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Orthodontics and occlusion

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In this part, we will discuss:

- What the goals of orthodontic treatment are
- The need for a full articulatory examination
- Specific treatment considerations:
Should orthodontic treatment involve extractions?
What is meant by growth modification and skeletal camouflage?
What is the significance of tooth drifting?
- The relationship between orthodontic treatment and temporomandibular disorders

What are the goals of orthodontic treatment?

- For the Orthodontist
 - For the Patient
- Are they the same?**

The discipline of orthodontics is directed towards alteration of the occlusion of the teeth and the relationships of the jaws. It is therefore somewhat surprising to find that there is little scientific evidence to support any of the concepts that suggest occlusal goals for orthodontic treatment. Most of the current concepts of orthodontic treatment are based upon personal opinion and retrospective studies. Nevertheless, an attempt is made here to provide a guide to the relationship of orthodontics and the occlusion that is evidence based. Where the evidence is weak, these areas have been highlighted.

The goals of orthodontic treatment for the Orthodontist

The orthodontist's goal of treatment is to achieve as near perfect occlusion as possible. But what is perfection and what is this 'optimal occlusion'? If we examine the early orthodontic literature, we will find that the founder of contemporary orthodontics, Edward Angle, attempted to treat his patients' occlusion with reference to the occlusion of a skull displayed on a shelf in his surgery. This skull was affectionately termed 'Old Glory' (Fig. 1a).

There is no doubt that the introduction of, firstly the six keys philosophy (Fig. 1b), and secondly, the pre-adjusted edgewise appliance designed to achieve them was a quantum leap for orthodontists.

Unfortunately, there is no evidence that achieving this 'optimal' occlusion has any influence upon long-term stability, masticatory function or the alleged association between orthodontic treatment and temporomandibular disorders.

The goals of orthodontic treatment for the Patient

The prime reason for a patient to seek orthodontic treatment is to gain an improvement in appearance. Arguably, we should primarily aim to treat the patient's needs rather than pursue a dogmatic adherence to the six keys of occlusion.

Form follows function

There is fortunately, however, a strong association between the aesthetics of the final treat-

ment (patient's goal — Form) and the achievement of an 'optimal' occlusion (orthodontist's goal — Function). This is because if at least keys 2–5 have been achieved, the patient will have perfectly aligned upper and lower front teeth, irrespective of the relationship between the jaws. In Figure 2, the patient has a 'six key occlusion'. In Figure 3, the patient does not have an optimal buccal interdigitation (keys 1 and 2 missing), yet there is very little perceptible difference in the aesthetics of the dentition.

The need for a full examination

Occlusal examination

It is important to emphasise that it is necessary to carry out a full occlusal examination for all orthodontic patients. It is essential to record

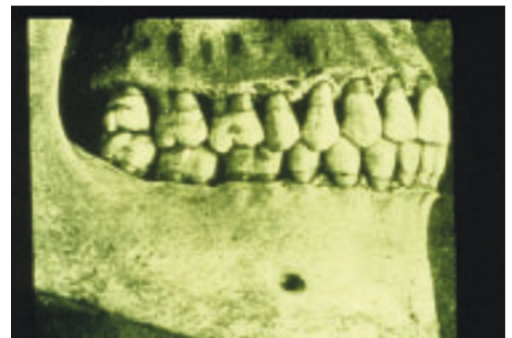


Fig. 1a 'Old Glory': Examination of the dentition reveals that this is, indeed, an 'optimal' occlusion. There is a perfect buccal interdigitation, overjet and overbite. These aims were modified by the concepts of Andrews who introduced the 'six keys of occlusion' (see Fig. 1b)

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The concept of treating toward an 'optimal' occlusion is not based on any evidence on the long-term effects of orthodontic treatment

One should remember that the 'perfect occlusion' of Old Glory:

