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## The ideal functional occlusion: A contemporary opinion

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### Abstract

Whenever we are involved in tooth displacement, we must refer to an occlusal concept. There are several, the most used remains that of gnathologists: the canine protected occlusion.

In this concept, the upper canine has the privileged role of guiding the laterality movement on its own, without the participation of the other teeth.

However, some authors in literature reviews believe that the concept of canine protected occlusion or even that of group function occlusion is without any real scientific basis. They were primarily proposed for the clinical simplification they represent.

The aim of this work is to discuss our knowledge on the general topic of functional occlusion in order to be able to make evidence-based treatment decisions.

**Keywords:** Canine function occlusion; Group function occlusion; Balanced occlusion; Laterality movements; Chewing function

### 1 Introduction

The classic studies of Angle <sup>1,2</sup> and more recently that of Andrews <sup>3</sup>, have established the criteria for optimal (ideal) morphological relationships of human dentition (although there is little evidence of a biological relationship associated with these criteria). However, the optimal model of functional occlusion has not been so easily identified and has largely eluded the dental profession. Ash and Ramjford <sup>4</sup> wrote: «*Orthodontic classifications are more dependent on anatomical and esthetic standards than on neuromuscular balance and functional stability. It has not been possible to develop a consensus, on a numerical index or a system of values that applies both to form and function of the masticatory system*».

Dentists and orthodontists have all been confronted at one time or another with the gnathological concept of occlusion. The principle of «canine protected occlusion» is certainly one of the best known and best defended precepts.

However, a significant number of authors <sup>5,6</sup> believe that the concept of canine function has no real scientific basis.

Scientific rigor requires us to practice orthodontics based on the level of evidence.

The purpose of this article is to discuss past and current knowledge in the field of functional occlusion (in particular those concerning canine protection and orthodontics) and to confront them with the scientific and relevant decision-

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making authorized by a grounded approach on the level of evidence. We offer a different perspective on what constitutes the optimal functional occlusal model in orthodontics.

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## 2 Historical-Literature review

At the beginning of the 19th century, life expectancy increased and eating habits changed. The number of totally edentulous patients is increasing considerably. Thus, dental surgeons are increasingly confronted with making total prostheses.

Between 1800 and 1930, occlusal concepts were studied in order to rehabilitate totally edentulous people. Eccentric movements in the concept of bilateral balanced occlusion are considered essential.

The concept of balanced occlusion (Simultaneous dental contacts on the working side and the non-working side during laterality movements) was introduced by the dentist and mathematician, Bonwill quoted by Sabek <sup>7</sup>, from 1885 who studied the foundations of the articulation of human teeth. He also presented the geometric and mechanical principles of occlusion.

Bilateral dental contacts during deduction movements of the mandible are a means of increasing the stability of prostheses.

Thus all prosthetic rehabilitations were carried out according to this concept because, at that time, it was thought that the teeth articulated naturally according to this occlusal diagram.

Von Spee <sup>8</sup> also originated the concept of bilateral balanced occlusion. He observes that « the masticatory surfaces of the molars align themselves according to a convex curve downwards for the maxilla and a concave curve upwards for the mandible »: this is what will later be called the curve of Spee. He suggests the use of this curve in the construction of complete prostheses: it makes it possible to increase masticatory efficiency and also to eliminate the effects of leverage during mastication.

In the 1920s, many practitioners were convinced that the therapeutic model adopted in total prosthetics could be applied to natural teeth.

However, Gysi <sup>9</sup> distinguishes the anatomical and functional difference of dentate and edentulous situations. According to him, the mandibular movements depend on the incisor slope and the condylar slope.

Schuyler <sup>10</sup> does not think that « all the principles applicable to complete prosthetics are also applicable to natural dentition. It is not possible to obtain the same degree of perfection of the occlusal relations as with a complete prosthesis ».

Stuart and Stallard <sup>11</sup> found that reconstruction of natural teeth in bilateral balanced occlusion:

- Results in an unstable occlusion;
- Often shows increased wear of teeth and restorations.

Following the clinical failures encountered, Stuart and Stallard introduced the concept of canine protected occlusion CPO in natural dentition.

With regard to the unilateral balanced occlusion, it was introduced by Shuyler in 1929. This concept comes directly from the concept of the bilateral balanced occlusion. The group function occlusin appears to be the direct descendant of the bilateral balanced occlusion theory.

Schuyler, a proponent of the group function occlusion, observes that even if contacts are essential in balanced occlusion to stabilize complete dentures, they can be traumatic in natural dentition and thus cause dysfunctions of the masticatory apparatus, periodontal involvement or excessive wear. . Schuyler and his followers therefore replaced balanced occlusion with unilateral balanced occlusion or group function occlusion.

