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An evidencebased guide to occlusion and articulation Part 4 Unworn dentitions

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An evidence-based guide to occlusion and articulation. *Part 4: Unworn dentitions*

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SUMMARY AND PREAMBLE TO THE SERIES

Although this is essentially a review, it has not been written in the passive, third-person style normally associated with scientific writing, as it is intended to be thought-provoking and, hopefully, educational. It has therefore been written in more of a conversational style, and is aimed at students, dentists and dental technicians who are receptive to a slightly different view of occlusion and articulation, based on evidence.

Occlusion is a topic that has become a kind of archaic minefield of conflicting ideas, propositions, and above all, solutions, most of which are based on a complete lack of understanding of the evolution and development of teeth, and by extension, of clinically objective evidence.

That in itself is a statement of conflict (and perhaps even heretical), but it is by way of warning that this guide is not going to be much like anything you will find in standard text-books of dentistry or dental technology. It is, rather, an attempt to help you navigate through what you will read elsewhere, in the hope that eventually you will find an understanding that you can live with. It will appear as a sequential series in 7 Parts.

Unworn dentitions

So now we must turn to unworn dentitions which nearly all of us have, with the exception of some aboriginal populations. The question is, What scheme do we follow? Do we deliberately set out to grind the teeth and create artificially what nature used to create naturally? Well, apart from my somewhat tongue-in-cheek suggestion to give teenagers chewing gum with carborundum paste,[1] clearly that would be absurd and (probably) unnecessary.

So first, we have to find out what all this analysis over the years of our unworn dentitions has revealed, because (a) we may want to change tooth positions if they have erupted with some difficulty in jaws that cannot accommodate them all neatly and (b) we may need to replace parts or all of some teeth or even all of them. This means that observations of the static relationships of unworn dentitions can have value, but as we shall see, will be a problem if misinterpreted and not looked at functionally. It is often this misinterpretation that gave rise to certain dogmas for which it appeared later, there was no evidence.

The discussion in Part 3 was concerned with where and how to place teeth in complete dentures so that they will not only be in harmony with the movements and functions of the mandible, but more importantly will assist in stabilising the dentures in function and parafunction. In the naturally wearing dentition, the eruption of teeth at different times helps this harmony with movement, by producing wear of cusps that might *interfere* with the movements of chewing (and grinding, and parafunction). Initially, the cusps are steep, with the canine cusp angles being the steepest (it is effectively a single cusp, hence the term 'cuspid' is more apt, to distinguish it from the premolars, or 'bicuspids'), followed by the premolars and then the molars. So when moving sideways, the contacts on the canines provide some protection for the erupting premolars and second and third molars. As wear occurs and continues, wear on the canines creates contacts on the posterior teeth in all phases of chewing, and the chewing load is spread throughout the arch, producing not only stability, but a more axial direction of forces, all of which is just what the system is set up to do.

If there is no such wear, however, then observations of which teeth contact and when, have given rise to two main theories of tooth contact when chewing: anterior and canine 'disclusion' and group function. These terms are merely from the observation that in order to incise, i.e. use our teeth as cutting tools, the jaw needs to move forwards and in doing so, it might be useful not to have any other teeth interfere with moving the mandibular incisors against the maxillary ones. Without food, a forward movement of the mandible results in the anterior teeth contacting, and *discluding* the posterior teeth. When moving the jaw sideways, the steeper inclines of the canines do the same, and disclude the posterior teeth.

This presupposes of course, that the canines *are* the steeper inclines, and that there is no wear, and that we all have the same morphology of cusps. This of course is not the case, and so in some dentitions, when moving sideways, *group function* is observed. This may not happen all at once, progressive*ly* more teeth may be recruited into contact the more the mandible moves sideways, hence the term *progressive* group function.

It would be useful to know how common these observations are, and if we really do not wear our teeth at

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all. Fortunately others have asked this question and have surveyed many natural unworn dentitions and it is worth briefly reviewing their findings, because they may well surprise you. In 1969, a study [2] looked at 1,200 "young men", ages 17 – 25, and measured cuspid contact in centric, protrusive and lateral excursive movements. At the time, it was generally considered that dentitions would display a cuspid guidance (disclusion) and certainly dentitions were restored to this scheme. However, this study found the following rather surprising results:

- In lateral excursions, there was *bilateral* cuspid contact in 57% of the dentitions, unilateral contact in only 16%, and no contact in 27%
- In protrusive, there was no cuspid contact in 99% of the dentitions
- In centric, there was cuspid contact in 92%.

