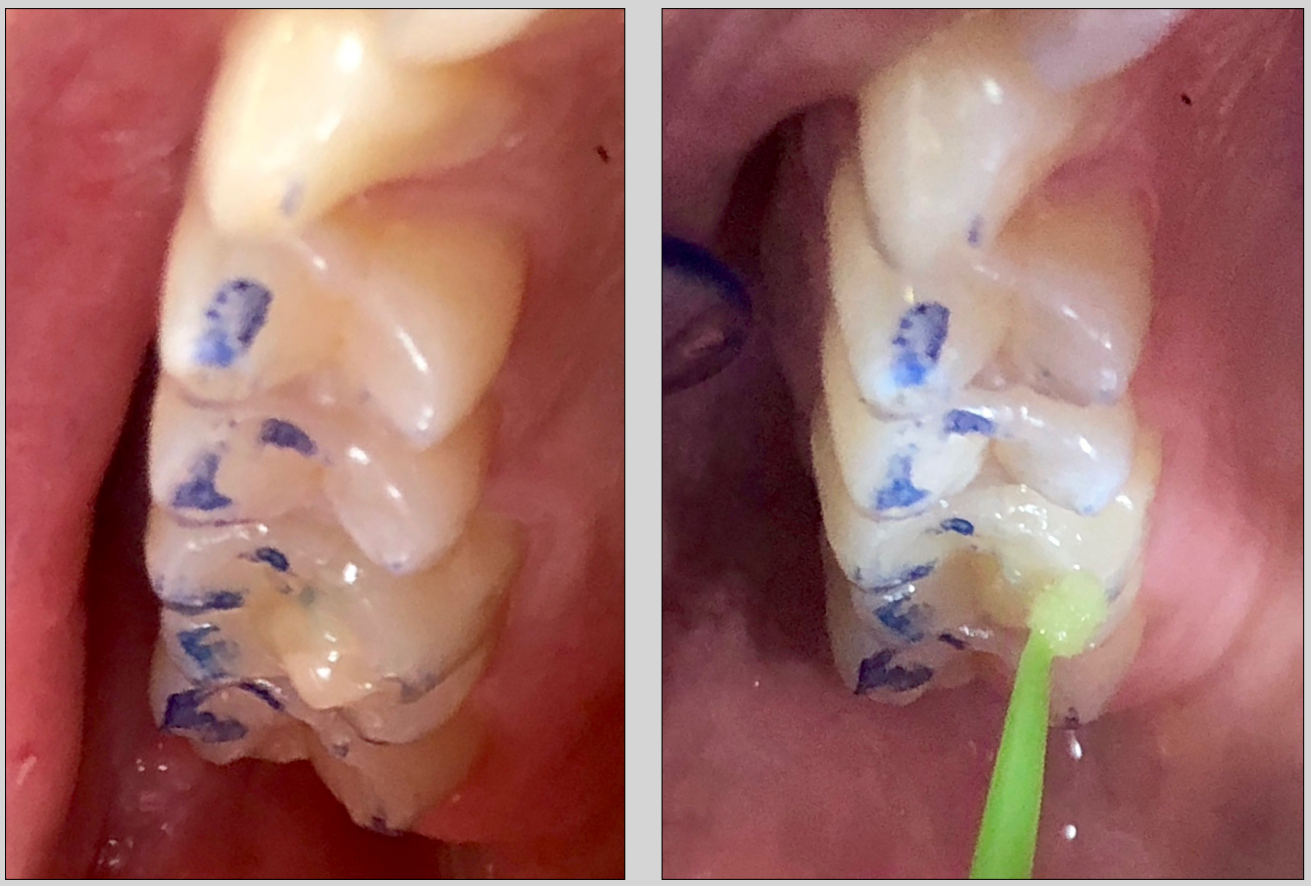
FUNCTIONAL OCCLUSION

PART 2

CLINIC OF OCCLUSAL BALANCING



Marcel G. Le Gall

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CLINIC OF

OCCLUSAL BALANCING

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Summary

The treatment principles described in this ebook apply to all dental, surgical, orthodontics, implant, prosthetic, postural and behavioral specialties, concerned with the establishment by restoration of the occlusal morphology, to ensure optimal efficiency, during chewing and swallowing. To achieve this, the classic rules of occlusal equilibration, by grinding, must be profoundly modified and replaced by additive techniques restoring lost dental volumes and efficiency of dental functionality.

Additive restoration techniques, of lost dental volumes, have been the subject of a thorough reflection on how to implement them with current composite materials. They obey a precise protocol. They will progressively evolve as the computerisation of procedures and the evolution of materials progresses.

Keywords: Occlusion, Tooth, Canine, Cuspid, Protection, d'Amico, Mastication, Function, Guide, Chewing Cycle, Swallowing, Deglutition, Tongue, Muscle, MIO, TMJ, Joint, TMD, Equilibration, Addition, Subtraction, Disc, Dislocation.

INTRODUCTION

An essential objective of all odonto-stomatological techniques is to maintain and/or restore the functional capabilities of the masticatory apparatus. Achieving this goal sometimes requires the use of more or less complex techniques such as:

- surgery, restorative, reconstructive, orthognathic, with the aim of reconstituting lost hard and/or soft tissue volumes and rehabilitating skeletal relationships.
- orthodontics to guide or modify the shape and / or position of the arches and teeth during growth or in adults.
- dental techniques accompanying these procedures ranging from conservative and periodontal care to prosthetic and / or implant reconstruction techniques.

Essential

The common point of all these therapies is the obligatory passage through the rehabilitation and/or the final adjustment of the occlusion, often adopting an occlusal scheme based on theoretical occluso-prosthetic concepts.

This is why the dental restoration and equilibration techniques of the occlusal function will be treated first, independently of the pathologies with which they could have links or interactions, which will be tackled then, in the rubric T M-Disorders

Recall that in the first part of this book, the analysis of d'Amico's publications (1958-1961) clearly showed:

- that the so-called canine protection had only been validated by simulating laterality and its return to MIO on a rudimentary articulator with a simple hinge. While in the mouth, our knowledge in physiology and clinical observation show that the chewing cycles are centripetal, that the molars on the chewing side come close to contact and that they are absolutely not protected by the canine during chewing.
- and that in simians, canine size in males was correlated with sex selection parameters, which had nothing to do with occlusion.

Moreover, in about 98% of adults (Posselt 1968, Joerger, 1991, 2005, 2012), CR is not confused with swallowing posture. which already exists in utero. Manipulated CR was constantly challenged and gave rise too many different definitions, invalidating its qualification as a unique and stable reference position.

It clearly appears as a boundary envelope of chewing cycle input guides, which is located behind the MIO. All CR's appear in this boundary envelope, in different positions depending on the operator and the type of manipulation. The more they have been located posteriorly, the more they limit the diagonal orientation of the cycle input and the more the patient tries to advance the mandible to recover its natural kinematics. All data on the physiology of swallowing and mastication have made it possible to understand the functioning of the masticatory apparatus and have shown the limits of the theoretical occlusal concepts of gnathology, based on completely different muscular recruitment, which have no links to real function and do not allow it to be restored, nor to establish a relation with dento-articular dysfunctions, while a new occlusal approach allows it.

The integration of chewing and swallowing to any occlusodontic procedure is therefore essential, in order to improve the analysis, the occlusal therapy, the prosthetic rehabilitations and the treatment of Teeth-TMJ Dyskinesias.

Definition

Occlusal equilibration includes all occlusal procedures, which maintain, improve or restore the balance and functional efficiency of the masticatory apparatus.

PATIENT EXAMINATION

Chapter 1

According to the case, this examination will be succinct or very complete.

- General Examination

Visual examination analysing their equilibrium as they walk (postural imbalance, traumatic consequences).

Psychologic profile assessment (increasing behavioural factors). Depending on the case, some general pathologies (for example postural or behavioural) will have to be treated before, simultaneously, or following the occlusal treatment. Local Examination

- Height of the lower part of the face,
- Symmetry of the face and the facial muscles,
- Dental and periodontal assessment,
- Opening and closure movements,
- Posture and shape of the tongue,
- Occlusal relationship and occlusion,
- Occlusal anatomy,
- TMJ noises,
- Chewing function test.
- If necessary, muscle palpation.
- Panoramic Xray (differential Δg, bone structures)

-Model Analysis

Analysis of the dental arches models must precede therapeutical stage. Wear facets, dental guidances, over-guidances or under-guidances, occlusal relationship, misplaced teeth, are identified, noted and compared to the clinical examination. Static occlusion relationships will be

appreciated on an articulator. For dynamic analysis, the manual coaptations of the models will often allow the simulation of chewing movements and the appreciation of functional guidance.

Important: The clinical analysis must precede the occlusal analysis on the articulator. It is necessary to remember that the dynamic functioning model is well represented by the patient and not by the mechanical simulator that one animates in the laboratory. It is clear that the laterality movements, usually requested in voluntary execution, have been copied on the kinematics of articulators with fixed hinge axes. This does not allow them to simulate the approximation of the posterior teeth observed in the mouth during mastication and makes them unable to reproduce chewing.

POSITIVE CLINICAL APPROACH

Chapter 2

The treatment principles described below can be applied to all the dental disciplines concerned with occlusal set-up and restoration of the functional model of occlusion such as orthodontics,, implantology , prosthetic, postural, behavioral specialities.

To achieve this, the classical rules of usual occlusal equilibration by subtraction, must be profoundly modified.

Non-mutilating techniques will be favoured to balance the occlusion: addition on natural teeth, addition/subtraction on prosthetic restorations.

- **Occlusal Equilibration by Addition or Subtraction: Referential Schema.**

How to rebuild an arcade when the anatomy of the occlusal surfaces is totally lost?

Figure 2-1: Use a moisture-insensitive marker film for chewing tests

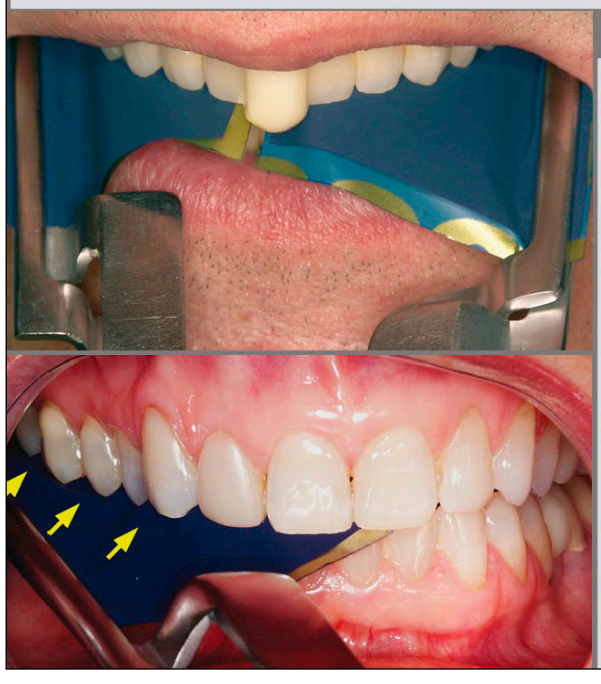
OCCLUSAL MANAGEMENT

OBJECTIVES:

Restore the physiology of occlusal functions: chewing and swallowing

POSTURE - WEDGING - GUIDANCE

Figure 8-1b:



THE MEANS:

Using techniques of:

-ADDITION (on natural teeth) and

-SUBTRACTION (on prostheses, the least possible)

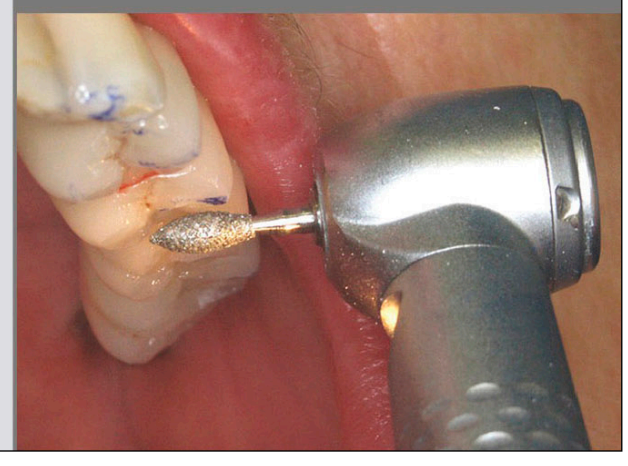


Figure 2-2 On natural teeth, addition (composite or similar) is the optimal method of restoration. On composites still polymerised and prostheses, it can be completed by substraction for the meticulous functional adjustment.

