarantee future stability
- Each case should be properly treatment planned to give greatest future stability

DOES EXTRACTING TEETH DAMAGE FACES?

Some practitioners in recent years have shown anecdotal evidence that extracting teeth for orthodontic purposes ruins a patient's profile and compromises their facial aesthetics. It has been claimed that the orthodontic extraction of teeth may cause less attractive smiles with dark buccal spaces lateral to the buccal segments, known as the 'dark buccal corridor', and also by the retraction of the upper incisors when closing

Orthodontic treatment on an extraction or non-extraction basis will still show some relapse in most cases

the remaining extraction spaces giving a 'dished in' aged appearance.

These practitioners advocate a non-extraction approach to treatment on the basis that it will produce a more youthful, protrusive facial profile – a view held by Angle some one hundred years ago. The opinion that non-extraction treatment is better than extraction treatment when assessing facial attractiveness is clearly misinformed given the studies that have now been carried out.

There is a relationship between retraction of the upper incisors and the posterior movement of the upper lip but for any given individual this is unpredictable. Indeed, when the upper incisors are retracted by 5 mm it has been shown there is on average 1.4 mm posterior movement of the upper lip.[9] Those patients treated on an extraction basis have been found to have slightly more prominent lips compared with those treated on a non-extraction basis at the end of treatment.[18,19] It is of note to mention that in the extraction group they tended to have more prominent lips before commencing treatment because of an increased overjet, an important consideration when treatment planning these patients. There are many patients who have been treated on a non-extraction basis with a 'dished in' appearance and many other patients with fuller profiles who have had four teeth extracted as part of their orthodontic treatment. An important consideration before deciding on whether treatment is going to proceed on an extraction or non-extraction basis is the profile of the patient before treatment. It is important at this initial stage of assessment and planning to identify which patients are vulnerable to worsening an already flat or 'dished in' profile as they may not be amenable to orthodontic treatment alone and may require a combined surgical and orthodontic approach.

Lay populations and patients cannot perceive significant profile changes after appropriate orthodontic treatment which may or may not involve orthodontic extractions

A question frequently raised is that of the differences in facial appearance if the same mildly crowded case was treated on an extraction or non-extraction basis. What would we expect to see at the end of treatment? One such retrospective study has addressed these issues by analysing the impact of extractions on the lip morphology in borderline Class II Division 1 malocclusions. In the extraction group where four first premolars were removed the lower incisors were on average 2 mm posterior and the lower lip 1.2 mm posterior when compared with a non-extraction group. It was seen that the non-extraction group had 2 mm fuller profile, although both groups were happy with their aesthetic appearance.[19]

Clinicians tend to be very critical about the changes, both in terms of the hard and soft tissues, which are brought about as a result of orthodontic treatment whether or not extractions have been carried out. Therefore the general public's perception about the profile of our patients after treatment should be given some thought. A timely and relevant study of the public's perception of the changes in profile of patients treated for a Class II Division 1 malocclusion concluded that they preferred the profile changes more in the extraction group compared with the non-extraction group. There was no preference for the profiles for either group two years after treatment.[20] It would seem then that there is no evidence to suggest that extraction based treatment when prescribed correctly 'damages faces'.

Summary of extracting teeth and damaged faces

- No evidence to suggest that extracting teeth in appropriate cases causes a 'dished in' appearance
- Lay opinion finds both extraction and non-extraction treatment equally pleasing

SHOULD WE EXTRACT SECOND MOLARS AS PART OF ORTHODONTIC TREATMENT?

There are said to be many advantages in extracting second molars as part of orthodontic treatment. These advantages include the following:

- Less detrimental to facial profile
- Facilitates the eruption of third molars
- Spontaneous relief of crowding in the premolar region
- Prevents crowding in a well aligned lower arch
- Aids distal movement of the buccal segments with extra oral traction
- Shorter treatment time
- Functional occlusion is better

It can be seen that it is an impressive list of advantages! There are however several considerations that need to be taken into account before extracting second molar teeth with radiological evaluation of third molar development essential. All third molars should be present, and have good size, shape and position.

The idea that extracting second molars is less detrimental to the facial profile is an interesting concept, given that the tooth to be extracted is in a more posterior position in the mouth compared with premolar teeth and is therefore thought less likely to adversely affect soft tissue profile. One study investigated this claim by comparing the effects of different extraction patterns on the facial profile between two groups, those treated by first premolar extraction and those by second molar extraction. They found the average decrease in the soft tissue angle of facial convexity of 1.7° for the second molar extraction group and 2.2° for the first premolar group. However, these reductions were not statistically significant and it must be remembered that these patients were not derived from the same population, as they were not randomised to one of the extraction patterns.[21]

The ideal time for extracting second molars is controversial, some studies have suggested the best time to extract them is when the third

molar crown is fully formed and others claim they should be extracted as soon as they erupt into the mouth. The evidence suggests that the importance of timing second molar extractions is not yet known. One disadvantage of extracting second molars is the 'predictably unpredictable' nature of third molar development and eruption. A number of studies have shown that third molar eruption is often unsatisfactory, including improper angulation and contact relationship with the first molar. This is seen ranging from 4–25% of cases[22] and raises doubts on the length of treatment time for second molar extraction cases compared with other extraction strategies. The loss of second molar teeth obviates the need for space closing mechanics but a second course of treatment may be required to orthodontically upright third molars at a stage in late adolescence when co-operation may not be at its best.