According to this concept, we must not have contact in lateral excursion on the non-working side, whereas on the working side, we must obtain a group contact.

### 3 Canine protected occlusion

According to Sabek's article <sup>7</sup> (1996), the work of Shaw <sup>12</sup>, Stuart <sup>11</sup>, Stallard <sup>11</sup> and D'Amico <sup>13</sup> originated the concept of modern gnathology.

The principles of gnathology are:

- Take into account the stomatognathic complex as a whole;
- Understand that mandibular dynamics have an effect on the anatomy of all teeth and their position on the dental arch;
- Take the time to measure and record mandibular movements to make a diagnosis;
- The patient information is programmed on an adjustable articulator, the occlusion is recorded in centric relation.

The occlusal diagram to be obtained is the following:

- In OIM, cusp-fossa relationships (one tooth on one tooth) ensure the stability of the mandibular position which is carried out in RC;
- In propulsion, anterior guidance ensures the absence of posterior contact;
- In diduction, a canine function on the working side ensures the absence of contact on the non-working side (**fig. 1**).



**Figure 1** Diduction on the left. Mandibular guidance is provided by the canines alone

Gnathologists also idealize the dental relationship. Indeed, at the level of the cuspid teeth, a relationship is established either between a cuspid tip and two antagonistic marginal ridges, or between a cuspid tip and a fossa. This relationship, through a triple stabilizing contact, has been considered decisive for vertical balance and occlusal stability: it bears the geometric name of tripodism.

Continuing their description of the modes of construction, gnathologists propose anterior contacts that are lighter than cuspid contacts in maximum intercuspation: the anterior teeth protect the cuspid teeth from efforts with a transverse component when performing movements; the cuspidated teeth protect the anterior teeth during the tonic phases that return during a chewing cycle.

During the diduction movement, the canine supports the immediate disocclusion of the cuspidated teeth: such is the gnathological point of view of mutual protection.

For gnathologists, canine function is the ideal functional pattern towards which any orthodontic treatment should be directed.

They even claim that orthodontists, who do not complete their case in accordance with this principle, potentially predispose patients to temporomandibular disorders (TMD) and orthodontic tooth relapse.

However, no particular type of functional occlusion seems to predominate in nature.

D'Amico <sup>13</sup>, Scaifet Holt <sup>14</sup> found that Canine protected occlusion was predominant. Beyron <sup>15</sup> and MacMilan <sup>16</sup> found a predominance of group function occlusion. Rinchuse <sup>17</sup>, Ahlgren and Posselt <sup>18</sup>, Weinberg <sup>19</sup>, Woda <sup>20</sup>.and others have found the prevalence of bilateral balanced occlusion.

The advocates of canine protected occlusion (D'Amico <sup>13</sup>, Nagao <sup>21</sup>) argued that humans naturally have long and dominant canines; moreover they are the most robust and have the most sensitive proprioceptive fibers. They are therefore the best suited to protect the occlusion from the forces that develop during mandibular movements.

However, occlusodontists (MacMillan <sup>22</sup>, Beyron<sup>15</sup>) maintain that the canines are not necessarily the most robust human teeth (molars which have 3 or 4 roots offer significant support to the teeth) and do not necessarily have more sensory receptors and proprioceptive than others.

In addition, Ash and Ramjford<sup>4</sup> argued that prominent canines can adversely “restrain normal lateral movements and the patient may develop chewing motions with a steep path of closure into centric occlusion.”

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#### 4 Group function occlusion or unilateral balanced occlusion

For supporters of Shuyler, it is not good to “lock” the dento-dental relationships in terminal closure. There is a space of antero-posterior “freedom” between the position of centric relationship occlusion and maximum intercuspitation occlusion called “long centric”. In the transverse direction, we speak of “wide centric”.

During mandibular movements, there are only sliding contacts on the working side (**fig. 2**) during lateral movements. Called “group function occlusion”, these contacts are based on:

- The external slopes of the mandibular vestibular cusps;
- Against the internal slopes of the maxillary vestibular cusps.



**Figure 2** Group function occlusion extended mesial and distal to the canine

Schuyler, quoted by Linda <sup>23</sup>, who is a group function occlusion trendsetter said: “Why put all this stress on the canine? Whenever the canine prevents contact with other teeth in an eccentric position, functional efficiency, comfort and the most desirable or favorable distribution of forces on the periodontium are detrimental.

The occlusodontists who defend group function occlusion <sup>24,25</sup> claim that population studies support the prevalence of group function occlusion over canine protected occlusion. They also indicate that Aboriginal Australians presented group function occlusion.

Beyron, quoted by Linda <sup>23</sup> in 1990, conducted a series of investigations into the progressive changes in dental occlusion in natural dentition. He demonstrated that group function contributed to occlusal wear and was even able to distribute tension.