REMINDERS: THE WAYS TO MANAGE OCCLUSION

Figure 2-3

The control means: marker film, **digital contact**, T-Scan?

An important means of control of the maxillary anterior:

The digital contact facial surfaces of the maxillary anterior teeth and, depending on the clinical mobility, maintaining with the pulp of a finger.

ADVANTAGE

- For the practitioner: fine perception of tooth movement

- For the patient: the contact and the maintaining, in case of significant clinical mobility, improves proprioception and perception of contacts, allows the location of surguidages and fine appreciation of their intensity.

No interest for single implant and large fixed restorations

- VDO can be restored simply by using facial criteria. In dentate patients there is a range of

normality, specific to each patient, in which the vertical dimension can be located. In the edentulous (without periodontal mechanoreceptors) the margin is even greater.

- The MMR and MIO associated with it, will be found self-determined by the patient, from his swallowing posture, associating simultaneously, the wearing of a deprogramming anterior jig to the natural posture of the tongue, at the beginning of swallowing.
- With regard to lost occlusal morphology, it is the dynamic memory of this anatomy, recorded in the shape of the TM-joint during growth that will allow its reconstruction. Chewing on the first molar couple finalised the shape of the TMJoint. The articular kinetics will then allow to find the lost occlusal anatomy of the first molars. Restoration of first molar pair guidance is usually necessary and sufficient to restore the range of chewing cycles, but sometimes it is necessary to restore also one or two additional neighbouring couples.
- But to restore the optimal masticatory efficiency of the affected side, all of the neighbouring teeth, will then have to be gradually integrated into this functional scheme found, to restore optimal masticatory efficiency of the affected side.

The importance of treatment will depend on the initial situation. Verification of MMR and chewing tests are routinely performed before and at the end of a prosthetic treatment and when the clinical examination reveals occlusal disorders and / or tooth-articular dyskinesias, indicating a possible involvement of the occlusion (in the latter case it is necessary to initially limit to completely reversible addition tests).

- Occlusal Equilibration by Addition or Subtraction: Indications

- Equilibration techniques, non-mutilating, are recommended.
- On the natural teeth subtractions are prohibited (excepted rare exceptions), because assimilated to mutilations on teeth whose progressive natural or abnormal wear, is not compensated by any regeneration. Additions should be favoured to reconstruct the lost volumes of natural teeth, using composite-additive tests (reversibles) or other materials,increasing if necessary the Vertical Dimension of Occlusion (VDO).
- On fixed restorations on natural teeth, occlusal retouching is possible and the return to the laboratory allows to make and adapt the necessary additions.

- On implant-fixed prostheses, the principles remain the same when osseointegration and peripheral bone adaptation are already obtained. If it's not the case, the progressive adaptation of the peri-implant bone should be favoured first

- **Occlusal Equilibration by Addition or Subtraction: Means and Protocol.**

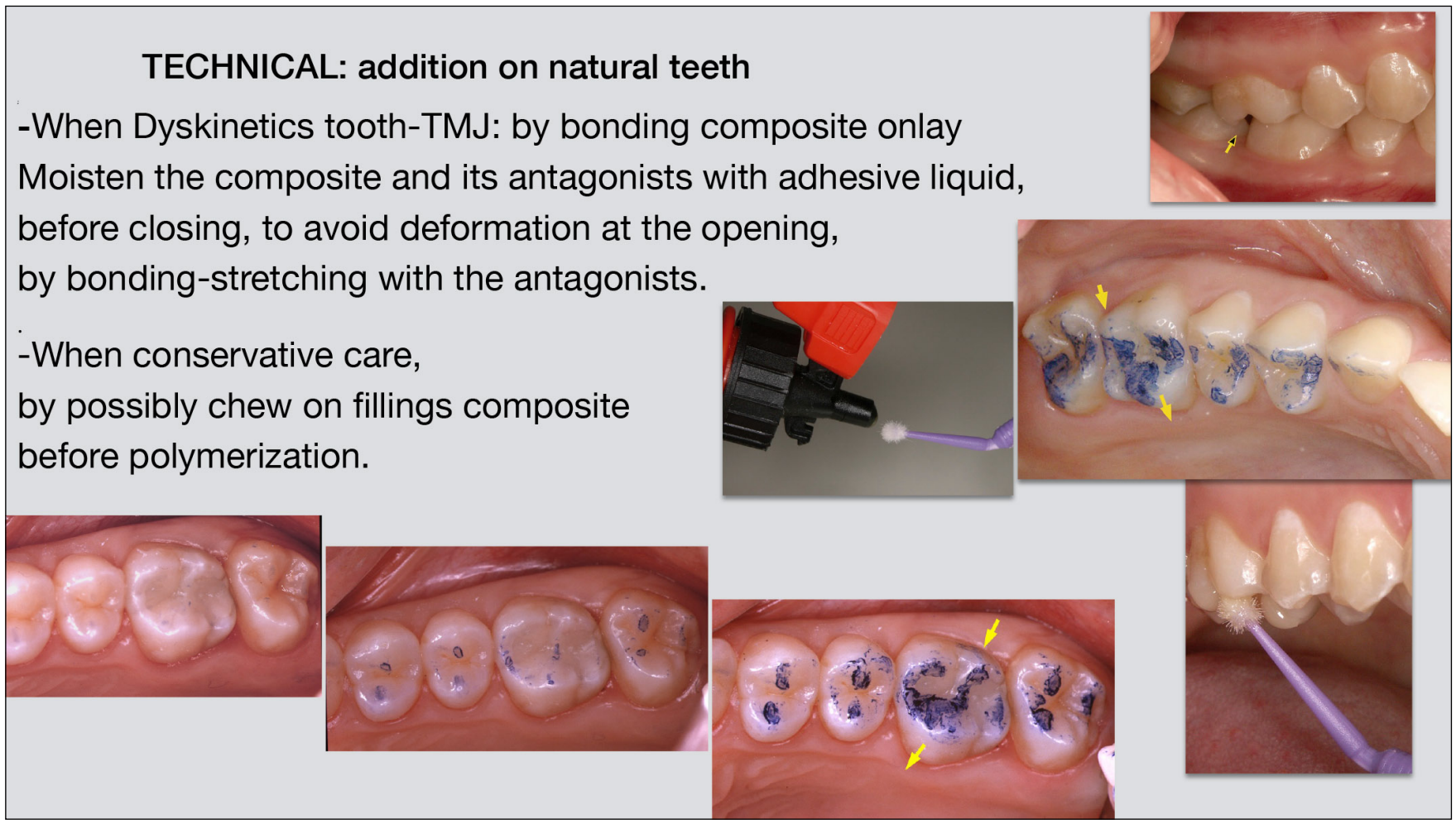


Figure 2-4: All treatment even the simplest is concerned by occlusion, for whose functional balancing must be done with the same meticulousness.

The use of bonded composites, micro or nano-filled (fig.: 2-4, 2-5), whose wear is of the same order as that of natural enamel (Lambrechts et al 2006), is the preferred way of restoring volumes and lost guides, as reversible tests. But other protocols can be considered.

The balance of these MIO contacts and the dental chewing guide envelope can be checked using a very thin coloured (articulating) film (15 to 30µm) that allows the patient to maintain the perception of malocclusions, while the interposition of very thick marker (articulating) papers does not allow it.

The presence of defects or excess of guides, even minimal, often limits the transverse amplitude of the cycle by the activation of TM-Joint protection mechanisms, that even reduce it to a simple shear. As soon as the balance of the guides is restored, in harmony with the kinetics of TMJ, the patient spontaneously describes the limit envelope of the cycles without

any learning. All cycles with interposed foods will then be located inside this envelope, without always reaching its maximum limit.

Compared wear at 3 years: composite ultrafine charge particles: from 110 to 149µm. vs122µm human enamel.

Composites charge ultra-fine particles, are at the moment, the choice of materials for filling posterior cavities.

(Lambrechts P et al Sciencedirect wear 2006)

Note wear facets balanced on cycle-in and cycle-out slopes

Which invalidate the concept gnathological on so-called slopes “non-working”.

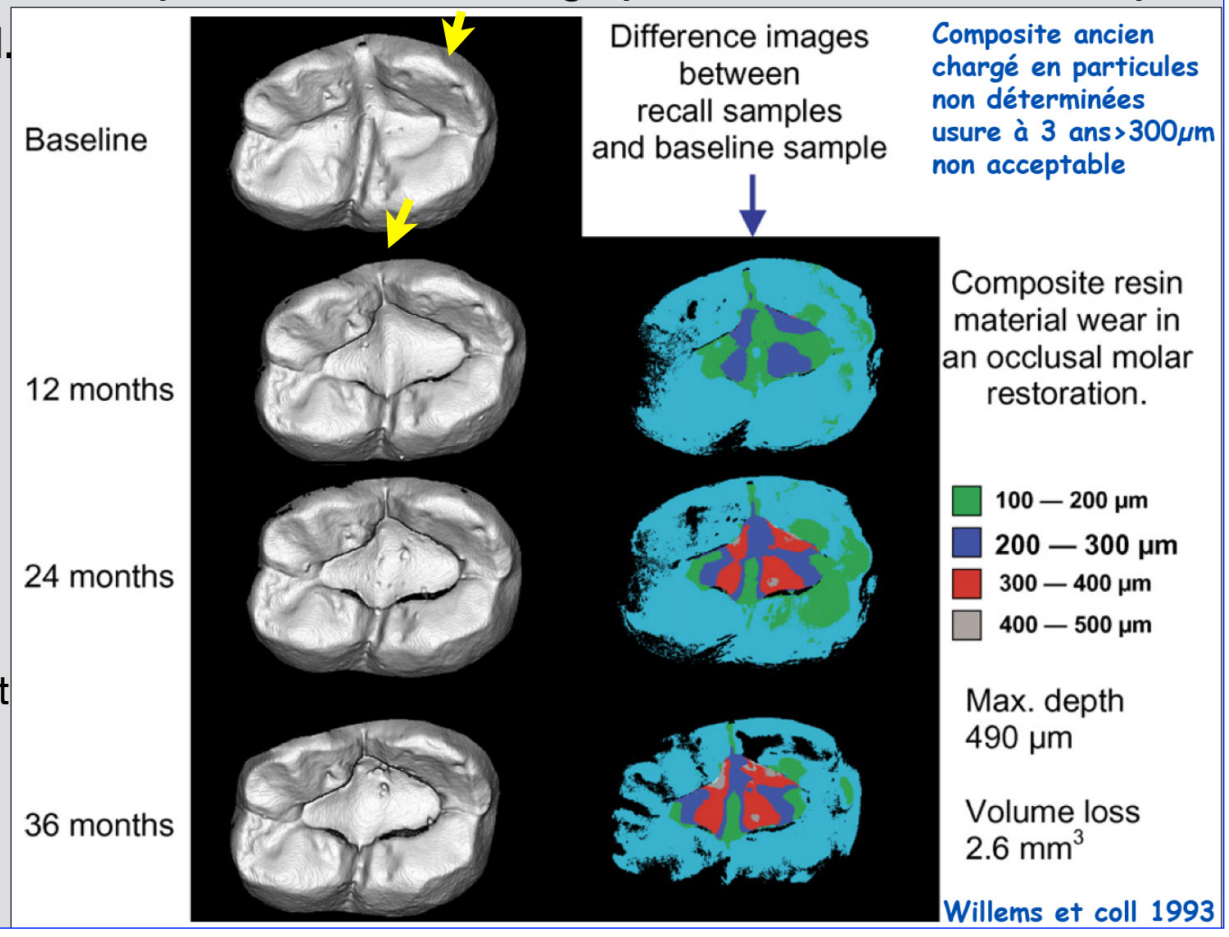


Figure 2-5 Micro or nano-charged composite can be considered as permanent treatment because They wear in the same way as natural teeth

