Orthodontic research: If we know the answers, are we asking the right questions? ☆

Kevin O'Brien

In this paper, I use the results of recently completed systematic reviews and randomized trials to introduce the concept that the results of orthodontic research are confined to values and "differences," which are only relevant to orthodontists and not our patients. As a result, a substantial amount of research findings may not be relevant to our patients. I will then suggest a way forwards so that relevant outcomes may be generated as part of a Core Outcome Set. (Semin Orthod 2013; 19:137–141.) © *2013 Elsevier Inc. All rights reserved.*

The best place to start this discussion is to consider whether malocclusion is a disease and, therefore, amenable to research involving patient-centered measures. Some have suggested that malocclusion is not a disease but a variation from a societal norm.[1] Others argue that severe malocclusion may be classified as a chronic disease.[2] If we accept the latter definition, it may be suggested that severe malocclusion fits into the World Health Organization framework of impairment, disability, and handicap definition of health and disease.[3] For example, impairment could be considered to be the appearance of the teeth, disability may be the ability to masticate food, and handicap could be the influence of teasing on a person with a severe malocclusion.

Over the years the relevance of this definition to oral health has been extensively debated and, perhaps, the best definition of oral health is the one proposed by Dolan

> Oral Health is a comfortable and functional dentition which allows individuals to continue in their desired social role.[4]

If we accept this concept, then we should consider that if we want to measure the degree that an intervention returns a person to a state of oral health then we should use outcomes that are relevant to this definition. As a result, they should include outcomes that are relevant to both providers and consumers of treatment.

What are outcome measures and outcome domains?

An outcome measure is the result of a test that is used to measure objectively a characteristic of a patient. Ideally, the same test can be used at the start and end of a course of treatment to measure the effects of any treatment. For example, orthodontists would commonly choose an occlusal index to measure the pre- and posttreatment alignments of the teeth.

Where several outcome measures evaluate a related concept, they can be combined to form an outcome domain. An example of this for orthodontic research may be a collection of cephalometric measurements that may be grouped together under the overall outcome domain of skeletal change.

What type of outcomes is used in orthodontic research?

When we consider the outcomes of orthodontic treatment that we traditionally measure, it is clear that we concentrate on values that are influenced by our "innate culture" in combination with a reliance on the availability of records that we take (and store) as part of the delivery of a course of orthodontic treatment. These outcomes tend to comprise numerical or visual recordings of study models, radiographs, and data extracted from

the patient record. The same could be said for the reduction in an overjet or change in ANB etc. Importantly, these outcomes are based on the morphological effects of treatment, and they do not address important issues of how the care was delivered, the process of care, and the way that the patients feel about themselves (disability). This latter point is of paramount importance when we consider both Dolan's model in that one of the aims of orthodontic treatment is to improve appearance and socio-psychological state.

This then moves us further toward the concept of patient-centered outcomes. These are outcomes that are important to patients. Importantly, they commonly include outcomes such as quality of life, self-esteem, and child behavior. As a result, it is clear that orthodontic research should include outcomes that are patient centered if we are to provide meaningful research. This is an important concept because a clinical study is only as relevant as the outcomes that are reported. For example, it has been suggested that if we confine our studies to outcomes that are only relevant to the providers of care, then we are at risk of carrying out research that is ineffective or that completely misses the point of providing care.[5]

This important point can be illustrated by reviewing the results of three Cochrane systematic reviews that our group has recently completed. These were into (i) the correction of increased overjets,[6] (ii) the effectiveness of implants in orthodontic anchorage,[7] and (iii) the effectiveness of methods of moving teeth distally.[8] These reviews were all registered with the Cochrane Collaboration, used standard Cochrane methodology, carried out to their high standards, and only included randomized controlled trials. I do not intend to go into the full details here, but I will outline some of the data that were reported.

Correction of increased overjets

This review included data from 15 RCTs. Four were concerned with evaluating the effect of early orthodontic treatment, and 11 looked at treatment carried out when the children were adolescents. The outcomes that were used in these studies are evaluated (Table 1).

Table 1. Outcomes identified from trials of Class II treatment

Outcome	Number of Studies
Cephalometric measures	15
Overjet	15
PAR scores	3
Incisal trauma	3
Self-esteem	2
Duration of treatment	6

From the included papers it was evident that most of the data were confined to morphological change (correction of impairment). Only two of the trials reported on incidence of trauma and only two reported on the self-esteem of the children.

Reinforcement of anchorage with surgical devices

This review was concerned with an evaluation of the effectiveness of any surgical device that was used to reinforce anchorage. We identified 8 trials for inclusion in the review. The outcomes we considered are given in Table 2.

Methods of moving upper molars distally

This review evaluated the effectiveness of several methods of moving upper first molars distally. We identified 7 trials for inclusion. The outcomes were tabulated (Table 3).

The evaluation of these outcomes can be taken one step further, and they can be grouped into outcome domains. It has been stated that the ideal outcome set should contain the following domains: disease activity, physical consequences of disease, functional status, resource utilization, social outcome, and side effects of treatment.[5] I have then put the outcomes from the systematic reviews into these domains and this results in the data provided in Table 4.