- May not always be possible
- Was itself an aesthetic appreciation by Angle

Camouflage vs Modification



Fig. 2 'Six keys to occlusion' are present (after Andrew); a perfect smile

Fig. 1b

Andrew's six keys to occlusion⁴

- I. *Molar relationship*: The distal surface of the disto-buccal cusp of the upper first permanent molar occludes with the mesial surface of the mesio-buccal cusp of the lower second permanent molar.
- II. *Crown angulation* (mesio-distal tip): The gingival portion of each crown is distal to the incisal portion and varied with each tooth type.
- III. *Crown inclination* (labio-lingual, bucco-lingual): Anterior teeth (incisors) are at a sufficient angulation to prevent overeruption
Upper posterior teeth – lingual tip is constant and similar from 3–5 and increased in the molars
Lower posterior teeth – lingual tip increases progressively from the canines to the molar
- IV. *No rotations*
- V. *No spaces*
- VI. *Flat occlusal planes*

not only the patient's habitual bite (centric occlusion CO or intercuspation position ICP) but also to record the patient's ideal jaw relationship (centric relation = CR or retruded contact position = RCP). This is done against the benchmark of 'ideal occlusion'.¹ Firstly does CO occur in CR? If not, what is the discrepancy between the two? Secondly does the anterior guidance on the front teeth occur with an absence of posterior interferences?

Without doing this the dentist or orthodontist cannot fully assess a malocclusion or avoid a potential mistake in treatment planning.

This is illustrated in Figure 4. In centric occlusion this patient has an overjet of 5 mm and appears to represent a relatively straight

forward orthodontic problem. However, when she is placed into centric relation, the mandible is considerably more posteriorly placed and she has an overjet of 10 mm, which is far more difficult to treat. This is an example of a 'postured bite' and is a relatively common problem in Class II Div i malocclusions. Similar problems may arise from crossbites and premature contacts. As a result, this aspect of an examination is essential if misdiagnosis and incorrect treatment planning is to be minimised.

Examination of the articulatory system

It must be appreciated, however, that the occlusal examination only comprises one part of the articulator system examination; the muscles and temporomandibular joints should also be examined.

The three elements of an examination of the articulator system² can easily be incorporated into an orthodontic examination protocol (Fig. 5a–c). This comprehensive examination is divided into two main parts. The jaw and facial examination will record the pattern of the skeletal bases and the facial symmetry, the condition of the TMJs and mandibular muscles, and the soft tissue characteristics. The dental and occlusal examination will record the position of the teeth and their occlusal contacts.

Treatment considerations

Orthodontic treatment methods can be divided into two depending on the goals of treatment,³ these are camouflage and modification. To introduce this concept we must first consider the aetiology of a malocclusion, which includes skeletal, dento-alveolar and soft tissue components, the first two compo-



nents being particularly relevant. An example of the dento-alveolar component is crowding as a result of an adverse tooth-alveolar tissue ratio. When the malocclusion is caused by the skeletal component, the patient typically presents with a discrepancy between the size or position of his or her skeletal bases in the antero-posterior, lateral or vertical dimension.

At a very simplistic level the orthodontist when faced with these discrepancies has two main choices:

- To provide treatment directed at camouflaging the problem and not changing the skeletal pattern.
or
- Attempting skeletal modification with either functional appliances or orthognathic surgery

Camouflage

If the treatment is directed at camouflage, space is created in the dental arches by extractions, arch expansion or both, and the other teeth are moved into this space to achieve the treatment objective.

Even if the person has a skeletal discrepancy, the orthodontist may choose to accept the discrepancy and attempt to camouflage the problem by simply moving the teeth.

Unfortunately, whilst the dental appearance can be predicted the facial appearance cannot (Figs 6 and 7). Furthermore, there is no scientific evidence for any technique that may aid in prediction. Some clinicians may say they can accurately predict facial changes, but this claim is totally unfounded.

Modification

An alternative treatment is to attempt to change the skeletal pattern. This may be achieved by 'growth modification' which comprises the use of functional appliances in the growing child pattern (Fig. 8) or by orthognathic surgery, in the adult pattern (Fig. 9).

