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Changes in Orthodontic Treatment Modalities in the Past 20 Years: Exploring the Link between Technology and Scientific Evidence

T. Gerard Bradley

Marquette University, thomas.bradley@marquette.edu

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Précis

Technology drives the market in orthodontics, with claims of better results in less time. In many instances the evidence for such changes is lacking.

Abstract

Statement of the issue: Is there a link between the many perceived advances in orthodontic techniques/therapy and science in the past 20 years? The purpose of this paper is to take five topics and match the perceptions with the scientific evidence. The variety of appliances and the swings in treatment philosophy have been dramatic, including the swing from extraction to non-extraction therapy, the introduction of space-age wires, appliances that grow mandibles, the introduction and extraordinary growth of Invisalign, and reduced friction brackets to reduce treatment time, all with claims by manufacturers of better results than ever before. The focus is on faster treatment, reduced visits/appointments and superior results. Most of these 'advancements' represent what has been the 'juggernaut of technology'.

Materials and methods: Five questions are posed, and an evidence-based approach is used to critically examine the literature in these selected topics.

Results: The evidence is lacking for some of the most commonly used systems and materials in orthodontic practice today.

Conclusion: More randomised clinical trials are needed in orthodontic practice to evaluate treatment outcomes.

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T. Gerard Bradley BDS MS

Address for correspondence:

Dr T Gerard Bradley

Professor and Chair,

Developmental Sciences,

Marquette University School of Dentistry,

1801 W. Wisconsin Ave,

Milwaukee, WI 53233,

USA

E: thomas.bradley@marquette.edu

Evidence-based dentistry and the pyramid of evidence

Evidence-based dentistry, as defined by the American Dental Association¹ and adapted by the American Association of Orthodontics, is "an approach to oral healthcare that

requires the judicious integration of systematic assessments of clinically relevant scientific evidence, relating to the patient's oral and medical condition and history, with the dentist's clinical expertise and the patient's treatment needs and preferences".

The hierarchy, or pyramid, of evidence has no universally accepted format, but there is general agreement that at the highest level, or tip, of the pyramid is systematic reviews of randomised clinical trials (RCTs), and at the lowest level is expert opinion.² The Centre for Evidence-Based Medicine (CEBM) at the University of Oxford has adapted a hierarchy of evidence from 1 to 5, with 1 as the highest and 5 as the lowest (Table 1), and grades of recommendation, with A as the highest, and D as the lowest (Table 2). In clinical practice, the challenge is that the numbers of RCTs are limited, and there are logistical and ethical issues that make such trials difficult to accomplish. However, the clinician must be able to find the highest level of evidence, and make decisions for patient care that adhere to the standard of evidence-based dentistry.

For this article, five questions were selected and, using the tools described above, the current status of the scientific evidence is reviewed.

Table 1: Levels of evidence

Level	Therapy/aetiology
1a	Systematic review (SR) (with homogeneity) of RCTs
1b	Individual RCT (with narrow confidence interval)
1c	All or none case series (absolute better or absolute worse)
2a	SR (with homogeneity) of cohort studies
2b	Individual cohort study (including low quality RCT, e.g., <80% follow-up)
2c	'Outcomes' research; Ecological studies
3a	SR (with homogeneity) of case-control studies
3b	Individual case-control study
4	Case series (and poor quality cohort and case-control studies)
5	Expert opinion without explicit critical appraisal, or based on physiology, bench research or "first principles"

Source: Produced by Bob Phillips, Chris Ball, Dave Sackett, Doug Badenoch, Sharon Straus, Brian Haynes and Martin Dawes, since November 1998. Updated by Jeremy Howick, March 2009 (partial table) – <http://www.cebm.net/index.aspx?o=1025>.

Table 2: Grades of recommendation

A	Consistent level 1 studies
B	Consistent level 2 or 3 studies or extrapolations from level 1 studies
C	Level 4 studies or extrapolations from level 2 or 3 studies
D	Level 5 evidence or troublingly inconsistent or inconclusive studies of any level

'Extrapolations' are where data is used in a situation that has potentially clinically important differences to the original study situation.

QUESTION 1: Is non-extraction therapy more stable and less harmful than extraction of permanent teeth?

The trend in recent years has seen the extraction percentage fall from the peak of 73% in the 1960s in the US to the current level of approximately 26%.³ The reasons include but are not limited to:

- the association of extractions with a detrimental effect on the profile;
- an increased risk of temporomandibular problems; and,
- non-extraction therapy with comparable stability.

