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## Clinical contribution

# Treatment of Class III malocclusion: the key role of the occlusal plane

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### ABSTRACT

Patients with a Class III malocclusion generally present with a counterclockwise inclination of the occlusal plane, converging with Camper's line towards the front. This slope has an effect on mandibular movement (forward posture) and on chewing mechanisms in general. As dysfunctional mastication is likely to influence facial growth and inter-arch stability negatively, early orthopedic therapy of the occlusal unbalance concurrent with Class III malocclusion is justified. The aim of this article is to present a method of Class III treatment based on a correct re-orientation of the occlusal plane in order to achieve an optimal masticatory mechanism, essential for stability of early treatment outcomes.

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## 1. Introduction

Most Class III malocclusions are combinations of maxillary retrusion and mandibular protrusion<sup>1</sup> and they are often characterized by mesio-occlusion of lower molars, generally accompanied by anterior crossbite. Class III malocclusions are associated with various dysfunctions, including chewing disorders. Chewing is the principal function of the masticatory apparatus. Restoring a physiologically normal mastication is an important objective of orthodontic treatment.

### 1.1. Physiologic orientation of the OP in Class I occlusion

Angle Class I molar and canine occlusion is considered ideal. Its parameters are interdependent, as expressed in Thielemann's formula.<sup>2</sup> Orientation of the occlusal plane (OP) plays a critical role<sup>3</sup> in allowing mandibular movement characterized by:

- symmetrical lateral excursion to the right and left sides;
- protrusion and vertical components of lateral movement that allow friction between almost all the teeth in both arches (Figs 1a-d).

### 1.2. Pathologic orientation of the OP in Class III malocclusions

Physiologic mastication depends on the relationship between the slope of the mandibular condyles and the orientation of the OP.<sup>4</sup> The shape and orientation of the OP vary from one individual to another. In fact, to ensure effective chewing, it is essential that the OP is close to parallel to the Camper's plane<sup>5,6</sup> (Fig. 2a).

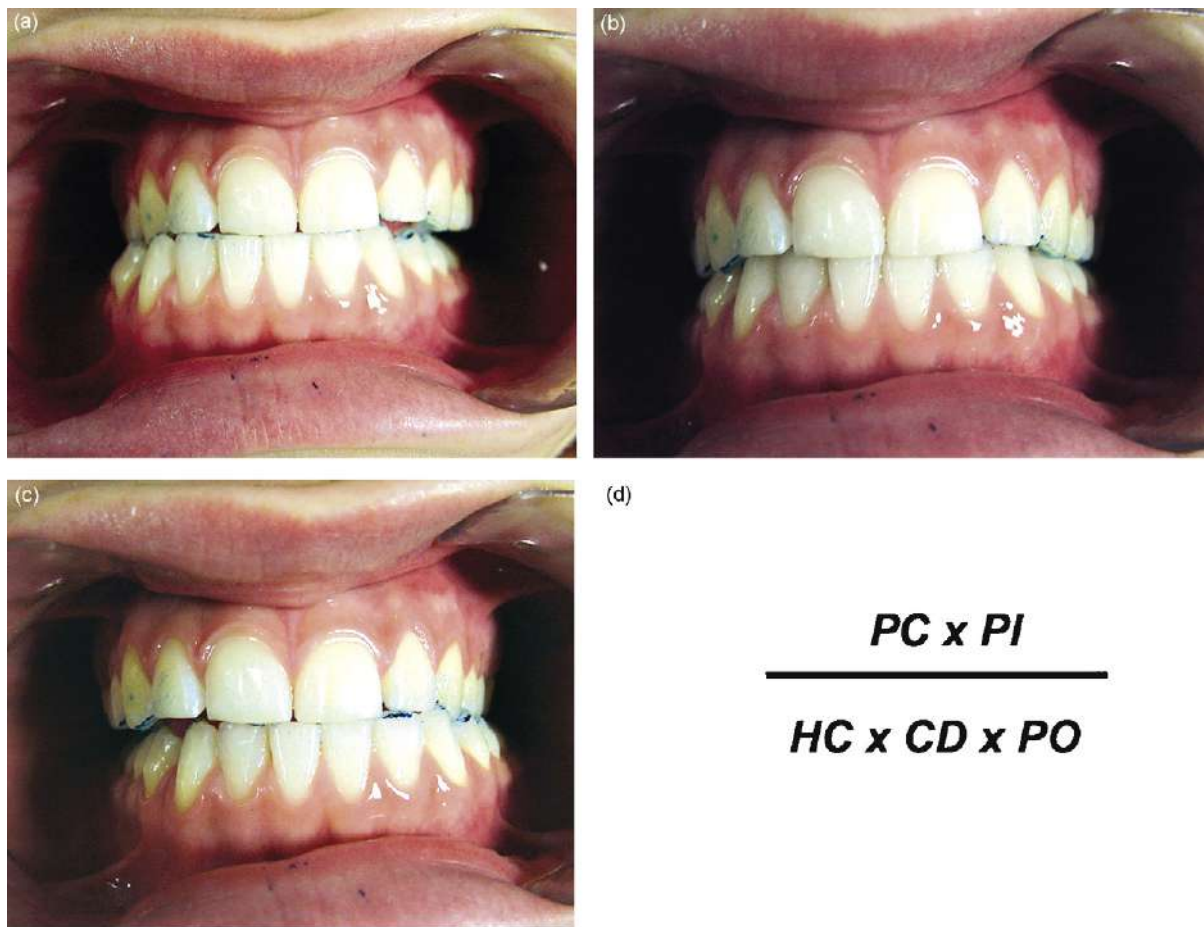
In some cases, OP orientation is so abnormal that its pathologic nature is easily identified. In others, the changes are negligible and can escape clinical detection when performed with investigations involving maximum intercuspation occlusion (MIO) or cephalometric analysis.