FIRST STEP: INTERMAXILLARY RELATIONSHIP AND VDO

Chapter 3

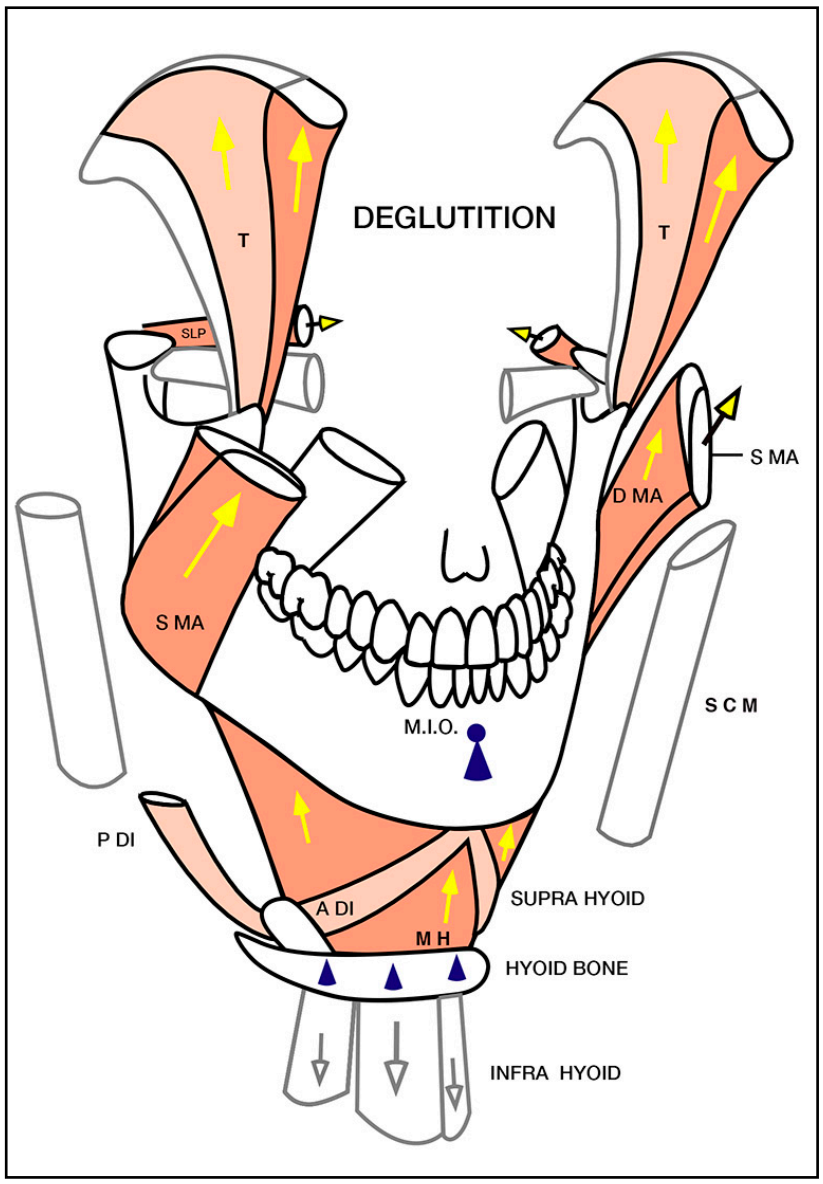


Figure 3-1: During the phases, buccal and pharyngeal, of deglutition, the mandible remains fixed with the teeth maintained in Maximum Intercuspation Occlusion (Pameijer et al. 1970) by the bilateral recruitment of muscles masseter, temporal and pterygoid medial. This provides support for muscle mylo-hyoid, whose contraction provokes the lifting of the hyoid bone and contributes to that of the tongue. For 97% to 98% of the patients, MIO is physiologically placed ahead the Centric Relation (Posselt 1968, Joerger 2005).

- **Physiology of swallowing**

Swallowing includes complete muscular and articular movements allowing transfer of the bolus (including saliva) from the buccal cavity to the digestive tract. It is made up of three successive phases: a buccal,pharyngeal and oesophageal.

When the bolus is prepared, it's collected on the tongue and directed toward the isthmus of the gullet, ready to be swallowed. At the same time, the teeth come into contact in MIO to stabilize the mandible, which becomes a fixed support. This allows the hyoid muscles to elevate and lower the hyoid bone, which triggers the peristaltic wave to transfer the bolus into the stomach. In utero and in newborns, it is the tongue, interposed between the arches, which serves as a support for swallowing. It is the same in edentulous patients.

In dentate patients, MIO is the natural wedging position of swallowing that occurs, in neuromuscular balance, more than one thousand times a day (Lear et coll., 1965).

a) The first buccal phase (Fig. 3-1) is the result of the combined action of mandibular elevator muscles, extrinsic-intrinsic muscles of the tongue, facial and those of oropharynx (Menekratis 1998,Le Gall and Lauret 2008). When the buccal preparation is finished, the tip of the tongue is leaned against palate, in an anterior position, and the bolus is collected on its dorsum and then directed toward the isthmus of gullet ready to be swallowed.

Thanks to the early MIO contacts, obtained by the action of elevator muscles, the mandible becomes a support point, that allows the supra-hyoid and infra-hyoid muscles, to raise and lower the hyoid bone. This action produces a peristaltic wave, moving the bolus towards the stomach.

The oral phase of swallowing is performed under the combined action of the masticatory and lingual muscles, but also the facial muscles (Le Gall and Lauret 2008) and the supra- and infra-hyoid muscles.

In a childs mouth, permanent functional stimulations resulting from numerous deglutitions, allow to progressively install during growth, a direct anatomic correlation, between: MIO in neuro-muscular equilibrium, and articular position during swallowing.

The role and position of the tongue are essential for physiological swallowing (Fontenelle et Woda 1993, Bonnet 1992, Bonnet 1993, Fournier 1991). In a child, mis-positioning is constantly associated to dysmorphisms and disruptions of growth . The reeducation of oral functions and the early repositioning of the tongue, allow to prevent the pathological consequences, by an early reorientation of the growth (Fournier 1991, Deffez et al 1995).

A keystone of reeducation is to place at rest, the tongue in a centred superior position , with the tip in contact with the anterior part of the palate, against the medial papilla, just posterior to the upper incisors,and to make several deglutitions (Fontenelle et Woda 1993, Fournier 1991),because it's the tongue natural position at the beginning of the first phase of swallowing, that allows optimal placement of the muscles recruited producing a physiological deglutition.

In these conditions, an adult mouth, the functional contacts during swallowing and Maximum Intercuspation are the same. This swallowing MIO is constant and can therefore be considered as the natural reference of the MMR. These data are individual and can't be standardized and applied, when based on average or theoretical values.

According to this data, we will describe a clinical protocol ,self-determined by the patient, more physiological and more reliable, allowing to adjust the MI in accordance to a well balanced swallowing, without performing any manipulations (Le Gall et al., 2010).

Indeed, the axiography data (Joerger 2005, Joerger et al., 2012) show that this occlusal deglutition wedge is not located in a CR joint position (regardless of the operator, type, and manipulation force), but the mandible finds its MIO equilibrium in a position more or less anterior to the CR, depending on the individual swallowing equilibrium of each patient and the +/- diagonal orientation of the guide rails occlusals of M1 couples. The occlusal anatomy and the orientation of these rails are determinants of the importance of the limit envelope of masticatory cycles input and its dynamics, before the passage of the MIO. It is therefore permissible to question the relevance of the many definitions of CR and the proposed manipulative techniques, in order to find the reference functional position specific to a patient (Romeroski, 2006). It appears that the reference position is given by the natural swallowing wedge and that the different positions proposed for the CR are located in the cycle input guide envelope, behind the MIO. As a result, they limit it, especially since the CR is more posterior.

To check or find, the natural swallowing position of the mandible in an adult, two complementary procedures, already used separately for many years, are going to be associated in a simultaneous way (Le Gall et al., 2010):

- Anterior Jig and Mandible Posture

The starting point for all of the mandibular movements is the Rest Position of the Patient. It's a Physiologic Posture of reference, steady and repetitive, when there is no disruption of the neuromuscular tract. The closure path associated (fig.3-3), leads to the Maximum Interdental Occlusion (MIO), that is responsible for mandibular stabilization during swallowing (Pameijer et al., 1970, Fontenelle et Woda,1993), and for the posture of the lower third of the face. In addition, all of the chewing cycles pass through MIO.

If the MIO is unstable or disturbed by premature occlusal contact, central mechanisms of adaptation move the mandible to another, more stable position (adaptive posture). The rest position is modified, in according with the new adaptive MIO. In this occlusion, the Rest Position of the Patient is shifted and the muscles are not in equilibrium. The postural muscle tone is not at a minimum, and the muscles are not in a symmetric neuromuscular equilibrium. That adaptive posture can result from other scenarios such as for : Tooth surface loss - attrition, erosion and stress corrosion , lesions articular and dental, accidental trauma, Muscular

fatigue related to hypernormal function or parafunction (centrally mediated) ,or to body in-balanced posture, and abnormalities in posture and dynamic of the tongue.
A simple occlusal analysis do not allow for detection of these possible mandibular deflections, because the patient spontaneously closes into his shifted adaptive occlusal position, avoiding the deflective contact.
Several methods, have been proposed, to try to find thisphysiologic rest position.
We prefer to use an anterior deprogramming device, placed on the maxillary central incisors, with only a contact median opposite. It allows for suppression of the proprioceptive information from the periodontal mechanoreceptors, (Wesberg et al 1983), except on the jig. (objectives are different from the initial jig by Lucia, 1983).Wearing this jig (Le Guern 1987)for several minutes, deprograms the reflexes of avoidance or adaptation, implemented by the CNS (central nervous system, from the very precise cortical representation of the dental anatomy, contacts and occlusal guidance (Netter,1991).
The cancellation of the avoiding mechanisms, and the relaxing of muscles, consecutive to the placing of the jig, allow the repositioning of the mandible in relationship with the skull, and allow a closure, directly onto the premature contact. This can then be corrected. Unless the neighboring teeth are in sub-contact which will then require restoration by addition.