How does the orthodontist decide on attempting camouflage or growth modification therapy?

There is currently a debate in orthodontics concerned with the detrimental effect of camouflage on the facial profile. Many orthodontists attempt growth modification treatment for children instead. Surprisingly, there is no evidence that functional appliances alter the skeletal pattern of the growing child in any significant way.⁵ A recent investigation has shown that most of the change arising from Twin Block treatment is dental tipping with only a small contribution from a change in the jaw relationship.⁶ It is still not known if such treatment changes the size and shape of the jaws or purely the relationship of the upper to the



Fig. 3 Not all 'keys to occlusion' have been achieved but aesthetics are still good



Centric Relation



Centric Relation



Centric Occlusion



Centric Occlusion

Fig. 4 A patient who has a 5 mm overjet when occluding in centric relation and has a 10 mm overjet when in centric occlusion

How do functional appliances work?
Do functional appliances change the position of the teeth within the jaws
 or
Do they change the relationship between the jaws?

Fig. 5a

Orthodontic examination including articulatory system exam ... Page I

General Record

Patient Date

Age

Medical history

Plaque control	Gingivitis
good <input type="checkbox"/>	+ <input type="checkbox"/>
mod <input type="checkbox"/>	++ <input type="checkbox"/>
poor <input type="checkbox"/>	+++ <input type="checkbox"/>

Jaw and Facial Examination

Skeletal Pattern	I	II	III	mild	mod	severe
------------------	---	----	-----	------	-----	--------

TMJ

Tender to palpation? Lateral pole Intra-auricularly

Noises Clicks Right Left or Bilateral
Soft or Loud
Consistent or Intermittent
Opening or closing or both
Early Mid Late
Painful or Painless
Single or Multiple
or Bilateral
Painful or Painless

Creptus Right Left

Range of Motion (mm) Vertical maximal comfortable

Lateral Pathway of opening straight or deviating lasting or transient to side

R ——— | ——— L

Muscle Tenderness

Temporalis Masseter

Lateral Pterygoid

Centre Lines

midface

U

L

Lips Comp

Incomp

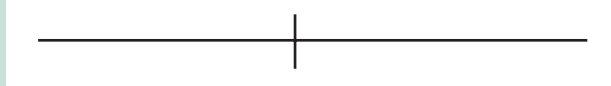
Tongue thrust

Fig. 5b

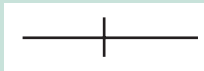
Orthodontic examination including articulatory system exam ... Page 2

Dental and occlusal examination

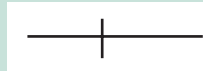
Erupted teeth



Unerupted teeth



Absent teeth



Upper arch

Crowding **Inclination**

mild none proclined

mod spaced AV

sev fraenum retroclined

Lower arch

Crowding **Inclination**

mild none proclined

mod spaced AV

sev fraenum retroclined

Incisor Class

I

I/I

II/I

II/II

Overjet in CO

.....mm

If zero

Freedom in CO?

Yes No

Overjet in CR

.....mm

Overbite

Increased

Average

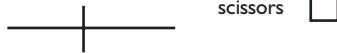
Reduced

Edge to Edge

Complete HT

Incomplete ST

X-Bites



scissors

displacement no.

.....mm R L ANT

IOTN

DHC.....

AC.....

Page 2

If there is a possibility of changing the jaw relationship, the clinician should examine the patient's jaw relationship before and after treatment

Fig. 5c

Dental and Occlusal Examination cont.

Buccal Segments

Molars

	I		II	III
R	<input type="checkbox"/>unit	<input type="checkbox"/>	<input type="checkbox"/>
L	<input type="checkbox"/>unit	<input type="checkbox"/>	<input type="checkbox"/>

Canines

	I		II	III
R	<input type="checkbox"/>unit	<input type="checkbox"/>	<input type="checkbox"/>
L	<input type="checkbox"/>unit	<input type="checkbox"/>	<input type="checkbox"/>

Static Occlusion

Does CO occur in CR? IF NOT..prem contact in CR?