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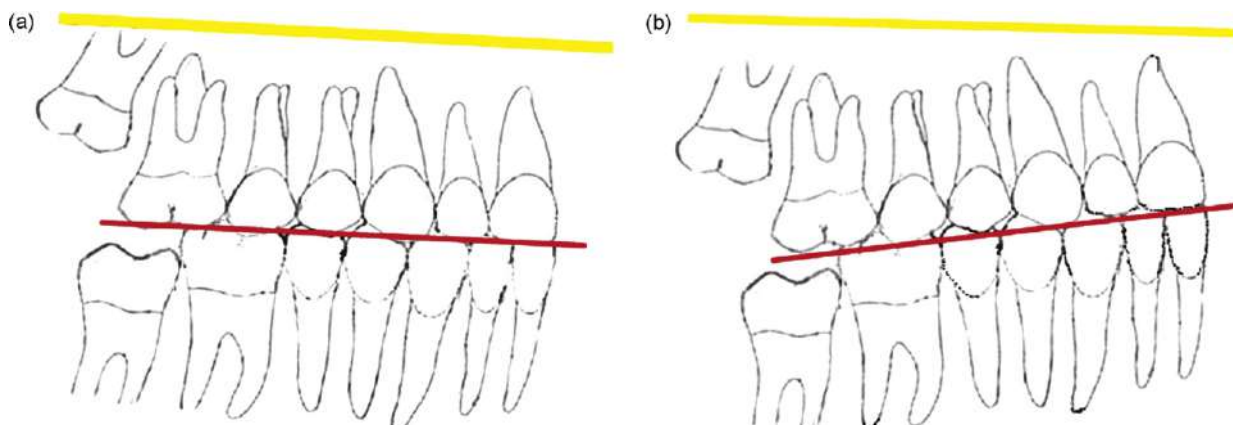


**Fig. 1 – Endo-buccal views showing: a) lateral mandibular movements: to the right; b) MIO; c) lateral mandibular movements: to the left; d) Thielemann's formula: CG: condylar guide; IG: incisor guide; CH: cuspid height SC: spee curve; OP: occlusal plane.**

A recent study by Tanaka and Sato<sup>7</sup> demonstrates a relationship between the inclination of the OP and mandibular position. Indeed, Class III malocclusion presents with an OP more or less inclined backward and downward with its posterior part (Fig. 2b). The examination of lateral mandibular movements reveals exaggerated propulsive and vertical components, thus rendering the incisor guide ineffective<sup>4,8</sup> (Figs 3a-c).