- **Tongue Posture and Swallowing**

The mandible displacements are provoked by the reciprocal and coordinated action of masticatory, hyoid and genioglossus muscles. They are collectively recruited in a selective way,

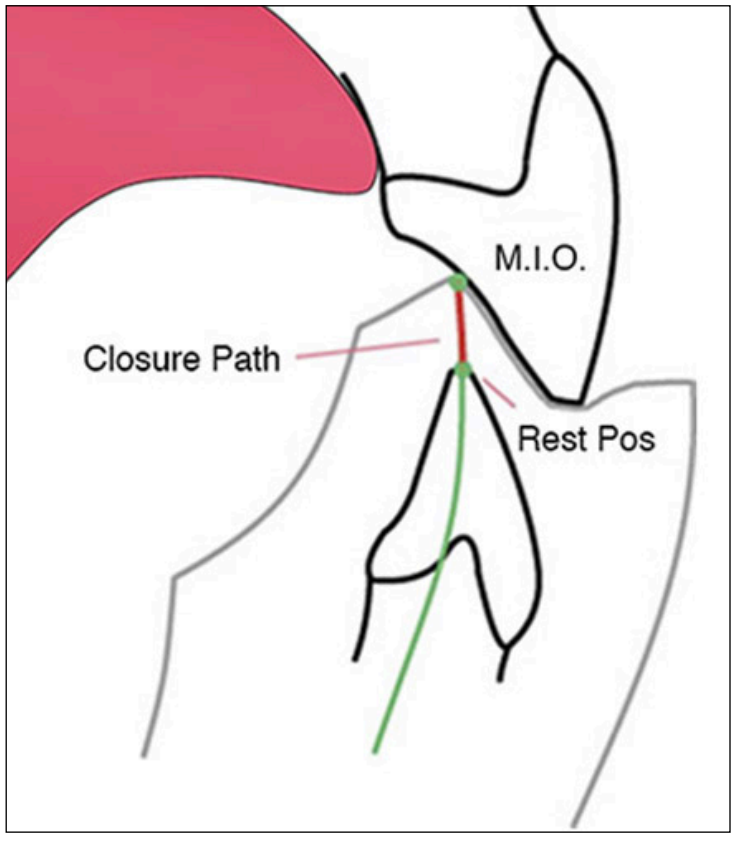


Figure 3-3: The rest position and the Maximum Intercuspation Occlusion are linked together by the closure path. When the position of MIO is modified, consequently the rest position and the path of closure change also. It is the consequence of a mandible displacement resulting from traumatic or pathologic processes, or from dental wear, or bruxism and from inappropriate manipulations…

depending on the oral functions, or voluntary movements and para-functions.
The movements of the tongue, depend on similar recruitments excepted for the tip that can be moved by the only will.
The role and effect of the tongue displacements, on the posture of the mandible, has been neglected in adult occlusion, and have not been taken into account by the jig protocol (Lucia 1964, 1983; Le Guern 1987). but it is widely used in orthodontics for the rehabilitation of swallowing.
To understand the dependence of the mandible to tongue displacements, some simple tests of placement can be easily recognised.
If you make a swallowing test with the tip of the tongue placed against the anterior median portion of palate, the closure is done directly in MIO. If the tongue is placed on the teeth of the maxilla , either right or left, the mandible moves to the side where the tongue is placed. During a swallowing test, there are only unilateral contacts on the side where the tongue is placed. In the same way, if the tip of the tongue is turned over against the soft palate, during a closure test, the mandible moves back and the contacts reported first, are situated at the back of the MIO. They are followed by a symmetric sliding (postero-anterior) of the mandible towards MIO. This is a constant and can be verified in the three planes of space.

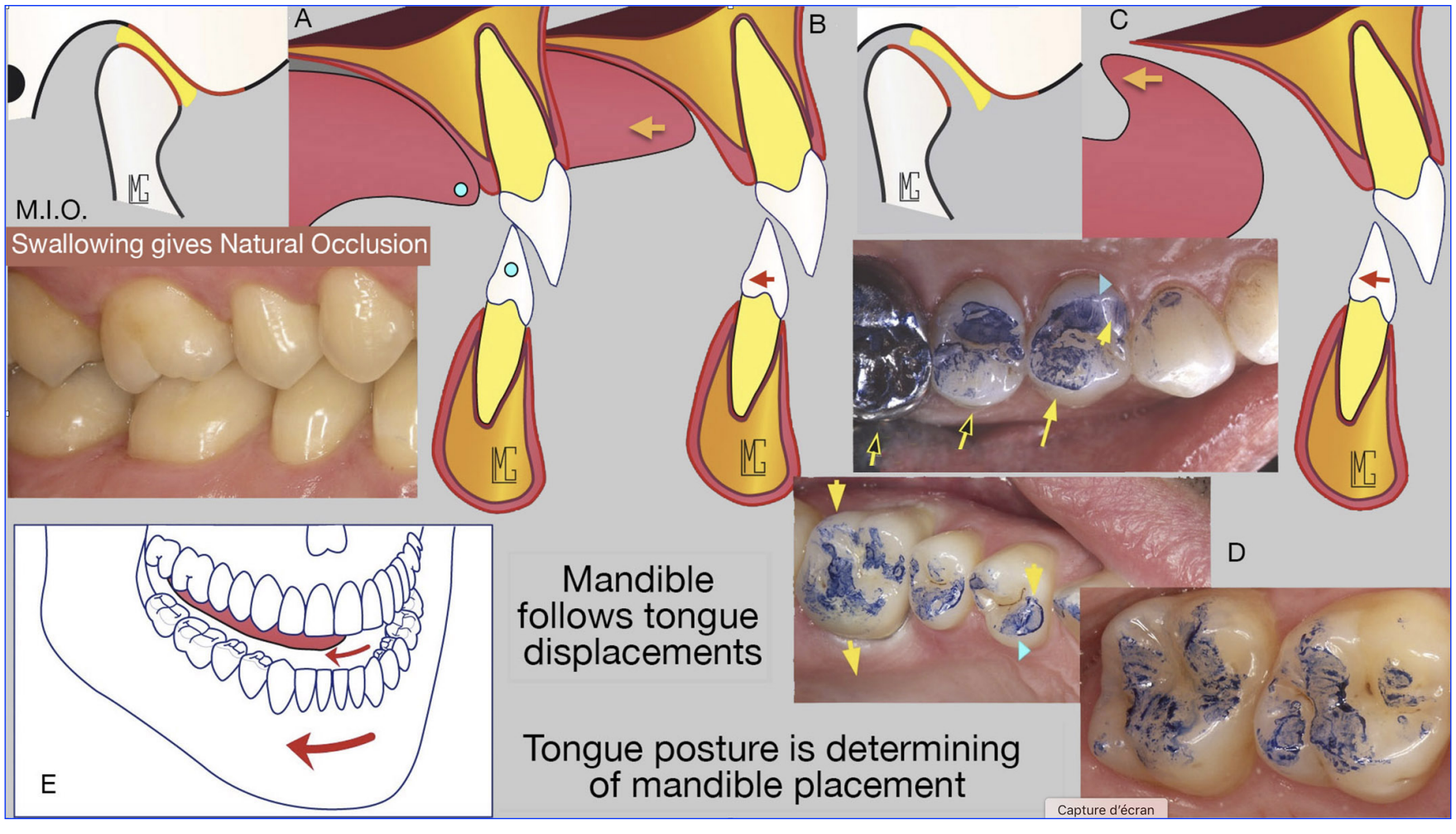


Figure 3-2: Tests to do with your own tongue, so as to well understand the repercussion of the tongue posture on the mandible positioning.

One can deduce that inter-maxilla relationship checking , with a bad posture of the tongue, will

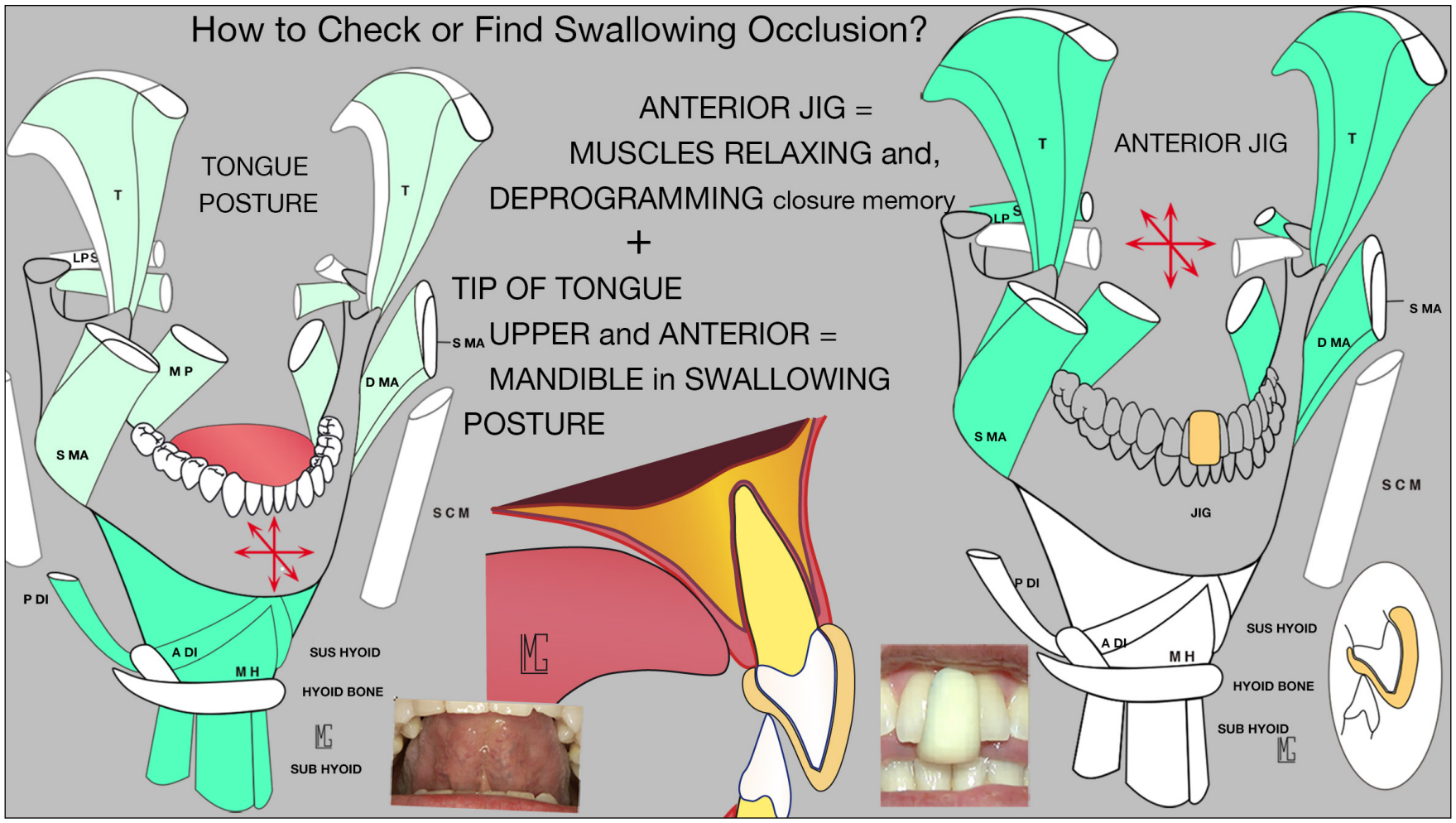


Figure 3-4 How to find clinically the swallowing posture of the mandible and how to coordinate it with Maximum Intercuspation? A clinical protocol is proposed above. In the absence of general postural interference, the simultaneous combination of two protocols already used separately, puts the mandible in swallowing conditions and gives its optimal posture, which allows to find and balance, Maximum Intercuspation accorded with swallowing, so self-determined by the patient and repetitive (Le Gall et Coll 2010):
- the wearing of an anterior jig, which allows the relaxation of the elevator muscles and the deprogammation of the closure memory of the mandible (Le Guern 1987),
- maintaining the tip of the tongue in a upper and anterior position which puts the mandible in the swallowing position (used in tongue and swallowing rehabilitation).

be more or less wrong, according to the proximity or the distance of the optimum position, of her tongue.