An important reason for elective extractions in orthodontics is the relief of crowding. First premolar teeth are ideally located as they provide up to 14 mm of space for the relief of crowding both anteriorly and posteriorly to the extraction site. Second molar teeth can provide some 18–22 mm of space, of which little is made available to the relief of crowding in the lower labial segment where crowding most often occurs. Given that arch length deficiencies rarely exceed 10 mm the removal of a second molar tooth and the space it provides seems a little excessive. However, if the premolar region is crowded by 4–5 mm then the removal of second molar teeth may provide sufficient space for spontaneous relief of premolar crowding. The relief of molar crowding in the early permanent dentition is an indication to extract second molars and it may also prevent late lower arch crowding.[23]

Many of the advantageous claims made for the extraction of second molar teeth are unsubstantiated. There is no evidence to suggest that treatment times are shorter, that distal movement of the first maxillary molar is enhanced and that there is less effect on the soft tissue profile. The benefits of extracting second molars appear to be relief of mild premolar crowding in the early permanent dentition but eruption of the third molar needs careful review and the possibility of a later additional course of orthodontic treatment needs to be made clear to the patient.

Summary on the extraction of second molars

- Many of the claimed advantages are unsubstantiated
- Evidence suggests relief of molar and premolar crowding is an indication
- Third molar development is 'predictably unpredictable' and may need further treatment to orthodontically upright them

THE 'ORTHOPAEDIC EFFECT' — CAN WE INFLUENCE GROWTH?

The potential to influence growth, whether it is promoting growth in a Class II malocclusion or restricting growth in a Class III malocclusion, remains an area of significant controversy. A number of studies have looked into the possibility of modifying growth with orthopaedic appliances and the results are liberally interpreted to suit the position of the challenger. An 'orthopaedic effect' is taken to mean a change in the position of the cranio-facial skeleton in relation to each other as the result of orthodontic treatment. This change should be permanent in its amount and direction.

Functional appliances have been used for many years for the correction of Class II malocclusions. Despite this long history there continues to be much debate relating to their use, mode of action and effectiveness. Undoubtedly, normal dentofacial growth has a genetic drive but may be influenced by environmental factors. There is no doubt that functional appliances can rapidly correct Class II malocclusion but this does not indicate or prove an 'orthopaedic effect'.

Some practitioners like to claim they can 'grow mandibles', but what is the evidence? Many studies find an increase in mandibular length of 1—2 mm per annum during active treatment.[24] Much of the work demonstrating the ability of functional appliances to stimulate mandibular growth is based on animal experimentation. A maximum of 5—15% increase in mandibular length by stimulating condylar growth can be expected in experimental animals under controlled conditions and during periods of active growth.[25] Animal experimental research is often cited as evidence but cautious interpretation of the results is required before it is applied to patients.

There is evidence from prospective randomised controlled trials that the effects of functional appliances may be transient, with reversion to pretreatment growth patterns over the short or long term.[26] Therefore this short-term growth enhancement is useful to correct incisor and molar relationships but does not result in a longer mandible. They produce their effects mainly by dentoalveolar changes such as retroclination of upper incisors and proclination of the lower incisors.[27]

An orthopaedic change has also been attempted in Class III malocclusions where it is largely assumed that the fault lies with a prognathic mandible. Hence chin cup treatment, once popular, was directed at restraining further mandibular growth and allowing maxillary growth to 'catch up' and therefore correct the anterioposterior component of a Class III malocclusion. A long-term study looking at the effect of chin cup therapy found that it was effective in reducing mandibular prognathism before puberty but this was then lost after puberty ie a short-term gain similar to that seen with functional appliances. Indeed, there was no difference in

The orthodontist's ability to influence facial growth is limited and much of the change that is seen relates to dento alveolar changes

the final skeletal profile of the mandible between treatment groups and control groups who did not receive treatment.[28]

However, there appears to be a promising method of achieving an 'orthopaedic effect' with the use of protraction headgear. Several workers have shown that a small but significant anterior movement of the maxillae using protraction headgear during the mixed dentition is possible which has remained stable some 2 years after treatment.[29]

In summary, orthodontic appliances that deliver an orthopaedic effect may induce a temporary improvement in the skeletal relationship. There is no evidence at present to show that orthodontic treatment can effectively restrain or enhance cranio-facial growth that is otherwise inherited by the individual.[30]

Summary of the current evidence on the 'orthopaedic effect'

- Orthodontic treatment cannot influence growth in the long term
- Any gain is small but is often lost in the long term
- Majority of the 'orthopaedic effect' is dentoalveolar tipping of the teeth

We have chosen four areas of smouldering controversy, not to rekindle historic arguments or generate a new turf war but to illustrate the somewhat flimsy evidence both sides of an argument can use. Forceful opinion currently dominates any cautious interpretation of the existing literature. Given time, the quality of the data and research will improve and as a consequence more definitive statements on true effects of treatment will be possible.

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