## 2. Treatment of Class III malocclusion taking into account the OP cant

In line with the study by Tanaka and Sato,<sup>7</sup> an etiologic approach based on the cant of the OP should be considered in the correction of Class III malocclusion. In this type of disharmony, orthopedic correction should not only be aimed



**Fig. 2 – a) Physiologic inclination of the OP (red line) is approximately parallel to Camper's line (yellow). b) Class III malocclusion: pathologic orientation of the OP backward and downward in comparison to Camper's line (yellow).**



**Fig. 3 – Class III malocclusion: a) during MIO; b) during lateral mandibular movement to the right; c) during lateral mandibular movement to the left. The vertical and sagittal mandibular movements are excessive.**

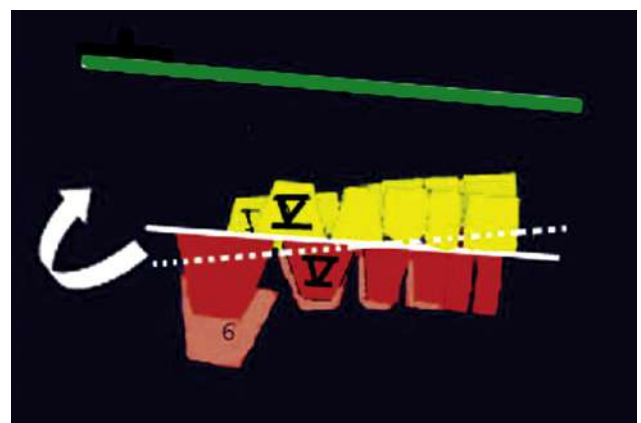
at protraction of the maxilla, but also correction of the orientation of the OP. Our objective in the present paper is to present a theoretical and clinical approach to the correction of the cant of the OP when treating Class III malocclusions in order to enhance the effectiveness and stability of treatment results.

### 2.1. Therapeutic objectives

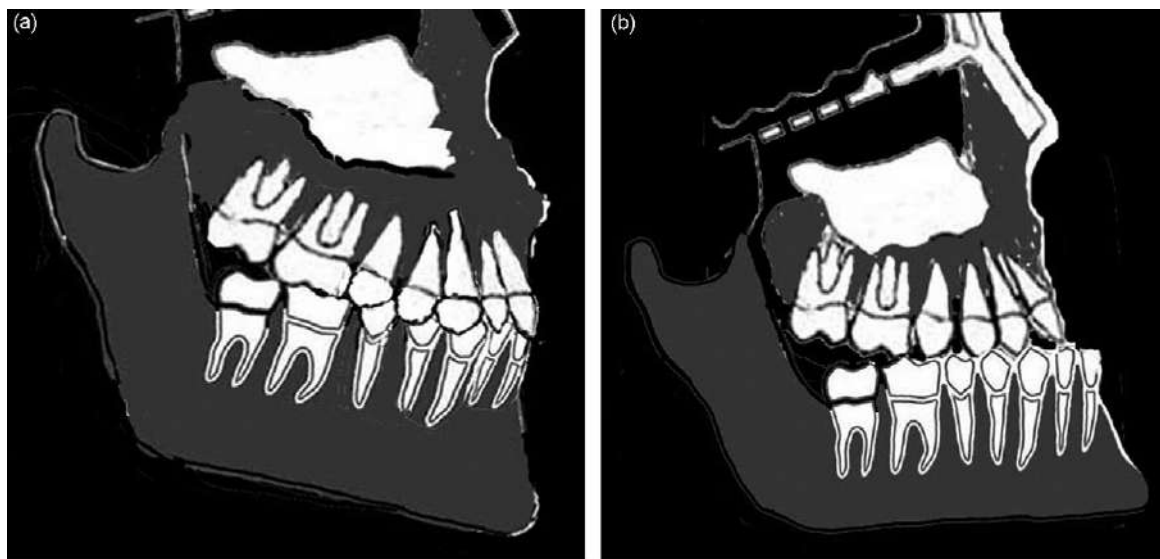
The main objective of orthopedic treatment that takes into account OP orientation is to ensure that the OP is compatible with physiological mastication<sup>3,9</sup> (Fig. 4).

Postero-anterior traction using a face mask with the aim of achieving just a “static” incisor relationship might be not sufficient to guarantee successful treatment and subsequent stability. Indeed, a treatment that leads to “satisfactory” incisor relation in MIO but does not correct the orientation of the OP may experience relapse during the eruption phase of the posterior teeth, when the OP lengthens and the occlusal disharmony due to the pathologic OP orientation worsens.

The relapse tendency can be explained by the fact that the inter-arch relationships are not adapted to physiological mastication. The arrangement is characterized by cycles of exaggerated vertical and propulsive mandibular movement



**Fig. 4 – Schematic drawing showing clockwise rotation of the OP: the dotted white line marks the initial pathologic orientation to the back and bottom; the solid white line marks the final orientation of the OP, which is approximately parallel to Camper's plane (in green). The inclinations are exaggerated for clarity.**



**Fig. 5 – Schematic drawing showing the forces of mastication with (a) a well oriented OP (Angle class I); and (b) a poorly oriented OP (Angle class III).**

induced by posterior occlusal “interferences” related to the flat orientation of the OP. This renders the anterior guide ineffective from the point of view of proprioception, as there is no friction between upper and lower incisors.