It is clear from this brief analysis that in these three recent reviews most of the studies were

Table 2. Outcomes derived from trials of surgical anchorage

Outcome	Number of Studies
Cephalometric measures	7
Patient perception	4
Success/failure	2
Pain	2
Self-esteem	2
Duration of treatment	3

Table 3. Outcomes derived from trials of methods of moving upper molars distally

Outcome	Number of Studies
Cephalometric measures	6
Time to distalize molars	3
Tooth movement	5

concerned with an evaluation of the morphological effects of treatment, while other outcomes that are particularly relevant to our patients were not considered. In many ways this is not unreasonable, as it is clear that the investigators needed to measure if the treatment "worked" as it should. Nevertheless, it is equally clear that in these studies the differences between interventions were small and perhaps not clinically significant. In this respect, we could suggest that if the investigators had measured values that were relevant to our patients then they may have found differences in acceptability, for example, cost, pain, and oral hygiene difficulty. This reflects the comment of Sinha when he stated that if we do not include patient values then "studies may be ignoring or completely missing the effects of treatment."[5]

Heterogeneity of research measures

One of the problems when reading and interpreting a systematic review is that the authors frequently draw attention to the fact that it was difficult, or even impossible, to combine the data into a meta-analysis because the outcomes identified in the trials were not uniform. An excellent example of this is the review into Class II correction.[6] In these 15 studies, the authors used 15 different cephalometric analyses. Even when the studies were attempting to answer

Table 4. Outcomes grouped into domains

Outcome Domain	Number of Studies
Disease activity (features of malocclusion)	51
Physical consequences of disease (dental disease)	3
Functional status (masticatory function)	0
Resource utilization (duration of treatment)	12
Social outcome (socio-dental measures	8
Side effects of treatment (decalcification)	2

identical questions, different measurements were used. For example, when we evaluated the "early treatment" studies, the Florida study used Johnston's analysis, the UNC used a simplified 12 measurement analysis, and the UK used the Pancherz analysis. It is, therefore, evident that there is no advantage to investigators using their "favorite" analysis to measure the same morphological features of the cranio-facial skeleton.

Outcome Reporting Bias

The last issue that I need to consider is the concept of Outcome Reporting Bias (ORS). This is defined as "the selection for publication of a subset of the original recorded outcome variables on the basis of the results."[9] This has been investigated in recent study where the investigators reviewed 283 Cochrane reviews and found that just over half did not include entire data for the review primary outcome for all eligible trials.[10] They also concluded that of 6% of the trials included, the researchers had measured and analyzed the review primary outcomes but did not report or only partially reported the results.

In this section, I have addressed issues such as measurement and reporting of outcomes in orthodontics and the particular need to include patient-centered outcomes in our research. Nevertheless, this does not address the problem of which outcomes we should use in our research. This brings us to the concept of Core Outcome Sets.

Core Outcome Sets

A Core Outcome Set (COS) is an agreed standardized set of outcome measures. Importantly, these should be measured and reported as a minimum in all clinical trials investigating a specific condition.[11] It is important to point out that these outcomes should be collected as a minimum and the investigators can select additional outcomes of their choice. The main advantage of the use of COS is that they reduce heterogeneity between investigations, enable high-quality meta-analysis, and are more likely to have outcomes that are relevant to patients and providers of care. There is extensive work underway on the development of COS for many

conditions (http://www.comet-initiative.org), and it is clear that there would be benefits for dentistry/orthodontics to take part in such an initiative.

But, how do we develop a Core Outcome Set? We are currently working on a study that is evaluating the feasibility for a trial of different methods for the treatment of otitis media with effusion in children with cleft palate. Part of this study is to develop a Core Outcome Set to be used in future trials. We are following this process: (i) review of the literature to identify all outcomes that have been used in previous research for this condition, (ii) three-stage Delphi process to gather clinicians' opinions on the relative importance of the identified outcomes, (iii) a series of qualitative interviews of patients and parents to identify what outcome are important to them, and (iv) final consensus meetings to come to a decision on the outcomes that should be included in the COS. Clinicians and patients and parents would attend this meeting. As a result, we would have developed a COS that includes the opinions and values of clinicians and patients/parents.

Core Outcome Sets for orthodontic treatment

Could we carry out a similar exercise for orthodontic treatment? This should be perfectly possible, and there have been previous studies that have evaluated patient and parent perceptions of the benefits of orthodontic treatment.[12,13] The findings have been interesting in that one main aim of undergoing treatment was to improve appearance and self-esteem.[12] This is a variable that is very rarely measured in orthodontic studies. From the point of view of providers of care, we would be expected to identify variables that are important to us, as orthodontists. This should be perfectly feasible, however, I do have concerns that a group of orthodontists could agree on a few cephalometric measurements that could be considered to be core. (Table 5)

Finally, I could consider putting forwards some outcomes that could be considered to be "core". It is, of course, relevant to point out that this is entirely my opinion and not based on any level of evidence higher than an interested academic orthodontist. These may be considered in the domains that I list in Table 4.

Table 5. Personal core outcome set for orthodontics

Outcome Domain	Outcome
Disease activity	Occlusal index scores One cephalometric measure (ANB?)
Physical consequences of disease	Incisal trauma Gingival trauma from occlusion
Functional status	A measure of masticatory function?
Resource utilization	Duration of treatment/cost
Social outcome	Socio-dental measure (CPQ 11-14) Teasing
Side effects of treatment	Decalcification Pain Root resorption

Conclusions

The quality of orthodontic research has improved greatly over the past decade with the increasing adoption of randomized controlled trial methodology. These trials have now been included into many quality systematic reviews. However, these reviews are reporting results that are mostly relevant to the providers of care and not necessarily of value to our patients. Secondly, our tendency to collect many outcomes that measure similar variables has led to major difficulties in carrying out meaningful meta-analyses. Finally, there is a potential of some of our trials being subject to Outcome Reporting Bias. As a result, we should continue to keep pace with research methodology in other fields and become involved in the development of Core Outcome Sets for orthodontic research.

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