- The jig alone doesn't take into account lingual posture.
- The lingual posture alone do not allow the cancellation of adaptive engrams.

It's why taking into account simultaneous protocols of anterior jig and lingual posture is complementary and necessary to find the physiologic posture of the jaw and check the balance of Maximum Intercuspation Contacts during deglutition.

Fig. 8-5 a,b: Two acceptable designs, with enough anterior interplay, allowing the deprogramed mandible to position itself freely, guided by the tongue.

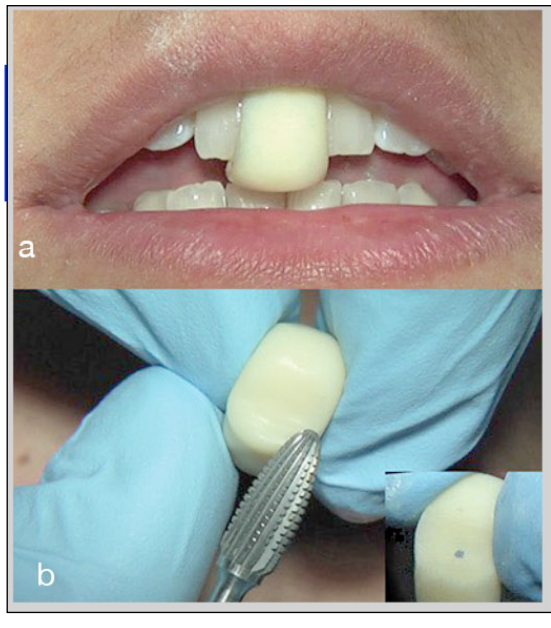
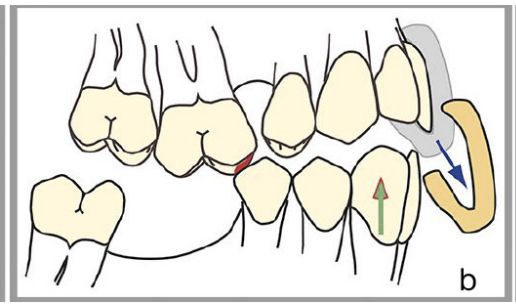
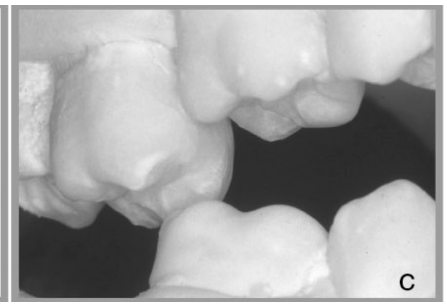


Fig.8-6:
a,b: Optimal relation of the jig with an anterior, median and not deflecting contact.
c: Simultaneous placement of the blue paper with Miller pliers
d: Optimal tongue position





Jig realization:
-preferably use a photo-polymerizable composite like: Revotek® from G.C.
-or any self curing resin

Figure 3-7: Clinical case: the wearing of an anterior abutment made it possible to demonstrate an anteposition of the mandible.

Dental contacts in swallowing MIO should be simultaneous, of the same intensity and well distributed on a maximum of teeth. This step is obligatory and precedes the equilibration of chewing.

- **MIO and Swallowing: Clinical Protocol**(Le Gall et al 2010, Le Gall et Lauret 2011, Le Gall 2013)

Vidéos cliniques Youtube: https://youtu.be/85sIx25-mCw https://youtu.be/E6e5sFx_GGc

During the occlusal analysis, conducted on the armchair to MIO test, the patient must be placed in a suitable posture to swallow food. Standing up, seated, or very slightly leaning back, carrying her head naturally, with no lateral rotation, avoiding to lie on the back (supine),

where it is harder to swallow (at night, swallowing saliva in this position is often realized with no dental contacts). Nevertheless, if the patient is placed in a semi-stretched out position, with her head, non tilted back, and maintained in the axis of the body, with the tip of the tongue in contact with the anterior part of palate.

Wearing for 1 to 5 minutes with no interdental pressure, this anterior deprogrammer with a single median antagonist contact, allows muscles to relax and to deprogram previous closure pathway from memory, by deleting others MIO contacts. At the same time, the firm positioning of the tip of the tongue against the median retro-incisive palatal region, associated with a few swallowing exercises, allows to put the mandible, the tongue muscles and the oropharynx in a swallowing situation. The optimal positioning can be obtained, step by step, by repeating the following: “place the top of your tongue in the middle, in contact with the palate…tip on front… firmly placed against the palatal papillae, just behind the upper incisors”.

When muscles are relaxed, the tip of the tongue is held against the anterior portion of the palate, during the removal of the jig, with half-open mouth. The patient must then slowly raise her mandible, with no muscular pressure, up to the first contact and indicate his position with a a finger. Carried out a second time, the procedure must confirm the first selection. A potential malocclusion can be objectified then, by the same procedure, by placing between both lateral sectors simultaneously, strips of very thin marker paper (15-20µm).

If there are multiple contacts, well distributed over a maximum number of teeth, simultaneous and harmonious, the position is in swallowing neuromuscular balancing. The reset of the memory of closure has been done in the same occlusal position.

If there is only one point of contact, the occlusal analysis of the neighboring teeth will allow to determine, whether, on this tooth, there is a excessive and/or deflector contact, or whether a lack of contacts, is responsible, during closure on the nearby teeth. After each test of closure, the jig must be immediately replaced on the incisors with an opposite point of contact, with the tongue touching the palate, to prevent the patient’s reprogramming in its previous closing memory.

When one or several corrections are done (addition/subtraction), the test of closing should show well balanced and stable contacts, of the same intensity and well distributed over a maximum number of teeth (MIO). If at this stage, the tip of the tongue is turned over against the posterior part of the palate (Fig. 3-2), the mandible comes back in a position of CR, and during closure, there must be a symmetric sliding towards MIO. There are not interferences, but there

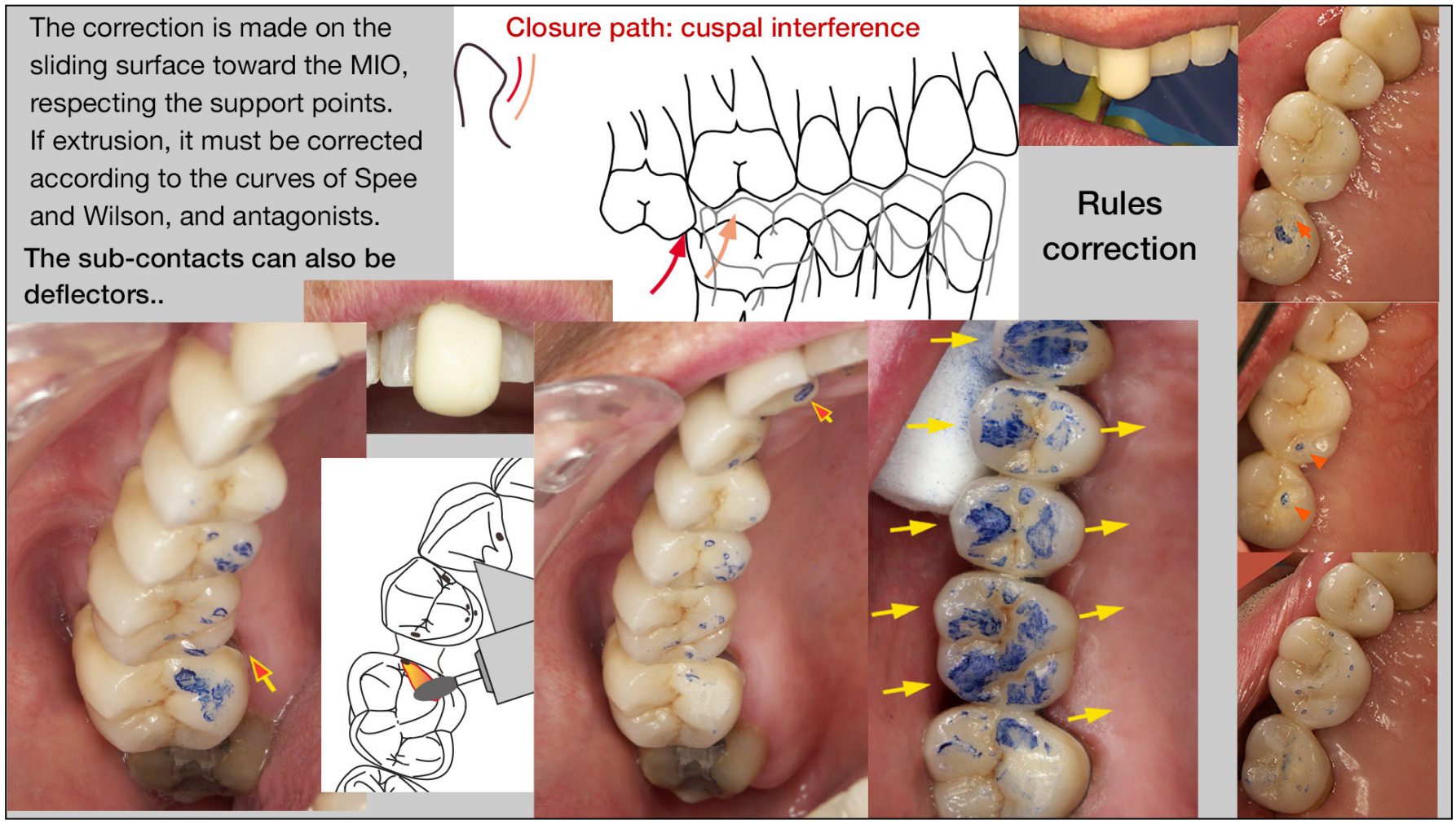


Figure 3-8: a - adaptive occlusion .b - An anterior deprogramming device is worn from 1 to 4 minutes, with one median opposite contact and without any pressure. It allows to cancel adaptive engrams and tensing muscles to relax c -Then the patient close directly on the prematurity. The jig must be put back instantly, to avoid the reactivation of avoiding engrams. Dont Forget that under-contact can also be deflector for the mandible.

are anti backward slopes, that delimit the posterior envelope of chewing cycles while protecting the TMJ (Le Gall and Lauret, 2011). If the sliding movement is not symmetric, retouch is ‘a priori‘ banned. These slopes are the transverse posterior limit of the guidance of cycles, on the posterior teeth.

When chewing is simulated and adjusted on the two sides (generally by addition), a new backward movement test, can be done in the sagittal plane. On assessment whether both sides are in symmetric balance or not, a correction is possible, by addition of the sliding slope in under-guidance.

When in doubt, intermaxilla relationship of deglutition must be recorded and the models mounted on a conventional articulator for a preparatory analysis and simulation of balancing, before any alteration, in the mouth.

When the swallowing occlusion is locked and balanced, the jig is no longer needed, but the placement of the tongue in the anterior, high and centered position remains the rule for any subsequent closure tests.