Roughly or exactly

Direction of slide from CR to CO

Dynamic Occlusion

		RHS	LHS
Non-Working Side Interferences		<input type="checkbox"/>	<input type="checkbox"/>
Working Side Interferences		<input type="checkbox"/>	<input type="checkbox"/>
Crossover Position	NWS Int	<input type="checkbox"/>	<input type="checkbox"/>
	WS Int	<input type="checkbox"/>	<input type="checkbox"/>
Canine Guidance		<input type="checkbox"/>	<input type="checkbox"/>
Group Function		<input type="checkbox"/>	<input type="checkbox"/>

lower jaw. This type of treatment, if it works, does provide excellent dental results (Fig. 8) and, perhaps, reduces the overall time that a child spends wearing fixed appliances.

Orthognathic surgery obviously alters a person's skeletal pattern, however, this is a very complex specialist treatment that should only be carried out, after counselling, for those patients who have major concerns with their facial and dental appearance.

One other form of 'growth modification' is expansion of the dental arches with either removable or fixed appliances. This type of treatment is gaining popularity with many dentists and orthodontists, especially those who attend courses of the latest 'orthodontic guru'.

There is, however, *no evidence* that these appliances can alter the growth of the alveolus and some research has suggested that most expansion is not stable and simply invites relapse in the occlusion.⁷

Extraction vs non-extraction

There has been considerable research into the potential 'harmful' effect of extractions on the dentition, the face and occlusion but it must be emphasised that no scientific study has concluded that orthodontic extractions are detrimental. Unfortunately, the myth still persists and the orthodontists who suggest this type of conventional treatment are frequently described as 'narrow minded' and those who 'do not know any better'.

If a thorough appraisal of the scientific literature is undertaken *no evidence of the deleterious effect of extractions can be found.*

Orthodontics and temporomandibular disorders (TMD)

This link, as always, courts considerable controversy. As discussed there is a tendency to be critical of tooth extraction as part of orthodontic treatment. Implicit in this is the feeling that orthodontic extractions adversely affect the occlusion and furthermore this then leads to a temporomandibular disorder. First premolar extractions are considered by some to be an aetiological factor in TMD, it is suggested that these extractions permit the posterior teeth to move forward resulting in a decrease in the vertical dimension of occlusion.⁸

Another theory is that first premolar extractions lead to over-retraction of the anterior teeth, particularly the maxillary incisors. The anterior teeth then displace the mandible and the condyles posteriorly. Again, it is hypothesised that this may lead to a TMD.⁹ These theories may superficially appear plausible. When, however, they are subjected to scientific scrutiny they do not satisfy even the most basic criteria of scientific investigation. The 'evidence' that is commonly quoted is derived purely from personal opinion. Until randomised clinical tri-



Fig. 6a shows the patient before treatment



Fig. 6b shows the patient after 'camouflage' treatment. There is a good facial and dental appearance



Fig. 7 A CI 2 div ii following 'camouflage' treatment; showing good occlusion (7b, 7d), but disappointing facial appearance (7a, 7c)



Fig. 8a,b Pre-treatment photographs of a CI 2 patient before 15 months of twin block therapy; **Fig. 8c, d** Post operative photographs illustrating good dental and facial appearances

als have been carried out these theories must remain as simply conjecture, anecdotal and lacking in evidence.

Orthodontics and temporomandibular disorders?

Does orthodontic treatment cause TMD?

Clinical experience and review of the literature does not support *any* aetiological relationship.

Can orthodontic treatment cure TMD?

Occasionally orthodontics will form some part of the treatment plan.

Summary

The relationship between orthodontics and occlusion is important. Unfortunately, supposition and hearsay can govern treatment philosophy.