These findings, however seem to have been largely ignored, as have the findings of a 2008 study, in which 834 subjects with a natural dentition and no prosthetic replacements were examined. [3] Their ages ranged from 20 to 63 years. During clinical examination of lateral and protrusive tooth-guided excursions of the mandible, the authors identified 5 distinct "dynamic" occlusions:

- ***bilateral canine-protected occlusion,*** *defined as "no occlusal contacts of the posterior teeth (premolars and molars) during lateral and protrusive excursions of the mandible. The only occlusal contacts on both working sides were usually between opposing canines, while contacts of opposing central incisors and sometimes of lateral incisors were noted in protrusive position of the mandible".*
- ***unilateral canine-protected occlusion,*** *defined as "contacts of opposing canines and posterior teeth were seen on 1 working side, while on the other working side, the only occlusal contact was found between opposing canines". Protrusive contacts were similar to those of bilateral canine occlusion.*
- ***group function occlusion,*** *defined as "during lateral mandibular excursions occlusal contacts of opposing canines, premolars, and sometimes first molars were observed on both working sides. However, such occlusal contacts were absent on both balancing sides". Protrusive contacts were similar to those of bilateral canine occlusion.*
- ***balanced occlusion,*** *defined as "multiple contacts of all posterior and anterior teeth occurring in all tooth-guided mandibular excursions, that is, in both working and balancing sides and in protrusive position of the mandible".*
- ***"other occlusions",*** *"established for occlusions that differed from the previously defined schemas of occlusion".*

Fig. 1 is the graph derived from their data, on the percentage occurrence of each of these occlusions per age cohort. The results may surprise many who have been taught to always and only use canine guidance.

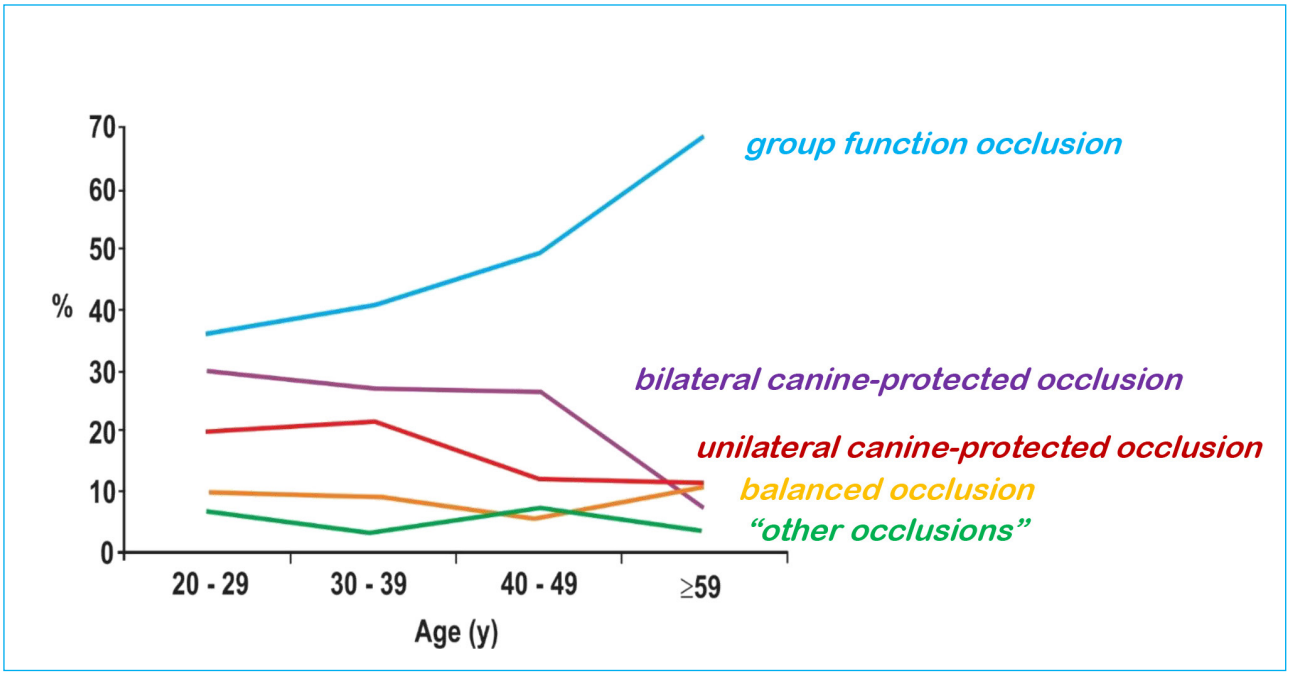
A systematic review of the clinical implications of lateral occlusal schemes in 2015 [4] reviewed 13 comparative and 13 clinical outcome studies. Two lateral excursive schemes were identified, canine guided occlusion and group function. Their conclusion was that *"the long-term studies indicated that there is no difference between the 2 schemes in patient comfort and restoration longevity".*

