

Is There Such a Thing as a 'Healthy Occlusion'? Lessons From History

Ronald G Presswood and Andrew Toy

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Opinions on occlusion and its link to oral health could not be more diverse. These opinions are used as justification for an equally diverse range of treatments for so-called occlusally related problems, from heavy wear to chronic orofacial pain. Many claim to have evidence to back up their opinions, although much of it appears to be from a very weak source or based on clinical experience. The strongest case appears to be made by those who believe there is no link, by virtue of a lack of evidence to support its existence. Yet for many clinicians, it is a self-evident truth that occlusion must be

related in some way to the function and dysfunction of the stomatognathic system. This article uses historical research to highlight where the pro-occlusionists may be going wrong. It also offers a new concept, based on anthropological studies, that indicates occlusion's link to oral health, and explains why most patients appear to have no occlusal problems for most of the time. This theory needs to be tested by researchers to establish its validity. In the meantime, dentists who feel the need to treat occlusal problems will find it supports a very conservative approach to care.

This paper comments on the often-conflicting opinions on dental occlusion and the nature of the evidence base used to support them. It offers another, possibly more coherent perspective on what constitutes a healthy occlusion. Our opinion is based on some preliminary studies performed by one of the authors (RP). This is blended with the authors' combined personal experience of over 60 years in dentistry, studying and teaching the subject of occlusion and, of course, treating patients in normal, everyday practice. We do not regard the evidence offered here as conclusive, but we hope that it will add some clarity and direction to further development of the evidence base. We also hope to offer clinicians a less invasive, yet more effective means of tackling the occlusal problems with which some of their patients may be presenting.

EVIDENCE? WHAT EVIDENCE?

Dental occlusion is often the subject of

heated debate. The great majority of United Kingdom (UK) dentists seem to pay little attention to the issue. The debate in the UK may well centre on whether it is even necessary to consider occlusion in the practice of dentistry at all. After all, most of the time, most patients do not seem to show any signs of occlusal problems, do they? In the United States of America (USA), on the other hand, the correction of malocclusion can be used as a legitimate reason to embark on extensive restorative treatment plans to create a healthy occlusal/temporomandibular joint (TMJ) relationship. In the USA, the debate is more likely to centre on what is the exact nature of the ideal occlusion and the different ways of creating it.

So which opinion is correct? The British, renowned for their conservative approach to conservation, or the drill-happy Americans? In the 21st century we must look to the evidence base for our answers. And that's where we come up against a major problem. What *is*

the evidence base for occlusion and its relationship with oral health? It can be found in the classic texts on occlusion.¹⁻⁷ These reveal that many of the stated facts are actually based on research with a very narrow focus. Subsequent circular citation and repetitive studies then add a certain gravitas to the opinions offered. Although it is still referenced, this work is often anecdotal and is rarely critically appraised.

Two recent Cochrane reviews by Koh and Robinson (2003)⁸ and Al-Ani *et al* (2004)⁸ highlight the paucity of evidence to support either view:

The review found there is no evidence from trials to show that occlusal adjustment can prevent or relieve temporomandibular disorders.⁸

The review found there is not enough evidence from trials to show whether or not stabilisation splints can reduce PDS [Pain Dysfunction Syndrome].⁹

In the first review, Koh and Robinson (2003)⁸ looked at over 660 trials. Only six were randomised controlled trials

(RCTs) and therefore met their quality criteria for inclusion. In the second review, Al-Ani *et al* (2004) found just 12 RCTs could be included.⁸ They went on to suggest:

...the need for further, well conducted RCTs that pay attention to method of allocation, outcome assessment, large sample size, and enough duration of follow up.

There are a couple of points to make on these conclusions.

First, the RCT is regarded with some justification as the pinnacle of unbiased, objective scientific evidence. However, it should be remembered that although it serves excellently as a method of isolating and studying a single factor in a disease process, it may not necessarily be the most *valid* form of inquiry for a messy, multifactorial issue such as dental occlusion or the perception of orofacial pain. This outstanding research method has its limitations.