This unsatisfactory situation has two immediate consequences for maxillo-facial development:

- increased stimulation of “propulsive structures” may induce excess mandibular growth;
- unfavorable orientation of the forces involved in mastication impairs the stability of the advanced position of the maxilla (Fig. 5).

## 2.2. Development of a treatment method that takes into account the OP

Maxillary protraction<sup>10</sup> with a face mask and egression of the lower molars allow favorable reorientation of the OP (Fig. 4). This repositioning of the lower molars determines the final three-dimensional orientation of the OP and is obtained using a bonded acrylic-splint with a rapid palatal expander (RPE) and a face mask treatment.

### 2.2.1. Sagittal and vertical orientation

The intra-oral appliance that we use is a bonded occlusal splint that does not cover the maxillary incisors and is equipped with a RPE<sup>3</sup> (Fig. 6). Changes can be made in three dimensions in order to achieve the desired effects. Its initial profile reflects the sagittal and vertical orientation of the desired OP (Fig. 7).

Posterior vertical occlusal space due to the anterior thickness of the splint constitutes a “reserve” of vertical space allowing the lower molars to erupt before grinding.

At the beginning of treatment, posterior grinding (type 1 grinding)<sup>3</sup> creates a vertical space for lower molar eruption. At the same time, mesial projection of the upper arch due to the action of the face mask increases this posterior space and, consequently, improves eruption of the lower molars (Fig. 8).

### 2.2.2. Transverse orientation

The transverse maxillary hypo-development<sup>10,11</sup> often associated with Class III finds its expression in different ways (palatal position of lateral incisors, retained permanent canines, etc.).

The choice to relieve the transverse constriction by extracting teeth should be avoided as reducing the number of teeth is equivalent to reducing osseous volume and also the potential perimeter of the arch. The latter is already under-sized, increasing posterior interference during lateral mandibular movements.

It is therefore necessary to carry out maxillary expansion taking into account occlusal requirements. In all cases, it is preferable to overcorrect the transverse dimension of the maxilla.



**Fig. 6 – Endobuccal view of the orthopedic disjunction splint.**

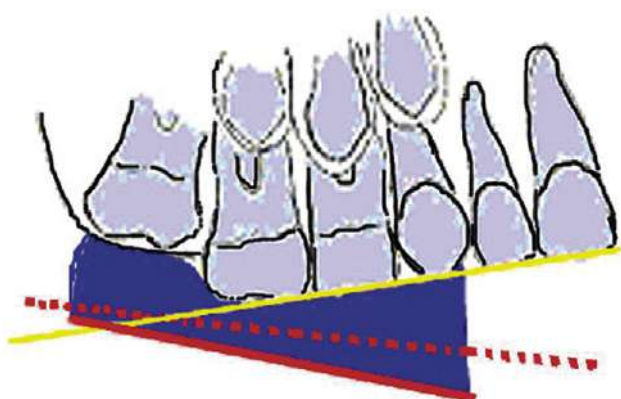


Fig. 7 – After grinding, the splint (in blue) constitutes a usable space for reorientation of the OP. The original pathologic orientation is shown in yellow. The dotted red line is the desired orientation of the OP. The initial orientation of the splint is in red.

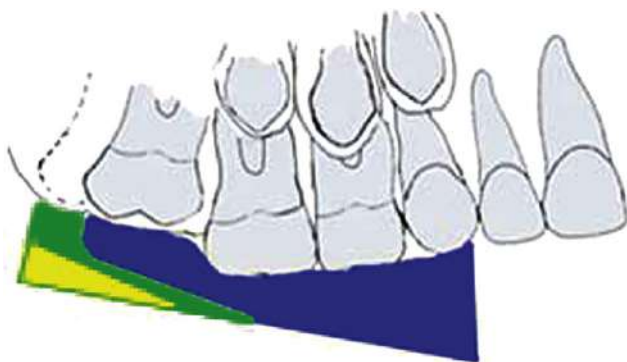


Fig. 8 – The posterior space obtained by grinding of the splint (blue) and by maxillary mesial displacement due to postero-anterior traction using a face mask. Yellow triangle: space created by type 1 grinding of the posterior part of the splint; green triangle: total space obtained with both grinding and protraction.