In mature natural dentition, physiological occlusal wear progresses which allows the teeth to be maintained in a state of balance.

## 5 Balanced occlusion

For followers of balanced occlusion <sup>9,26</sup>, we must have simultaneous contacts laterally on the working and non-working side (**fig. 3**):

- Working side: contact between the external slopes of the mandibular vestibular cusps and the internal slopes of the maxillary vestibular cusps.
- Non-working side: contact between the internal slopes of the maxillary palatal cusps and the internal slopes of the mandibular vestibular cusps.

In propulsion, simultaneous contact of the anterior and posterior teeth.



**Figure 3** Simultaneous dental contacts on the working side and on the non-working side

For Pedro Planas <sup>26</sup>, the normal shapes of teeth are evolving thanks to the function. Which makes him reject «*stereotypical theories such as canine protected occlusion, group function occlusion, cusp -pit occlusion...*».

For Planas, a balanced occlusion is an occlusion where «*all the mandibular teeth articulate, up to bordering occlusion, with all the maxillary counterparts, with the exception of the canine on the swinging side*» <sup>in 27</sup>.

This is a very difficult objective <sup>in 27</sup> to obtain, which is why most occlusodontists have given up trying to achieve it, proposing easier «models»: canine protected occlusion, group function occlusion... and reproach the balanced occlusion to have been designed for total prostheses on the one hand, and especially to be abrasive on the other hand, because of the generalized sliding of the lower teeth against the upper ones.

For Gaspard <sup>28</sup>, without denying the possibility of contacts between the opposing teeth on the orbiting side during physiological mastication, "*contacts that are always fleeting, lightly supported, sporadic, essentially stochastic, and which are absolutely not essential for perfectly effective mastication*" the rule of the constant bilateral contact, during diduction, does not verify either in children or in adults.

For Rinchuse <sup>5</sup>, no scientific study has proven that canine protected function is the occlusal optimum to be achieved; group function occlusion or balanced occlusion remain just as valid.

For Borie <sup>29</sup>, the work of the canines is less intense than that of the molars during mastication.

For Woda and Fontenelle <sup>30</sup>, nothing proves that an occlusion in diduction with non-working contacts (but without interference) is dangerous. Practically, the fact remains that avoiding an occlusion with non-working contacts is, without doubt, one of the sure ways of obtaining an occlusion without interference from the non-working side.

Raymond and Kolf <sup>31</sup> propose a hypothesis according to which the three concepts (group function occlusion, canine protected function, balanced occlusion) of occlusion could be three different states of an occlusal organization which evolves, or matures, over time and functional demands.

But for there to be wear, you need normal operating conditions with an adequate diet.

This process of maturation of the occlusal organization can be observed for example among the Yanomami Indians <sup>32</sup> who have a diet composed of hard and dry foods (**fig. 4**).

Finally, according to Philippe <sup>33</sup>, it does not seem imperative to seek one or the other form at all costs, either by significant extrusion of the canine, or by extensive grinding that risks going as far as the dentin, but it is It's best to respect everyone's situation.



**Figure 4** Yanomami Indians according to Van Der Laan <sup>32</sup>. Lateral movements for two individuals of different ages: a - around 18 years old; b - around 30 years old. These two mouths reveal an early « maturation» of the occlusion which is organized according to the « balanced type»

An important point regarding functional tooth contacts on the non-working side needs to be clarified, the terms “contacts” and “tooth interferences” are often confused.

The term non-working interference is reserved for a situation where the non-working contact prevents the working contacts.

Faulkner <sup>34</sup> and Weiland <sup>35</sup> assert that non-working occlusal interferences can cause dental mobility, occlusal trauma and deviation of the mandible, bruxism, recurrence by dental displacement and dysfunction of the manducatory apparatus.

Agerberg <sup>36</sup> and collaborators found these interferences in 25% of adults with symptoms of craniomandibular dysfunction.

Even if the specialists agree to consider occlusal disorders (malocclusions, interferences, etc.) as a predisposing or aggravating factor but not a triggering on its own, for the orthodontist who reconstructs the occlusion, it seems necessary to avoid situations which are often associated with pathological conditions.

The term non-working contact (but without interference) is benign and there is no evidence that an occlusion in diduction with non-working contacts is dangerous.

For some authors <sup>30</sup>, avoiding an occlusion with non-working contacts is undoubtedly one of the safe ways to obtain an occlusion without interference from the non-working side.

Korioth and hannam, Gesh <sup>in 5</sup> consider on the contrary that non-working contacts laterally could exert a protective action on the temporomandibular joints.