It has been observed that because research methods act as filters through which the environment is selectively experienced, they are never atheoretical or neutral in representing the world of experience. Exclusive reliance on one method, therefore, may bias or distort the researcher's particular slice of reality s/he is investigating.¹⁰

In the social sciences, a multi-method approach to research is employed to provide insight into the complex nature of human experiences. Ideally, objective measurements are compared and contrasted with subjective opinions. The different sets of data are then 'triangulated' with each other to provide a more complete and accurate representation of the situation under study. If the different methods lead to a seemingly coherent and sensible conclusion, one can have more confidence that the truth of that particular human situation has been more accurately described. In this particularly complex area of dentistry, it is possible that it is necessary to gather evidence using a number of different methodologies (each perhaps less objectively rigorous than a RCT, but also perhaps allowing for a closer approach to the reality under study). Through a process of triangulation, some tentative

Common Concepts of Dental Occlusion

- 1. Group function:** the simultaneous working side contact of multiple teeth in gliding movements of the mandible. Presented by von Spee (1890)¹⁸ and commonly used by dentists until the 1960s when it was replaced by cuspid (canine) protection.
- 2. Cuspid (canine) protection:** the simultaneous contact of the anterior and posterior teeth on mandibular closing, with immediate dis-occlusion of the posterior teeth in excursive movements. Introduced by D'Amico (1958)³⁰ the canine and anterior teeth 'protect' the posterior teeth from occlusal overload by inhibiting the masticatory muscles. This concept proposes that muscle inhibition is beneficial to TMJ function and heavy function with associated wear is regarded as unhealthy.
- 3. Neuro-muscular/physiologic/esthetic:** uses electromyographic (EMG) measurements to determine the 'ideal' muscle length and jaw position for an individual. Like cuspid (canine) protection, the concept proposes muscle inhibition as beneficial and heavy occlusal wear as unhealthy. It uses a technical system (EMG) originally presented by Jankelson (1969).⁷⁴
- 4. Psychological/behavioural/habitual:** proposes that physical function of the teeth have little effect on the general health and function of other aspects of the stomatognathic system. The concept as presented by Dworkin and Burgess (1968)⁷⁵ suggests that the system is adaptable to almost all physical change and that clinical issues of discomfort and pain are more psychosocial than physical.

Figure 1 Common concepts of dental occlusion.

conclusions can then be drawn about the true nature of the link between dental occlusion and oral health (if any).

The second point to make from the Cochrane reviews is, exactly which occlusal concept were the various studies measuring anyway? There appears to have been an assumption that there is a single, universally accepted model of dental occlusion. We do not believe this is the case. A summary of some of the most common concepts of occlusion is provided in *Figure 1*.

In our opinion, the whole field of dental occlusion is a confused mess of competing theories derived from an inadequate evidence base, constructed with less than ideal research methodologies. To bring some clarity to this, we suggest it is time to take a journey back into history to study the origins of occlusal thinking.

THE HISTORICAL BACKGROUND

Current dental occlusal designs have their beginnings in the mid-19th century. The drawings of Carabelli initiated an awareness of cuspal form and the *beauty* of human teeth.^{11,12} Both Bonwill and Williams added to the complexity of tooth morphology and proposed functional dynamics in their competitive attempts to develop the first true tooth-form porcelain artificial denture teeth. A cusp-to-fossa contact was regarded as the correct anatomical occlusal relationship.¹²⁻¹⁶

Most of today's occlusal concepts are still based on Bonwill's original work. However, it is not often recognised that this work was grounded in the religious philosophy of *divine creation* rather than objective, scientific study.¹³ Dr Bonwill (1894) saw the form of the tooth as representing a most beautiful design of

creation: '[A system] ...so beautiful and so mathematical in design cannot but call forth our admiration and wonder'. Bonwill arbitrarily proposed a four-inch equilateral triangle as 'the basic design of the human body most clearly manifest in the architecture of the jaws and teeth.' This is reflected in Monson's geometry of mandibular motion and survives today in almost all adjustable and semi-adjustable articulator designs.¹⁷

Interestingly, in this same time period, von Spee was evolving his theory of occlusal dynamics, culminating in the Curve of Spee.¹⁸ Of specific interest, von Spee's work was done on skulls with well-worn teeth. Cusps, he felt, got in the way of good excursive function and limited the lateral motion of the mandible.

At the beginning of the 20th century, Angle idealised the dental arch and described his design for proper occlusal function.¹⁹⁻²¹ This work was closely followed by many various concepts of restorative design and occlusal function.²²⁻²⁷ Most of these were comprised of personal opinion by individuals of 'substantial' character.