However, a review of the literature does not support these claims.^{4,5,6}

For the purpose of this paper, post-orthodontic stability was the primary focus of the literature review. Little and his group^{5,6} at the University of Washington concluded from retrospective cohort studies looking at patients 10 years and beyond, that satisfactory mandibular anterior alignment exists in only 30% of patients with extractions. In the expansion non-extraction group, this was only 19% after ten years. In a retrospective cohort study of 98 patients,⁷ half of whom were treated with four premolar extractions and half with non-extraction, the authors found that the incisors tended to return to the pre-treatment position, so in the extraction group the incisors proclined after being uprighted, and after non-extraction treatment they retroclined after being proclined. This was in agreement with a previous study,⁸ which found that the initial position of the mandibular incisor is the most stable.

Level of evidence: 3

Recommendation: C

Summary

The weight of the evidence that is available is that non-extraction therapy could be more problematic than extraction, highlighting the importance of careful consideration of all the options. The literature points to the long-term value of retention to hold the result rather than the appliance or technique used.⁹

QUESTION 2: Are Invisalign treatment results as effective as conventional fixed appliances?

Since the introduction of the Invisalign system in 1999 (Align Technology; Santa Clara, Calif., USA), the popularity of the system in terms of sales has grown enormously. However, a systematic review in 2010 concluded that there was no evidence to either support or reject the use of the appliance.¹⁰ This review had included two longitudinal trials^{11,12} and many case reports. Subsequent to these papers, the company has modified the acrylic used and refined the use of the attachments. There is evidence to suggest that certain types of tooth movement can be accomplished with this appliance, but movement such as torquing, extrusion and bodily movement are problematic.

Level of evidence: 3a

Recommendation: C

Summary

The weight of evidence currently available is weak, with the majority of case reports showing a preference for less complicated cases, while more recent case reports show its use in more complex malocclusions. In view of its widespread use, randomised controlled clinical trials are needed to evaluate treatment outcomes.

QUESTION 3: Do reduced friction brackets or self-ligating brackets (SLBs) make teeth move faster and get better treatment results than conventional edgewise (CE) brackets?

Many advantages have been claimed regarding the use of SLBs,^{13,14} such as:

- faster initial alignment and space closure;
- decreased treatment time with fewer appointments;
- reduced chair time;
- more alveolar bone generation;
- more expansion with less need for extractions;
- less proclination of anterior teeth;
- less pain experienced by patients;
- decreased frictional resistance and better sliding mechanics; and,
- decreased apical root resorption.

The use of SLBs among American orthodontists increased from 8.7% in 2002 to over 42% in 2008. There is not sufficient high-quality evidence to support the claims that SLBs are more efficient than CE appliances. Three systematic reviews consisting of eight randomised trials^{15,16,17} indicate that other than time saving during archwire tie in, no other claims have been supported by scientific evidence.

Level of evidence: 2a

Recommendation: B

Summary

The weight of the evidence is that SLBs offer no advantage over conventional brackets in all measurable outcomes of treatment other than the time at the chair side while tying in the archwire.

QUESTION 4: Is treatment for patients with deficient mandibles with one phase of treatment in the late mixed dentition as effective as having a growth-modifying appliance placed earlier and fixed appliances/growth modification later?

The best available evidence is a systematic review on early orthodontic treatment for patients with prominent upper front teeth.¹⁸ They selected studies that were RCTs and controlled clinical trials for children less than 16 years old. The authors narrowed their search down to three trials of 432 participants where early treatment with functional appliances was compared to no early treatment. Both functional appliances and headgear were evaluated as part of the early treatment, while the other group's treatment for prominent anterior teeth began in adolescence. The results showed no statistically significant differences in overjet, ANB, or PAR scores between the early and late treatment groups.

Level of evidence: 1a

Recommendation: A

Summary

The weight of the evidence is that one phase of treatment for mandibular deficiency is as effective as a two-phase approach involving intervention at an earlier age.

QUESTION 5: Do newer generations of orthodontic wires make teeth move faster and deliver less force?

The introduction of nickel-titanium archwires into orthodontic practice has made it the wire of choice by the majority of orthodontists for the initial levelling and aligning of teeth due to its superelasticity and springback properties. The majority of bench top and case reports over the years have highlighted the improved metallurgical properties of these wires compared to those of conventional stainless steel.¹⁹ However, in one systematic review in 2010²⁰ the authors point out, after reviewing seven randomised clinical trials with 517 participants, that there is little evidence to suggest that these wires offer significant clinical advantages. They conclude that the RCTs were of poor quality and that the result should be viewed with caution and more RCTs should be performed.

Level of evidence: 1a

Recommendation: B

Summary

The weight of the *in vitro* laboratory bench top evidence suggest that these wires have superior properties over conventional stainless steel wires but there is some evidence that there is no difference in the clinical outcome based on the RCTs on this topic.

Conclusion

Technology has driven the marketplace, with claims that results are better and faster. In many instances the evidence to support manufacturer claims are lacking. RCTs that look at clinical outcomes are needed. Claims by manufacturers of treatment efficiencies with advances in technology should be critically evaluated.

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