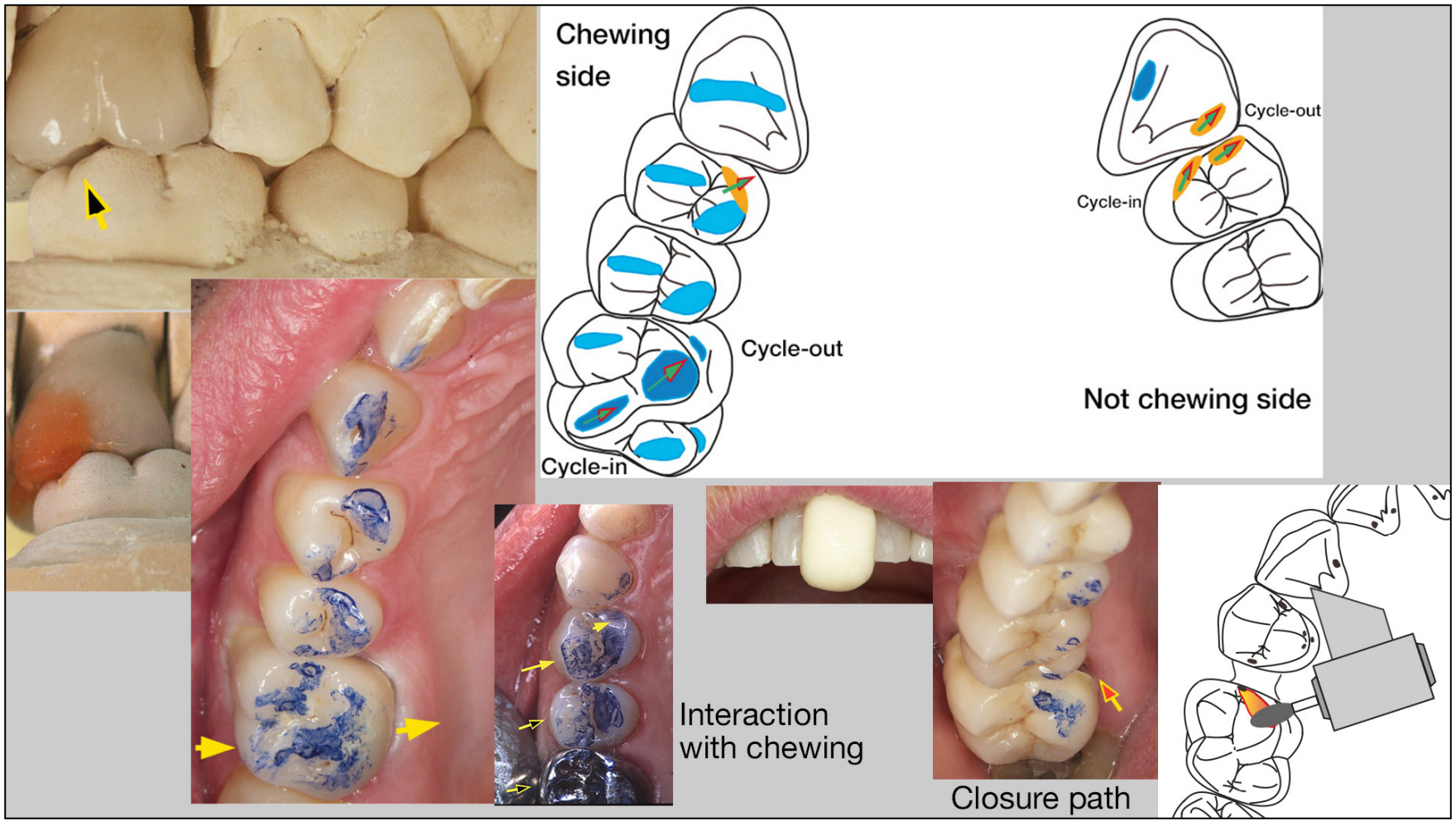


Figure 3-9: (a) Clinical case showing the correction of a cycle-in underguiding, upon insertion of the restoration of the right maxillary first molar. After correction, the molar cycle-in guides, are balanced with that of the mesial palatal side of the first bicuspid. (B) Other cases. The 2 cycle-in guides of the first premolar are the only assets. Those of the second bicuspid and molar are under-guiding and must be restored by addition. The cycles-outs, are balanced. (c) General figure of these clinical situations. Read below. (d) Checking of the closure path, using an anterior jig and tongue. The posterior deflector contact must be deleted by subtraction preserving MIO support, before the adjustment of mastication.

Note 1:

If an imbalance of the body posture is suspected, It's suggested to check first the closure path, with the patient seated or in a slightly reclined position, with the general postural component ineffective, and secondly standing up with a reactivated postural component. If the occlusal contacts are different, there is probably a general postural imbalance, which interferes with the posture of the mandible. In this case, after balancing the patient in a semi-stretched position or seated one , he must adressed to a posturologist and after treatment of the postural problem, the closure path must be checked again immediately. if possible the same day.

Note 2 :

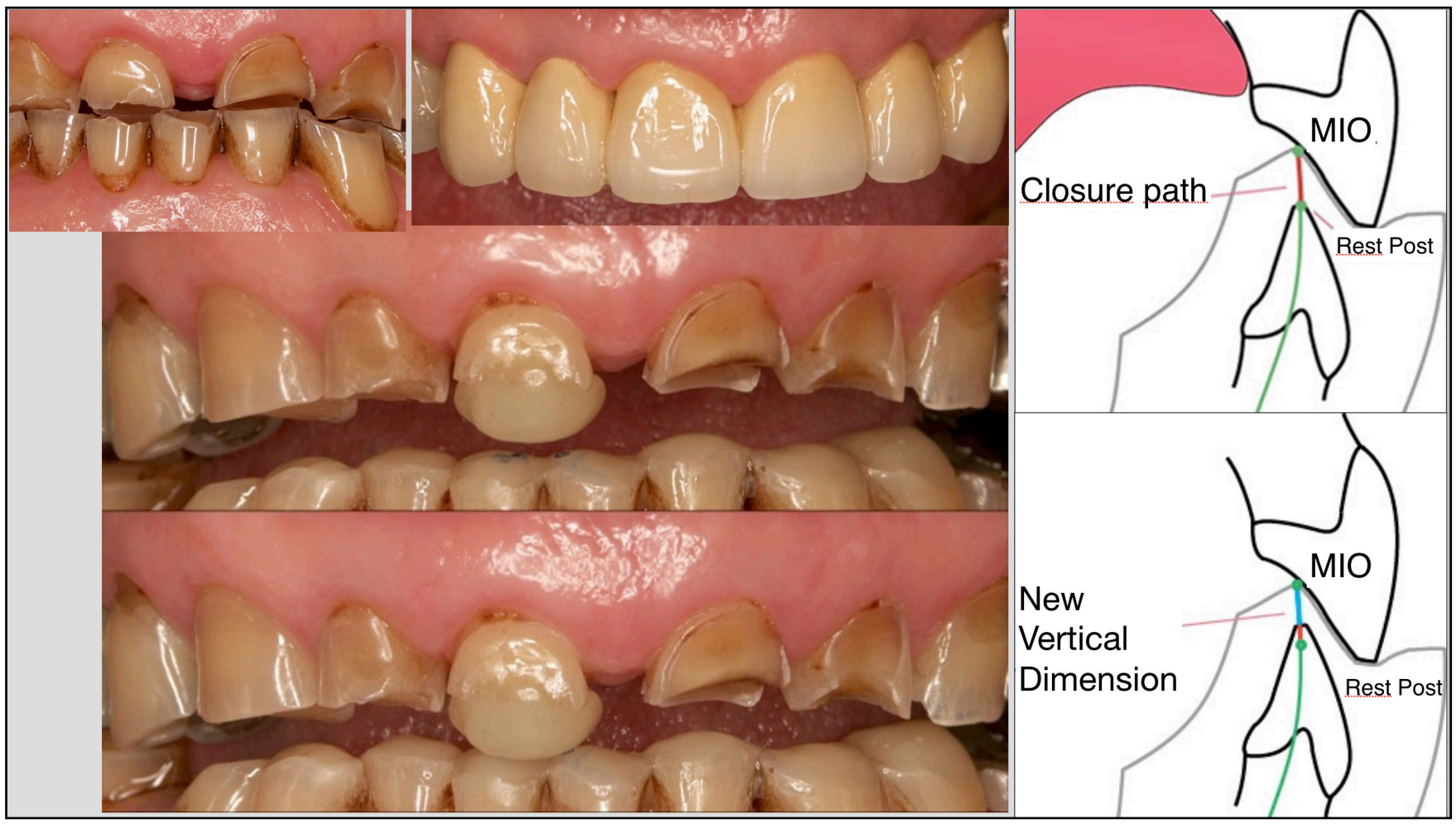


Figure 3-10: Figure 8-10: The use of an anterior jig associated with phonetic tests and several deglutitions makes it possible to find the patient's rest position and its vertical dimension. The tests are based on the pronunciation of the "S". Optimally, in dentate subjects, each increase in DVO should not exceed the height of the free space of rest, so as not to disturb the muscle equilibrium. If necessary a second increase can be made a few weeks later.

This protocol can be applied to additional uses: to record the intermaxillary relationship for occlusal analysis on an articulator and for prosthetic rehabilitations.

If the vertical dimension is reduced , the protocol of jig + tongue position, with several deglutitions and associated phonetic tests (similar to those of complete dentures), allow us to find the vertical dimension and to record it.

Vertical dimension is a variable located in a custom normality range. Changes in vertical dimension of less than 5 mm are generally well supported by the neuro-muscular tract (Moreno and Okeson 2013). Personally, in dentate subjects, we limit the change of VD to a slightly lower value at the height of the freeway space , so as not to disrupt the neuromuscular equilibrium. (Fig 3-10). If the increase of VD is insufficient, a second increase is provided a few weeks later, when a new freeway space has re-established .

Note 3 :

Checking chewing functional surfaces simultaneously with the analysis of the closure path is often necessary. The mesio-palatal side of the first upper bicuspids often appear as an early contact, considered a prematurity on the closure path. Before any alteration, check that it's not a cycle-in guide, on the same side, balanced or not, with posterior teeth cycle-in guides. Or in the case of cycles, in frontal orientation, as in Class II division 2 Angle, that it is not a cycle-in guide, balanced with contralateral side. These guides are physiological and should not be retouched. They participate in the protection of the TM joint structures, with other cycle-in guides and they maintain the functional interplay, posterior to MIO, necessary to do cycle-in on the same side. When checking the posterior functional play in the sagittal plane, with the tip of the tongue turned, toward the back of the palate, it may appear an asymmetry when sliding forward after. Before subtracting on the side apparent overguiding, be sure that the other side is not under-guiding and requires an adjunction.

Note 4 :

Classically, the anterior jig disengages all the posterior teeth to deprogram the engrams of adaptation created by the malocclusions (Le Guern 1987). The value of the disocclusion between the posterior teeth should be minimal but sufficient, about 1mm:

- to prevent the patient from finding contact between his posterior teeth, by contracting his elevator muscles,
- and to avoid any uncontrolled displacement of the mandible.

Since the tongue is used in addition to the anterior jig,

- it's the posture of the tip of the tongue, on the anterior part of palate, which gives and maintains the mandible in swallowing position (Le Gall et al. 2010).
- The thickness of the jig can therefore be moderately increased, without displacing the mandible.

Summary:

Protocol of the anterior positioning of the tip of the tongue, simultaneously with the port, of an anterior maxillary jig of deprogramming

- Worn from 1 to 5 minutes, average 3 minutes

- With only one antagonistic, anterior and medial contact, and no deflector
- Worn without occlusal pressure,
- The point of the tongue held in support against the anterior part of the palate,
- Some swallows are required, the tip of the tongue kept in contact with the palate
- Then jig is then removed with half-open mouth and the patient slowly raises her mandible until the first contact. He: indicates the position with a finger. Performed a second time, procedure must produce the same result.
- The marker film can then be positioned simultaneously on both sides to visualise the first contact, or the occlusal balance.

SECOND STEP: MASTICATION

Chapter 4

- **Mastication : Incision Guidances**

The physiology of chewing has been largely developed in the previous chapters. What is not, is the case of the incisal guidance.