Transverse correction begins as soon as the appliance is fitted. The sutural separation of the palate, by rapidly correcting maxillary hypo-development, facilitates early restoration of symmetrical mandibular lateral movements. If not, the ante-

rior occlusal part of the splint can be ground (type 2 grinding)<sup>3</sup> in order to obtain symmetrical movements.

When lower molar eruption (which determines a correct OP orientation) is achieved, the operator can selectively decrease the height of the splint (type 3 grinding).<sup>3</sup> Over a series of grinding sessions – three or four on average – the vertical dimension can be gradually reduced while preserving symmetrical movements of diduction. Bringing the incisors together in this way progressively establishes a functional anterior guide.

### 3. Justification of the early orthopedic treatment of Class III

The majority of authors recommend early treatment of Class III malocclusions<sup>12-19</sup> based primarily on:

- the possibility of influencing maxillo-facial development at the time of growth;
- the trend of Class III skeletal malocclusions to natural worsening.

Early treatment can produce significant favorable modifications in both maxillary and mandibular structures that can still be assessed at a post pubertal re-evaluation (19).

These factors are indeed an important justification for early treatment, but also the significance of the role played by occlusion should be considered.

#### 3.1. Occlusal factors that justify early treatment: simple occlusal structure

##### 3.1.1. Shape of the OP

In deciduous dentition, the architecture of the OP is simple, as the curves of compensation (Spee, Wilson) do not exist. They emerge progressively along with the eruption of the teeth, particularly the permanent posterior teeth. Achievement of therapeutic objectives, particularly grinding of the orthopedic splint, is therefore simpler with early treatment.

##### 3.1.2. Length of the OP

The length of the OP, in other words the number of molars present on the arch at the beginning of treatment, in large part determines the degree of difficulty of treatment when this includes reorientation of the OP.

The late deciduous dentition represents the simplest stage. Eruption of the first molars, marking the beginning of early mixed dentition, corresponds to additional but manageable

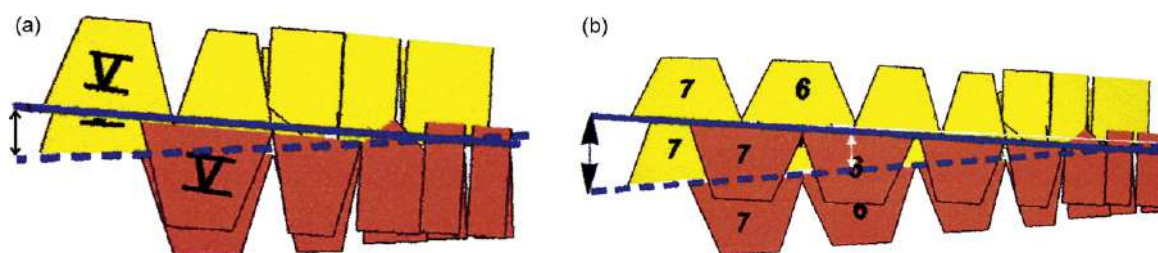
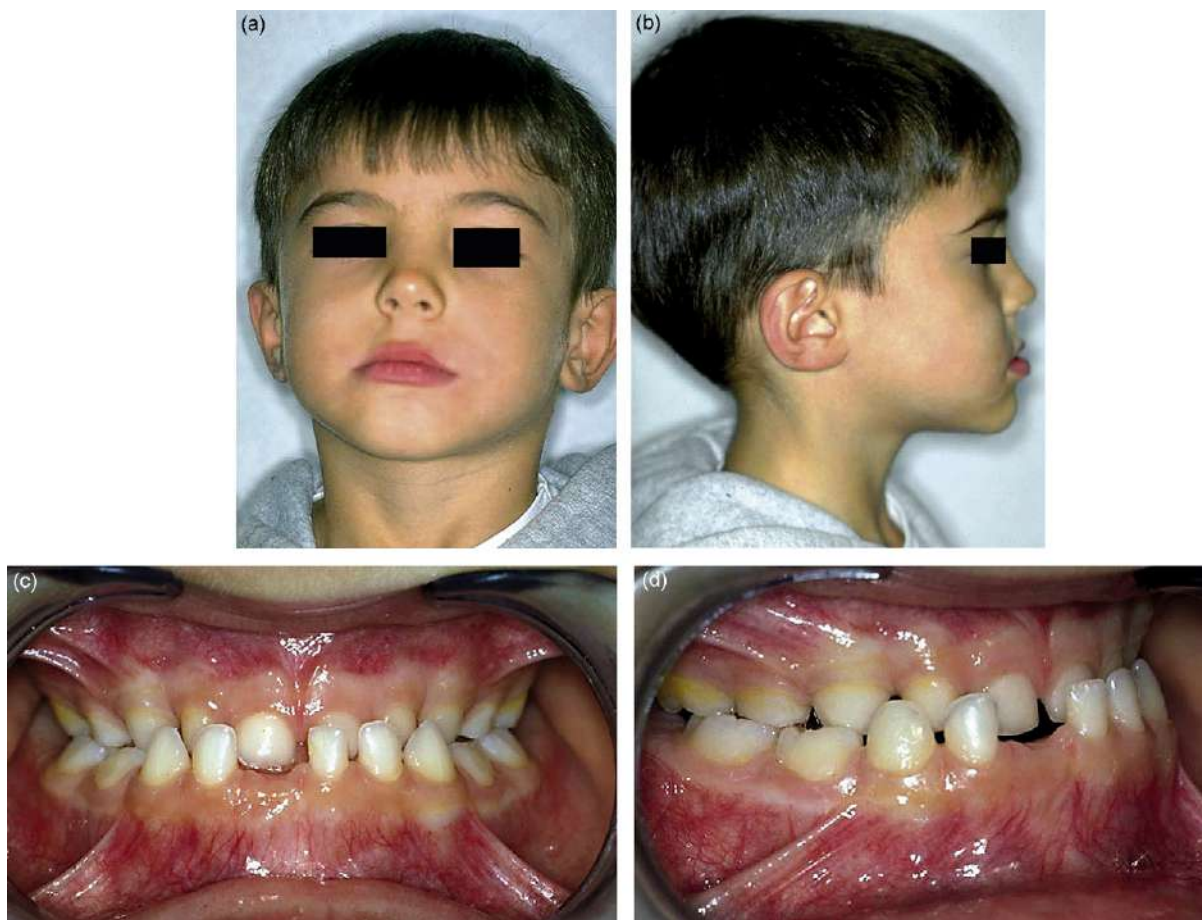