Ash and Ramjford<sup>4</sup> argued against the claim that all lateral forces and stresses on the teeth from balancing contacts are problematic and undesirable: “Lateral stress on the teeth is desirable within physiologic limits; it stimulates the

development of a strong fibrous periodontal attachment around the neck of the teeth and decrease the risk of traumatic periodontal disease by occlusal forces.

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## 6 Relationship between static occlusion and functional occlusion

Contrary to what gnathologists claim, the results of a study carried out by Tipton and Rinchuse<sup>37</sup> on 101 subjects, show that it is the balanced occlusion which appears more frequently in subjects presenting normal (ideal) static occlusions (class I occlusion), compared to subjects with Angle's malocclusion.

Rinchuse<sup>5</sup> writes : « *It appears that balanced occlusion exists to a far greater extent than gnathologists maintain and that balanced occlusion appears to be more predominant in subjects with normal (ideal) static occlusions (or Class I occlusions) vs Angle malocclusions.*

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## 7 Is the functional occlusion data valid?

For Rinchuse<sup>5</sup>, Clark and Evans<sup>38</sup>, the validity of the functional occlusion data from the research is subject to question.

For the recording of functional occlusion, the patient is not asked to chew or swallow but to make movements laterally mandibular. Is that logical?

However, an operating model based on chewing and swallowing exists, it was described by Lauret and Le Gall<sup>39</sup> in 1994. It validates the relationship between form and function; it may still have to be put into extensive practice to validate it.

For Marcel Le Gall<sup>40</sup>, the movements and contacts of the teeth during incision and chewing are completely opposite to those usually obtained for analyzing the occlusion.

He even thinks that the model chosen so far to study the occlusion is not the manducator apparatus but rather the articulator and the canine protected occlusion as it is conceived by gnathologists, is in reality only a way to simplify what is really happening with the teeth.

Without minimizing the role of the canine which accompanies (with the other teeth) the mandible at the start of chewing, this author<sup>40</sup> thinks that it is the first permanent molars which are the guiding teeth of the dento-dental guidance from their appearance at 6 years of age (marking thus the establishment of adult chewing) and that they will remain so thanks to their anatomical structure and their abrasion facets more marked than those of other teeth.

At the end of chewing, on the non-working side, the canine plays the supporting role of a lever of the second kind allowing an optimal action of the elevator muscles on the opposite side. (It is in this context that the canine protected occlusion takes all its meaning).

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## 8 Discussion

To assert that canine function is superior and preferable to other functional models seems to us to be abusive.

This is not a criticism of canine function as such, we just want to show that other types of functional occlusions can also be physiological and beneficial to health; it depends on the individual characteristics of the stomathognathic system of each patient.

Isaacson<sup>41</sup> recommends the «biological concept of occlusion». For him, no single type of functional occlusion will be physiologic for every patient.

For instance, he argued that, for a patient with periodontal bone loss involving the anterior teeth and who also bruxes, perhaps occlusal forces and stresses should be removed from these teeth and more force placed on the posterior teeth.

If we accept the validity of canine protected occlusion and finish an orthodontic treatment respecting this concept, what can be its durability, where the wear of the canines will be inevitable with aging? Can canine protected occlusion subsequently evolve into a group function occlusion, then into a balanced occlusion by progressive functional adaptation?

Weiland <sup>42</sup> and Storey <sup>43</sup> think so and state that canine protected occlusion is not stable over time and that it tends to become a group function occlusion for one and a balanced occlusion for the other due to the wear of the teeth.

On the other hand, the dogma claiming that only CPO ensures the stability of orthodontic alignments and prevents TMD is neither logical nor correct <sup>29</sup>.

Data from epidemiological studies lead to the conclusion that occlusal factors play only a minor role in the multifactorial etiology of TMD (Mc Namara <sup>44</sup>, Griffiths <sup>45</sup>, Dolwicks <sup>47</sup>, etc.).

In addition, no study has been able to show that canine protection has a therapeutic value and that it prevents or treats TMD.

With regard to the role of canine protected occlusion in the stability of orthodontic results, Lopez-Gavito <sup>47</sup> and his collaborators found no difference in long-term stability between patients who present canine contacts during functional excursion and those who present anterior open bite without any canine contact in centered occlusion (nor in functional excursion).

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## 9 Conclusion

Our aim is not to stir up any quarrel between different occlusal concepts, but to make orthodontists aware that the criteria which determine an "ideal" functional occlusion have not been conclusively established.

Canine protection may only be one of the possible models of optimal functional occlusion, towards which to orient orthodontic treatments.

Group function and balanced occlusion (without interference) appear to be acceptable functional occlusion patterns, depending on the patient's own characteristics.

A functioning model based on the chewing function would perhaps provide more answers.

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## Compliance with ethical standards

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I declare that there is no conflict of interest regarding this article.

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