So what conclusions can we draw from these studies? The most obvious one of course, is that everyone is different, or "unique, just like everyone else". [5] Also that occlusions change over time, and patients adapt in the long term. And that canine guided occlusion or disclusion should not to be the goal of every occlusal scheme, which the gnathologists in the USA and elsewhere would no doubt gnash their teeth at.

Restoring unworn dentitions: to change or not to change?

If you are still with me, you may now be asking whether every time an occlusal surface must be replaced by an artificial material, it should look like a worn down tooth.

Fig. 1. Distribution of occlusions relative to age cohort (redrawn from Panek et al 2008 [3])



But of course, this is not the case (well, not quite, we'll come to that) and there is ample evidence now that there are two approaches to occlusion in unworn dentitions, the conformative and the re-organised approach.

The *conformative* approach is characterised by the fact that not every occlusal surface or tooth is to be replaced. So when it is replaced, it needs to be as close to what it was originally, depending on the material used, but more importantly, in harmony with how all the other teeth are working and moving over each other. A paper in 1976 was probably the first time this was described as a *conformative* approach, though the emphasis of the paper was more technical, on how to reproduce a functional occlusal surface. [6] The authors stated that *"A stable occlusal position that shows no evidence of occlusal disease should not be altered. Conformative restorative dentistry deals with making restorations that are in harmony with existing jaw relations."* This was confirmed in a review paper several decades later in which it was stated: *"One important outcome of the modern understanding of occlusion … should be avoidance of occlusion-changing procedures in healthy functioning patients".* [7]

This would or should seem to be self-evident, yet because many clinicians are unaware of the dynamics of functional occlusion, it is a sad fact that artificial occlusal morphology often unwittingly introduces morphology that is not in harmony with the patient's normal function. This has become more acute of late with the increased use of ceramics, and the comparative ease with which they can be produced in-office using digital procedures.

The *re-organised* approach is more commonly associated with the replacement of the majority of occlusal surfaces for partially or completely edentulous situations. This is, or should be, in the realm of the specialist Prosthodontist and it is not my intention to step on the toes of the very demanding years of training that prosthodontists undertake. But it is necessary to step on the toes of general dental practitioners who undertake full mouth rehabilitation without such training and by training I do not mean weekend courses unless such courses are accredited by the Regulator of the profession.

One of the reasons for all the confusion around the terminology of occlusion, such as the current definition of centric relation, is that when confronted with a broken down dentition, or the need to replace it entirely, the need to position the teeth (a) in the correct place and (b) at the correct height becomes a huge problem, because there is no reference point. Remember that the mandible is held in a sling, the joint that allows its movement is 5 times more slippery than ice on ice, and is the only joint in the entire body whose limitation is outside the joint itself. And that limitation, the teeth, is now under our control as clinicians.

Remember that definition of centric relation in the Glossary of Prosthodontic Terms? [8] Here's a reminder: *"A maxillomandibular relationship, independent of tooth contact, in which the condyles articulate in the anterior-superior position against the posterior slopes of the articular eminences; in this position, the mandible is restricted to a purely rotary movement; from this unstrained, physiologic, maxillomandibular relationship, the patient can make vertical, lateral or protrusive movements; it is a clinically useful, repeatable reference position"*. The really only important part of that nonsense is the very last part, a clinically useful, *repeatable* position. As we have seen, this has to be found clinically, because we now know that a pure hinge movement simply does not occur: there is always some translation as well. So it is necessary to find what appears clinically to be a repeatable movement (and it does not matter where the condyles are in the fossa) and this generally does *appear* to be hinge-like. This is the movement we try to repeat when making complete dentures and when re-organising a dentition.