As described in Lucia's text,⁴ balancing contact (cross-arch balance) was an accepted concept in gnathologically defined restorative dentistry as late as 1962. Granger²⁸ and McCollum and Stuart²⁹ developed gnathological systems and techniques at about this time. Restorations were completed with steep posterior (condylar) control, steep and tight incisal coupling, and steep posterior cuspal form to create a balanced occlusion. Notably, little regard was given to muscle function and flexibility within the stomatognathic system. This misunderstanding of muscle physiology and bony adaptation led to significant clinical failure. In 1958, D'Amico suggested the advisability of cuspid (canine) protected occlusal designs as a response.^{30,31} However, cuspid (canine) protected occlusal design has been implicated in dysfunctional problems of the TMJ.³²

Research studies of occlusal function, mandibular range of motion, muscle effort and physiologic adaptation were often conducted with passive and/or

manipulated mandibular movements. These studies tend to support the cuspid (canine) guidance models, reinforcing the opinion that cross-arch occlusal contacts are abnormal in dentate subjects.³³⁻³⁷ However, when occlusal function studies were made with active muscle function, a significant number of subjects displayed balancing side contact and/or guides. These results were often unexpected and unsought in the research protocol.³⁸⁻⁴⁰ One study of cuspid (canine) guidance and group function classification involving 86 subjects reported 9% cuspid (canine) guidance, 45.3% group function, and 41.9% balanced occlusion.⁴¹

So, who is right? With so many conflicting concepts, they cannot all be right, can they? Or perhaps there is no such thing as a malocclusion, as the Cochrane reviews might imply. We must be careful how the research findings are interpreted. To many practising clinicians, it is a self-evident truth that how the teeth fit together can have an effect on a patient's oral health (at least in some patients, some of the time), be it through toothwear, mobility or TMJ function and associated muscle pain. What is the nature of a healthy dental occlusion?

As a possible solution to this conundrum, the authors of this paper refer readers to a series of preliminary studies conducted by one of the authors (RP) that, through triangulation, may be considered as stronger evidence for description of a healthy dental occlusal scheme. This involves another historical journey, although the period this time is not a couple of centuries but thousands, and even millions of years.

A NEW CONCEPT: THE ANTHROPOLOGICAL MODEL

Anthropological research consists (in part) of comparing the physical characteristics of today's population with those present in records of historic populations. One may then draw conclusions on their relative value to the human being. Essentially, if a characteristic has

persisted over a period of several thousand years, it is reasonable to assume that this characteristic is beneficial to the organism's health and survival. It is thus possible to build a tentative description of the correct physical form and function.

What can be found when applying anthropological methods to the issue of dental occlusion? Kaifu *et al* (2003),⁴² in an extensive anthropological review of the design of dental occlusion, concluded that available evidence supported the hypothesis that:

1. The human dentition is designed on the basis that extensive wear will occur.
2. The dentitions of ancient populations continuously and dynamically change because of life-long, attritional, tooth-reduction and compensatory tooth-migration.
3. Modern-day humans have inherited these compensatory mechanisms.

It should be remembered that the humans studied had heavily worn but highly efficient dentitions, with powerful masticatory musculature for surviving on their coarse, relatively unrefined diet. The anthropological evidence strongly suggests that these patterns of function and adaptation are the intended design for proper use of the stomatognathic system. Particularly for toothwear and skeletal adaptation, the extensive literature relating to research in anthropology and dental anthropology far exceeds that for clinical research on these topics. There have been several hundred such anthropological publications, of which the key texts are listed in the reference section of this paper.^{32-36,43-73} The question remains, how does this apply to modern day dentitions? To what extent is the balanced occlusion present in the 'cuspy' dentitions of soft-dieted Westerners?

The next part of the study was conducted on subjects from the modern world (they were all members of dental study clubs). Twenty-eight dentists were asked to report subjectively on whether they were aware of balancing side contacts when sliding back *with force* from a lateral excursion. They were then asked

to repeat the movement and the tooth contacts were marked with inked silk ribbon for a more objective report (Figure 2).

All of the subjects exhibited balancing side contacts when tested with the inked ribbon. This small study supports findings reported by Ogawa *et al* (1998) on 86 students.⁴¹ They found that cuspid (canine) protection was rarely present when the mandible was within 0.5 mm of maximum intercuspation. It would appear that with active muscle function, such as chewing, balancing side contacts could be regarded as very common, and therefore probably normal and beneficial to oral health.