Fig. 9 – Vertical displacement of the OP according to its length. In the deciduous dentition (a) clockwise rotation of the OP - lower molar eruption is relatively weak compared to that necessary when second molars are present (b).



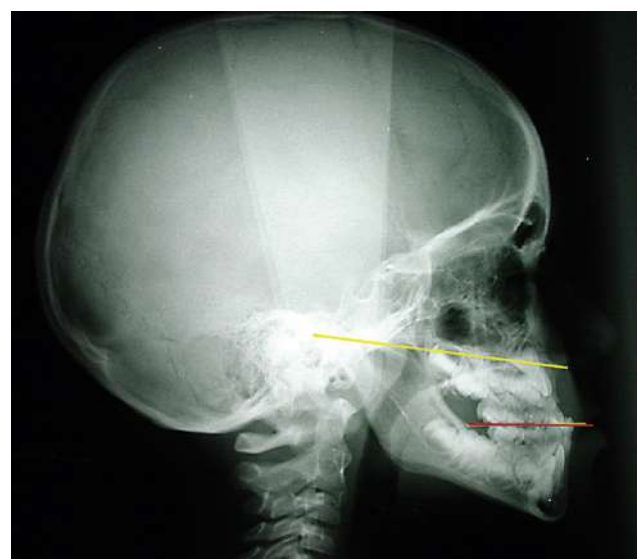
**Fig. 10** – Initial photographs taken on December 1998 (patient was 6 years and 3 months of age). a,b) Frontal and lateral views of the face. c,d) Pretreatment intraoral views (anterior and posterior crossbite).

difficulty with a strong likelihood of success. Eruption of second molars represents transition to a much more complex stage. Depending on the severity of the initial sagittal shift, the chances of success are poor, also in relation to unfavorable skeletal response.

These increasing therapeutic difficulties are due to the fact that the longer the OP, the greater the vertical movement required of the lower molars, which may be beyond the possibilities of current therapeutic techniques (Fig. 9).

In conclusion, the longer the OP, the more difficult it is to reorient the OP.<sup>3,9,14</sup> In other words, correction is easier when the OP is short – hence the importance of early treatment. Moreover, at the beginning of orthopedic treatment, the goal is “relative shortening” of the OP:

- by postero-anterior traction via a face mask, which, by moving maxillary teeth forward, produces a “relative reduction” in the molar zone;
- by delaying eruption of the last upper posterior teeth by means of a splint, which covers the occlusal surface of the molar or is in correspondence of the eruption site if eruption of the molar is imminent. The teeth in question are the first permanent molars in the deciduous dentition, and the second permanent molars in the mixed or permanent dentitions.