Confining considerations to factors that are supported by scientific evidence, the following conclusions may be accepted:

1. The aims of orthodontic treatment are, surprisingly, unclear. On the one hand an argument can be made for providing a 'perfect or optimal occlusion'. There is little evidence in the literature to suggest that this is necessary. Some features of ideal occlusion do, however, provide optimal aesthetics. This introduces the alternative treatment aim to provide the patient with an appearance that is acceptable to society's aesthetic norms.
2. Acceptable orthodontic treatment goals (including a good occlusion) can be achieved by either the camouflage or skeletal modification approach.
3. Extraction of teeth is needed as a part of many courses of orthodontic treatment. When carried out as a part of a comprehensively planned course of orthodontic treatment, no damage is done to the facial profile or occlusion.
4. There is no evidence in the literature that a treatment plan involving the extraction of teeth is more prone to relapse or predisposes the development of a TMD.
5. An examination of the patient's static occlusion must not only include assessment of the habitual bite or centric occlusion (CO), but also the occlusion in centric relation (CR). This is because the presence of large discrepancies between CO and CR are a positive indication for orthodontic treatment. Equally, such discrepancies should not be introduced during orthodontic treatment. In restorative terminology orthodontic treatment is a 're-organised' treatment plan; and to leave or create a large discrepancy between CO and CR would be to provide the patient with a less than ideal occlusion.



Fig. 9a i –iii Pre-treatment photographs of a CI 2 patient before orthognathic surgery



Fig. 9b i –iii Post operative photographs illustrating good dental and facial appearances

Guidelines of good occlusal practice

- 1 The examination of the patient involves the teeth, periodontal tissues and articulatory system.
- 2 There is no such thing as an intrinsically bad occlusal contact, only an intolerable number of times to parafunction on it.
- 3 The patient's occlusion should be recorded, before any treatment is started.
- 4 Compare the patient's occlusion against the benchmark of ideal occlusion.
- 5 A simple, two dimensional means of recording the patient's occlusion before, during and after treatment is an aid to good occlusal practice.
- 6 The conformational approach is the safest way of ensuring that the occlusion of a restoration does not have potentially harmful consequences.
- 7 Ensuring that the occlusion conforms (to the patient's pre-treatment state) is a product of examination, design, execution and checking (EDEC)
- 8 The 'reorganised approach' involves firstly the establishment of a 'more ideal' occlusion in the patient's pretreatment teeth or provisional restorations; and then adhering to that design using the techniques of the 'conformational approach'
9. An 'ideal occlusion' in removable prosthodontics is one which reduced de-stabilising forces
- 10. The occlusal objective of orthodontic treatment is not clear, but a large discrepancy between centric occlusion and centric relation should not be an outcome of treatment**
- 11. An 'orthodontic' examination of the occlusion should include: the dynamic occlusion; and the jaw relationship in which the patient has centric occlusion**

- 1 Ash M M, Ramfjord S P. Occlusion 4th ed. pp84-85, Philadelphia: Saunders, 1995.
- 2 Gray R M J, Davies S J, Quayle A A. Temporomandibular disorders: a clinical approach, pp9-25. BDJ publications, 1995, 1997.
- 3 Proffit W R. Contemporary orthodontics, 1st ed. London: Mosby, 1986, p212.
- 4 Andrew L F. The straight wire appliance. *Br J Orthod* 1979; 6: 125-143.
- 5 Tulloch J F C, Philips C, Koch G, Proffit W R. The effect of early intervention on skeletal pattern in Class II malocclusion; a randomised controlled trial. *Am J Orthod* 1997; 111: 391-400.
- 6 Lund D I and Sandler P J. The effect of twin blocks. A prospective controlled study. *Am J Orthod* 1998; 113: 104-110.
- 7 DelaCruz A, Sampson P, Little R M, Artun J, Shapiro P A. Long term changes in arch form after orthodontic treatment and retention. *Am J Orthod* 1995; 107: 518-530.
- 8 Witzig J W, Spahl T J. *The clinical management of basic maxillofacial orthopaedic appliances*. Littleton, Mass.: PSG Publishing Co Inc, 1987.
- 9 Fennell M, Frost S. Dentofacial orthopaedics and the GDP Part 3. *Dent Prac* 1993; 31: 8-9.