Figure 4-1:The incision movement, that split and introduce the food bolus in the mouth, is in centripetal orientation. The elevator muscles with retropulsive action are responsibles for itt (deep masseter, medium and posterior temporal

Spelling error - itt

-Protrusion VS Incision

What movement should we ask the patient to do in assisting balancing of the anterior teeth? The protrusion movement usually requested of the patient to verify anterior occlusion, has an inverse orientation of the incision movement, with symmetrical muscle recruitment, ILPs (lower and propulsor) and propulsive elevator muscles maintaining a slight anterior contact . When simulating the protrusion movement, only anterior contacts are observed. Guiding is usually located on the palatal surfaces of maxillary incisors and sometimes canines. They must be in coordinated and symmetrical contact and guidance with their antagonists.

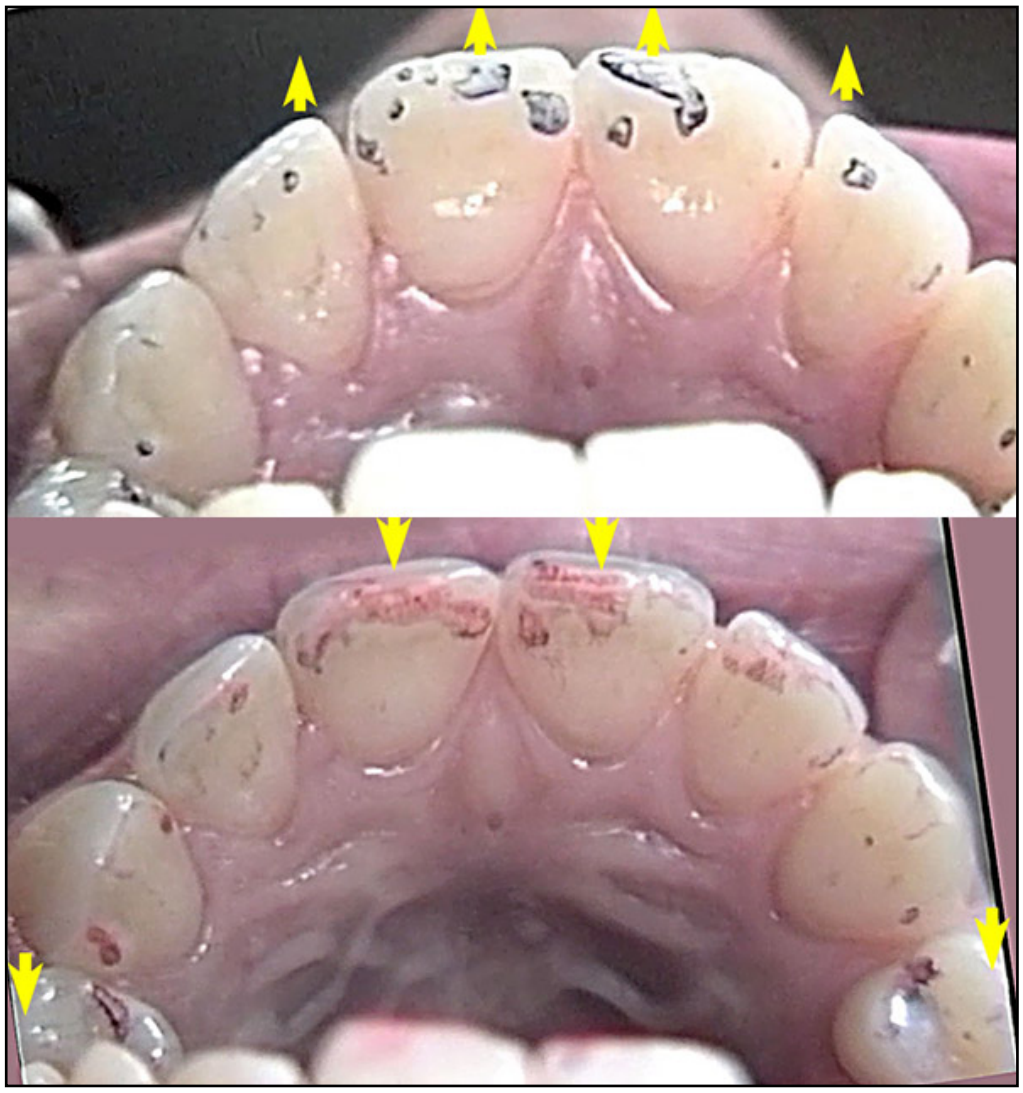


Figure: 4-2,3: Clinical Video Youtube: https://youtu.be/0inIZj9HvRM Protrusion and incision in a 20-year-old woman in class 1 occlusion, with optimal chewing. The protrusion (top) and incision (bottom) movements are compared on the video. They are different. The incision guides are more marked than those of proclusion in the canines and 1st premolars (The pictures a and b are extracted from the video file).

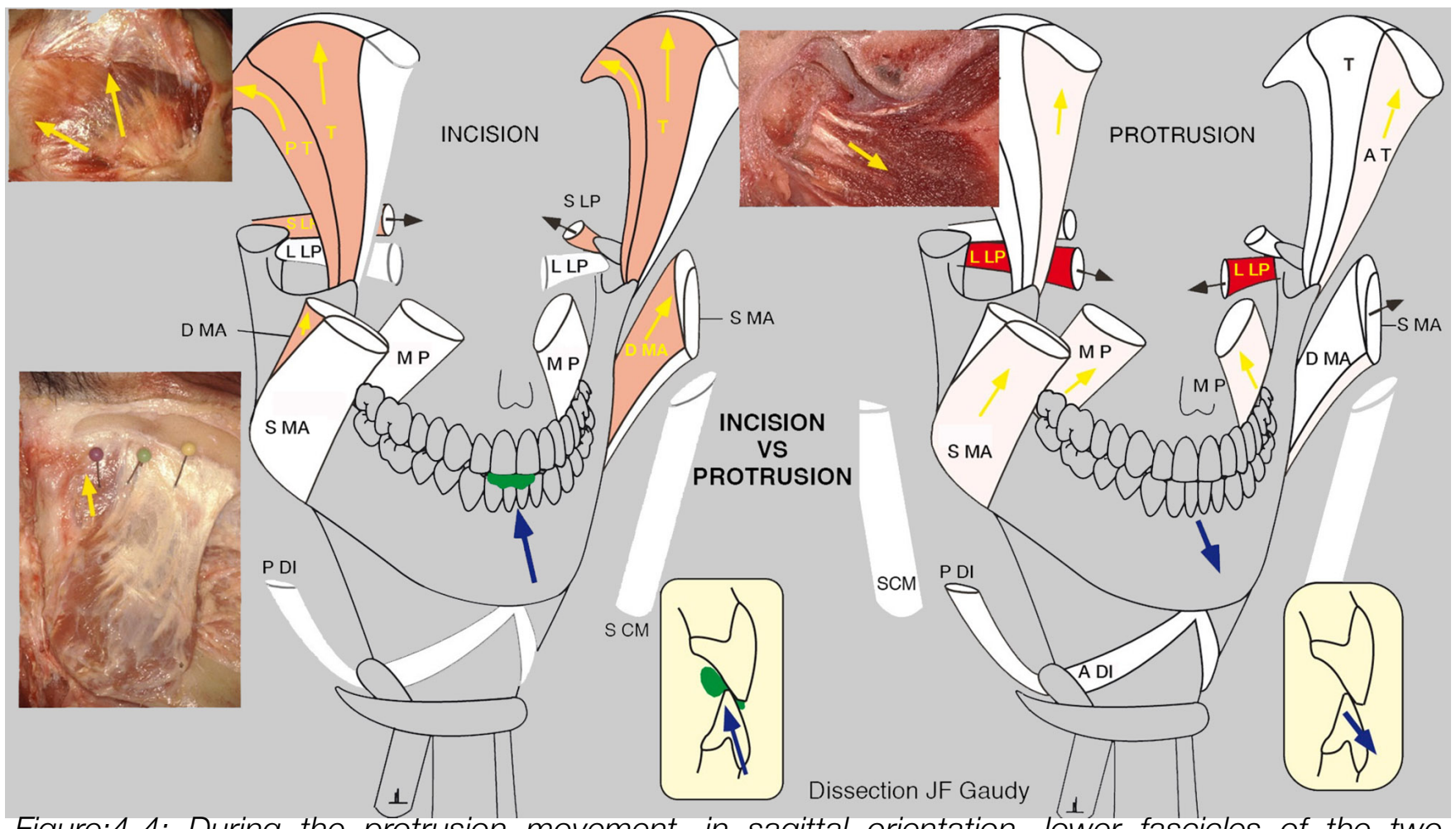


Figure:4-4: During the protrusion movement, in sagittal orientation, lower fascicles of the two symmetrical muscles lateral pterygoid are recruited simultaneously, they are then depressor and propulsor. The fascicles of the temporal anterior and masseter superficial, that are elevator and propulsor, are recruited enough to maintain anterior contacts. There is no posterior touch (unless gap …). During the incision, the elevator and retropulsor fascicles of the masseter (superficial, medium) and temporal (posterior, middle) are simultaneously contracted, to introduce the bolus in the mouth. When empty, the anterior guidances are leading, they are accompanied by posterior subsidiary ones

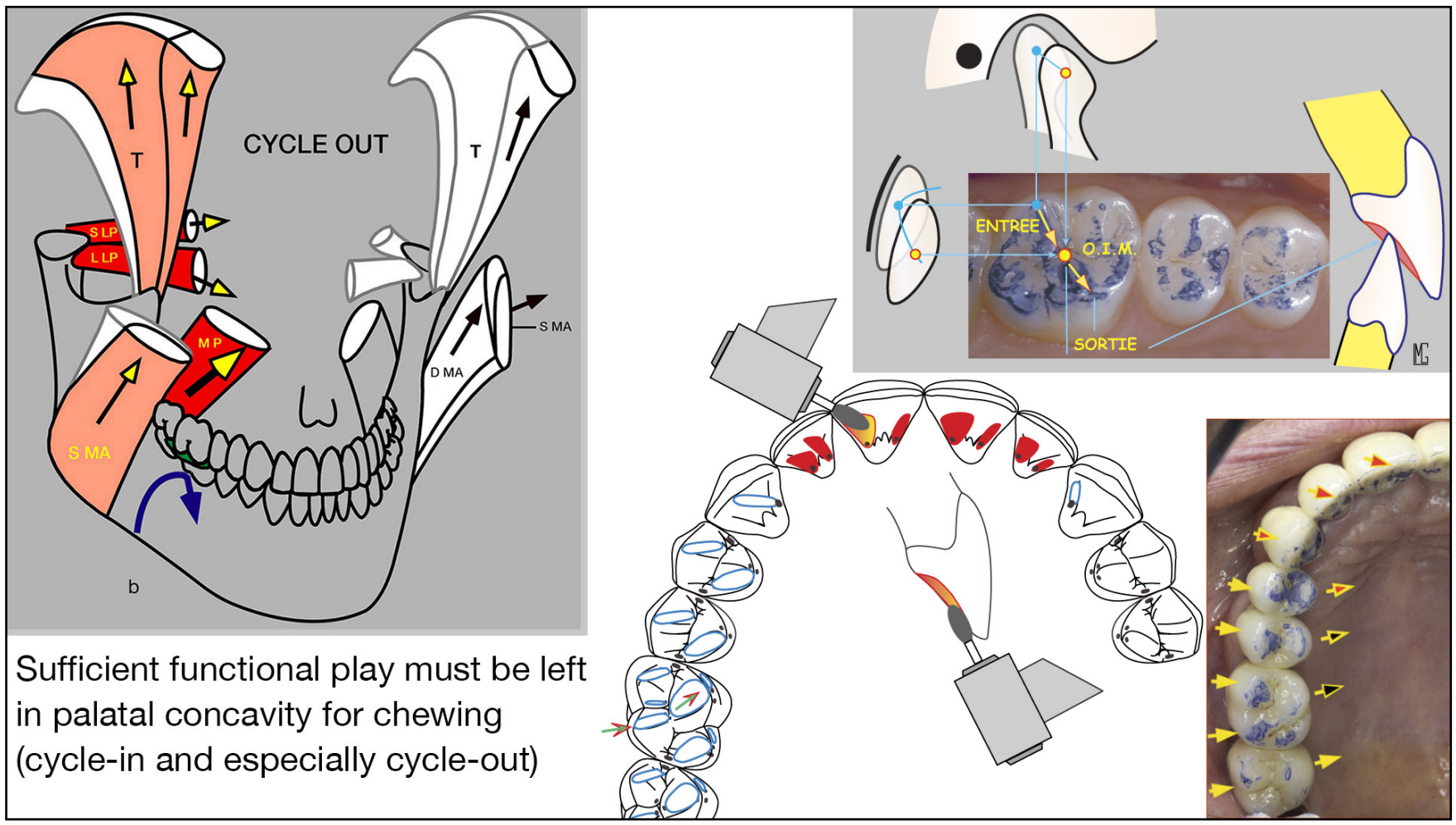


Figure:4-5: Sufficient functional play should be provided at the level of the cingulum for chewing, before checking the incision. The reduction or absence of cycle outputs on the molars causes overguiding in the maxillary palatal concavity.