Experienced clinicians will, however, tell you that this pathway changes. In the elderly, a centric position for a complete denture made one year may not be the same the following year: in a full-mouth rehabilitation, provisionals are (should be) recommended to be worn for several months and generally require continual adjustment to maintain freedom of movement, as the jaw positions itself into its most comfortable orientation.

Now although I rather facetiously said that it doesn't matter where the condyles are in the fossa, that's not strictly true, because their positon is under the influence of the ligaments of the joint, the disc, and most importantly, of the muscles. As long ago as 1973, Celenza [9] observed that after restoring a dentition to what he called the "ligamentous position", which was basically his term for a terminal hinge movement, he found that the customary intercuspal position adopted by his patients was, in 30 of the 32 patients followed up over a period of up to 12 years, anterior to the original position. So it does change, and is not an immutable position. This is why prosthodontists are trained to do two thing when carrying out full mouth rehabilitation: (1) use an inter-occlusal appliance for some weeks to (a) assess the vertical dimension to be used and (b) to try to 'undo' the habitual closing patterns and reduce stress in the muscles; and (2) to place patients in provisional restorations, sometimes for up to 18 months, with constant monitoring and adjustment of the interocclusal relationships prior to the definitive restorations being placed, because the antero-posterior position of the mandibular closing arc does change. And as said earlier, experienced clinicians will tell you that in the elderly, a centric position for a complete denture made one year may not be the same the following year.

This is why the concept of interdigitation makes little sense, and the freedom of movement in all planes makes the most sense and is probably one of the main reasons why patients show a preference for lingualised occlusal schemes in complete dentures, and why steep cusps should be avoided in dentate rehabilitations. However, the question of the most appropriate morphology of the occlusal surfaces remains, as well as the manner in which all teeth interact. We have dealt with the issue of complete dentures and we will deal with the occlusal morphology in Part 5 but for conventional fixed prosthodontics, there are some principles that can be derived from a non-mechanistic view of occlusion, as there seem to be some common threads from the literature that have taken such a view,[10-13] but with the caveat that *"There are no controlled studies on the optimum features of a harmonious natural and/or restored occlusion".*[14]

I would respectfully suggest, therefore, that the principles in conventional fixed prosthodontic treatment should be as follows:

- An acceptably aesthetic vertical facial height after treatment;
- An acceptable and comfortable interocclusal distance with the mandible at rest ;
- Intra-arch stability obtained from firm interproximal contacts;
- Inter-arch stability obtained by providing occlusal contacts on all opposing teeth;
- There should be bilateral synchronised contacts in the intercuspal position;
- Cusp inclinations should be shallow and there should be minimal fossa depths with no occlusal grooves (see Part 5);
- In protrusion there should be anterior contacts with none posteriorly;
- There should be freedom of movement in all eccentric movements with no interferences to chewing motion naturally generated;
- If appropriate there should be conformity to existing excursive contacts;
- Existing tooth mobility can be maintained but there should be no worsening of any mobility;
- Occlusal plane orientation should be determined predominantly by aesthetics but can be modified by differing gonial angles;
- There should be no soft tissue impingement during occlusal contact.

To end this section, a word about occlusal plane orientation, especially with respect to complete dentures. There are many myths that surround prosthodontics in general and complete dentures in particular,[15,16] and one of the most common is that the occlusal plane should orient to Camper's plane or line. There are several problems with this, not least of which is just what Camper's plane is, as its definition has changed over time. But more importantly, the evidence is that the natural occlusal plane does not orient to Campers plane. This has been shown in a number of studies and reviews over the years: for example a 1996 study[17] concluded that *"the reliability of Camper's line as a guideline to simulate the natural occlusal plane is questionable"* and in 2003 a paper concluded "Cephalometric analysis alone cannot determine the location of the occlusal plane in edentulous patients. Intra-oral structures should also be considered."[18] A more recent study in 2017 confirmed this by advising that whilst a horizontal plane or even Camper's plane may be useful initially, "additional anatomic and aesthetic parameters are required for verification of an aesthetically pleasing occlusal plane angle".[19] In developing an appropriatech technique for complete dentures we have found that the most consistent method of obtaining an occlusal plane that is functionally stable is to use an aesthetically acceptable arrangement of the maxillary anterior teeth as an anterior determinant, and the unchanging retro-molar pad as the posterior determinant. [20]

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