Interestingly, a number of these dentists had previously been equilibrated to a cuspid (canine) protection occlusal design. However, the balancing contacts appear to have re-established themselves. Perhaps this is a case of nature restoring us to a healthy occlusion, despite our best efforts to control it artificially.

CHEWING ABILITY: THE PURPOSE OF DENTAL OCCLUSION

The first two pieces of evidence may seem a little esoteric to many readers:

- Our ancestors had worn and balanced occlusions.
- Nicely coloured dots, in all the right places, can also be demonstrated on a group of dentists' posterior teeth.

So what? How does this help dental clinicians in daily practice, treating ordinary patients, living in the modern world? The final piece of evidence offered in this opinion paper centres on a more functional aspect of occlusion: the ability to use the muscles of mastication. How well can you chew?

In the final preliminary study, an eight-channel electromyograph (EMG) machine was attached to the masticatory muscles of some more volunteer dentists. Muscle function was compared between the subjects' natural teeth and two lower splints of different occlusal designs (one was canine-guided with posterior disclu-

Anterior Guidance Study (28 subjects)			
Subjective reporting	Cuspid (canine) guidance	Group function	Balancing contacts
Slide out	75%	25%	27%
Bite back	45%	55%	73%
With inked ribbon			
Bite back			100%

Figure 2 Results of anterior guidance study.

sion and the other was group function with a balanced occlusion). The dentists performed normal lateral and protrusive movements and also (crucially) forceful clenching and bite-back. In every case, the greatest and most coordinated muscle function occurred with the balanced occlusion splint. Incidentally, the subjects also noted that this occlusion felt the most comfortable of the three options.

RECOMMENDATIONS

Combining these varied observations, we believe it is possible to draw up a reasonably coherent description of a new model of occlusion. We offer the following advice for dental clinicians interested in this area.

For researchers

The small-scale preliminary studies referred to in this paper require development to establish with greater certainty (or not) the ability of the anthropological model to describe the healthy dental occlusion. If this is established, it may then be possible to create RCT studies to test the model and provide more conclusive answers to questions around dental occlusion and its relationship with health and disease.

For clinicians

Be conservative! The anthropological model promotes the idea that, in general, toothwear is a normal and healthy state. In the greater part, the active use of the muscles of mastication is also healthy; it is fine to clench and grind when you have a balanced occlusion. A Class 1 cusp-to-fossa relationship is not required in all patients (orthodontists take note). It also suggests that the body possesses its own

compensatory mechanisms to recreate a healthy occlusion, even following professional intervention. Attempts to correct worn occlusions with 'cuspy' alternatives should proceed very tentatively, if at all.

When it is necessary to rebuild an occlusion (to restore inadequate function, for instance), provision must be made to allow for balanced molar contacts in early excursive movements. Lateral excursions should be as smooth and flat as possible with a group function occlusion. Anterior restorations are likely to have a greater life expectancy if heavy occlusal forces in excursions are distributed around the arch, very pertinent to our patients' current craze for veneer-based dental facelifts (Figure 3).



Figure 3 A porcelain-fused-to-metal anterior bridge placed 26 years ago to a fully balanced anthropological occlusion. Note the lack of significant wear on the lower anterior teeth.

The anthropological model also suggests that the dental/TMJ complex is designed to create active, powerful stomatognathic muscle function. Practitioners using occlusal splints for treating TMJ and stomatognathic muscle disorders could consider using the fully balanced occlusal design to assist the muscles in returning to normal function and to stabilise the joint complex. This is in contrast to those who advocate a reduction in muscle activity as the route to

health, as proposed in Neuro-Muscular occlusal concepts.

CONCLUSIONS

As so many teachers have told us in the past, studying history can be very useful for understanding the present. In the case of dental occlusion, the anthropological study of ancient humans may provide a superior understanding compared with more recent 19th-century religious dogma. The goal of the perfectly interdigitated occlusion as necessary for health is perhaps a social construct of our times. Occlusions of all shapes and sizes can be healthy and functional if they have the ability to have balancing contacts under active muscle pressure. And, fortunately, the body has the ability to restore itself to health despite our efforts to disrupt the occlusion, either by commission (in the USA?) or omission (in the UK?).

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Correspondence: A Toy,
Gorse Covert Dental Practice,
34 Maxwell Drive,
Loughborough LE11 4RZ.
E-mail: andy.toy@talk21.com