**Fig. 11** – Initial cephalometric radiograph showing a pathologic orientation of the occlusal plane backward and downward in comparison to Camper's line (yellow).

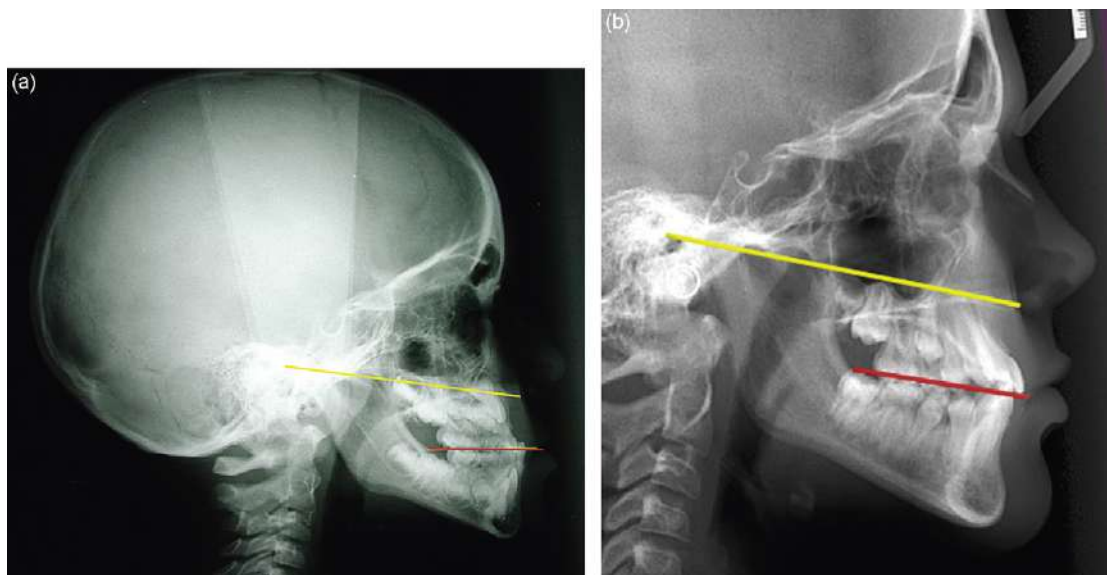


**Fig. 12** – Intraoral views taken in November 2000 (9 months after the removal of the orthopedic appliance, a,b) and in January 2001 c,d): 1) during lateral mandibular movement to the right; 2) during lateral mandibular movement to the left. They show the upper incisors eruption and the setting up of a functional anterior guide.



**Fig. 13a-c** – Right, frontal, and left intraoral views taken 4 years and 11 months after orthopedic treatment. No over appliance was used after the removal.





**Fig. 14 – a) Initial cephalometric radiograph before orthopedic treatment; b) cephalometric radiograph taken 4 years and 11 months after orthopedic treatment showing clockwise rotation of the occlusal plane.**

### 3.2. Functional justification for early treatment

#### 3.2.1. Stopping progression of unfavorable growth

Early normalization of mastication via reorientation of the OP can yield two immediate consequences:

- it may reduce the pathologic growth mechanism that favors mandibular development over that of the maxilla;
- correction of the Class III skeletal base also requires normalization of muscular posture (labio-mental, lingual, velo-pharyngeal) and of orofacial functions (nasal ventilation, swallowing, mastication).

#### 3.2.2. Improvement of outcomes

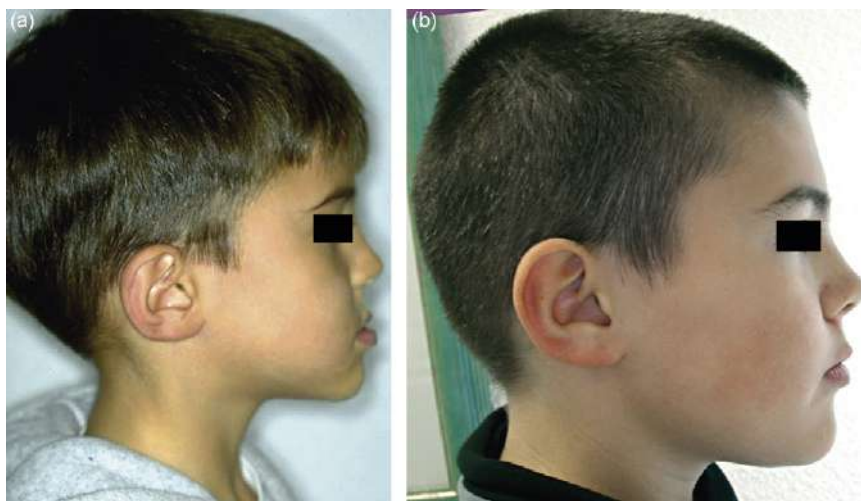
Restoration of physiologic mastication by early treatment helps the effectiveness of therapy. The mechanisms of alveolar growth determined by the forces of mastication project the maxilla forward, while maintaining

the mandible in a posterior position (Fig. 5). Early re-establishment of the anterior “guide” (and consequent facilitation of inter-incisor friction) stimulates maxillary development.

Finally, early reorientation of the OP creates favorable conditions for the eruption of posterior teeth. Their presence in the arch helps physiologic mastication, while the direction of OP serves to consolidate the orthopedic correction. For this reason, one could regard rehabilitation of physiologic mastication as a factor that reduces the likelihood of relapse.<sup>3,9,14</sup>

The case report described in Figs 10 through 15 illustrates treatment modalities and outcomes for Class III correction.

The author(s) declare that the work has been realized in agreement with the Helsinki Declaration principles and that the Informed Consent has been achieved from all the participants involved in the study.



**Fig. 15 – Lateral view of the face: a) before orthopedic treatment; b) 4 years and 11 months after orthopedic treatment.**

#### 4. Conclusions

Reorientation of the OP is essential for the rehabilitation of mastication – which assists in the effectiveness and stability of the outcomes of orthopedic treatment for Class III malocclusions. The correction of the OP orientation is as much easier to achieve as the OP is shorter, ie when the patient is younger (late deciduous dentition).

#### Conflict of interest

The authors have reported no conflicts of interest.

#### Riassunto

I pazienti con malocclusione di III Classe presentano generalmente una inclinazione antioraria del piano oclusale che tende a convergere anteriormente con la linea di Camper. Questa inclinazione ha degli effetti sul movimento mandibolare (postura anteriore) e sui meccanismi di masticazione. Dal momento che la masticazione disfunzionale sembra in grado di influenzare negativamente la crescita craniofaciale e la stabilità interarcata, la terapia ortopedica precoce dello squilibrio oclusale associato alla malocclusione di III Classe appare giustificata. L'obiettivo di questo articolo è quello di presentare un metodo per il trattamento della malocclusione di III Classe basato su un corretto ri-orientamento del piano oclusale per ottenere una funzione masticatoria ottimale, essenziale per la stabilità dei risultati precoci della terapia.

#### Résumé

Les patients qui présentent une malocclusion de Classe III ont généralement une inclinaison antihoraire du plan d'occlusion convergent avec le plan de Camper en avant. Cette inclinaison exerce un effet sur le mouvement mandibulaire (posture vers l'avant) et sur les mécanismes de mastication en général. Parce que la mastication dysfonctionnelle est susceptible d'influencer négativement la croissance faciale et inter-arcade, la thérapeutique orthopédique précoce des instabilités oclusales dans les malocclusions de Classe III est justifiée. Le but de cet article est de présenter une méthode de traitement de la Classe III basée sur une réorientation correcte du plan d'occlusion afin de réaliser un mécanisme optimal de mastication, essentiel pour la stabilité de résultats des traitements précoces.

#### Resumen

Los pacientes con maloclusión de Clase III generalmente presentan una inclinación del plano oclusal en sentido orario, convergiendo con la línea de Camper hacia la parte anterior. Esta inclinación tiene un efecto sobre los movimientos mandibulares (a inclinarse hacia adelante) y sobre los mecanismos de la masticación en general. Como se sabe ya una masticación disfuncional puede influir en el crecimiento facial y/o influir negativamente estabilidad entre los arco maxilares, por lo tanto el tratamiento temprano/precoz con ortopedia funcional del desequilibrio oclusal de las maloclusión Clase III es claramente justificada. El objetivo de este artículo es presentar un método de tratamiento de las Clase III, basada en una re-orientación correcta del plano oclusal con el fin de lograr un mecanismo óptimo de la masticación, esencial para la estabilidad de los resultados de un tratamiento precoz.

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