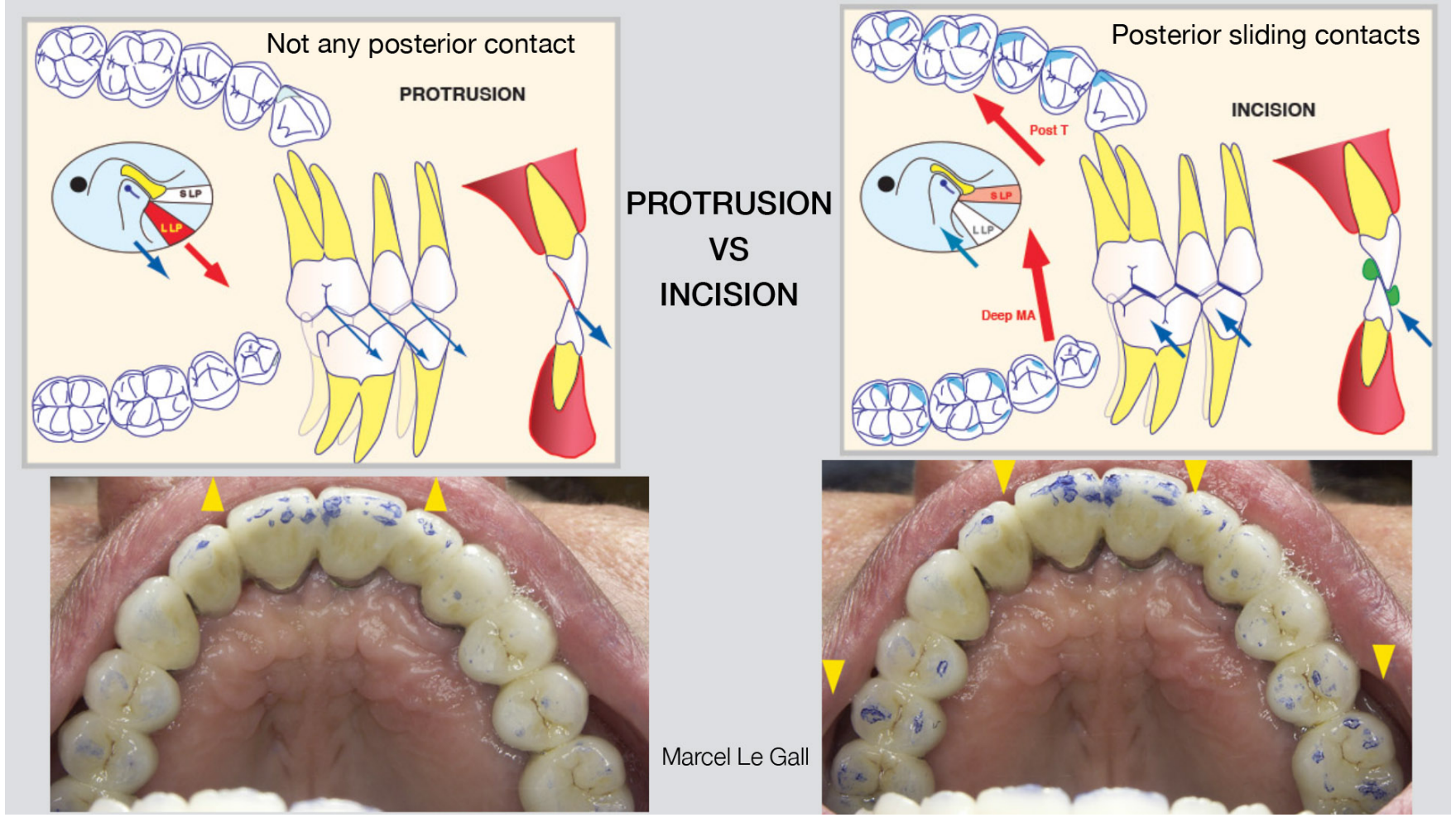


Figure:4-6: The difference of muscular recruitment slightly changes the mandibular position:
on left figures depressors= no rear contacts,
on right figure,s elevators= rear accompanying guides

Use a moisture-insensitive marker film for chewing tests. Whereas during the incision, caused by the retropulsive component of the elevator muscles, the dominant anterior guidance is almost always accompanied by symmetrical and non-dominant symmetrical bilateral posterior guidance.

This rear accompaniment of the anterior teeth is working early, in class 1, when the overbite, cingulum and intracoronal opening angle are normal (Slavicek 1983).

When a deep incisor overbite is present, with a closed incisor angle, like in class II division 2, the posterior subsidiaries incision guides appear late and occur in the close area of MIO.

In open bites, the only guides are posteriors. There is a posterior incision.

In young adults, these posterior guides, are often present, but generally thin. They become more prominent with age and occlusal wear . They follow, in a personalized way, the progressive degradation of the initial optimal model.

About palatal anatomy of maxillary incisors.

The presence of a well marked palatal concavity in maxillary incisors finds its functional significance, when in cycle-out, the edge of lower incisors pass transversely across these palatal concavities in a slightly anterior situation. They therefore have a functional equilibrium relationship with the undisputed volume of the molar cycle output tables. But they have not any significance for incision and protrusion movements.

Seevideo Youtube: https://youtu.be/3UdTX2Pzxiw

Important: During protrusion movement, only anterior guidances are generally recorded, when during incision, posterior balanced contacts, going with anterior leading guides are revealed on marking papers. If you first test, a protrusion movement till incisors edge to edge, and then an incision movement, with pressure of elevator muscles, you can be aware of this reality.

- **Mastication: Reference Scheme** (Le Gall et Lauret 2011, Le Gall 2013)

Taking chewing function as a reference, requires significant modifications of occlusal approach.

From swallowing MIO, dynamic balancing is not limited to balance by subtraction cuspid guided movement laterality and protrusion. Purpose finality is the full rehabilitation of the dental limit envelope, guiding the cycles and antero-posterior incision guidances.

From simulation of functional movements, this aim is generally obtained by clinical built up technics. In case of prosthetic rebuilding, the concept of the articulator must be fitted to reproduce functional movements or alternatives technics must be considered.

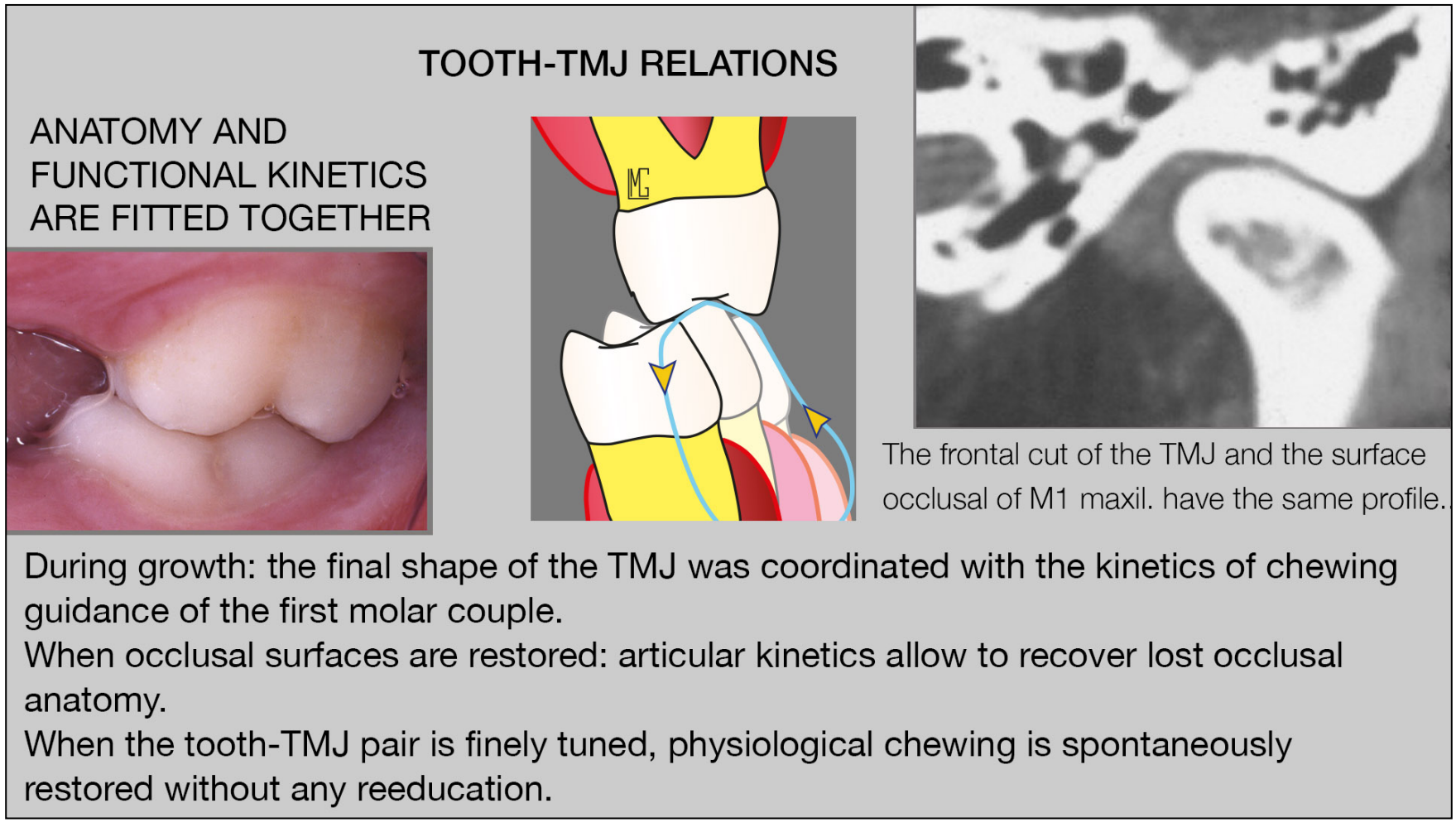


Figure 4-7: The memory of the first molar anatomy, fossilized in the articular shape during growth, will allow later to rebuilt the lost occlusal anatomy. The next teeth, in their order of emergence, will be incorporated progressively, to the found again, functional scheme of the first molar, including cuspid, and even anterior teeth, to rehab the half arcade. If necessary, the other half arcade will be also rebuilt.

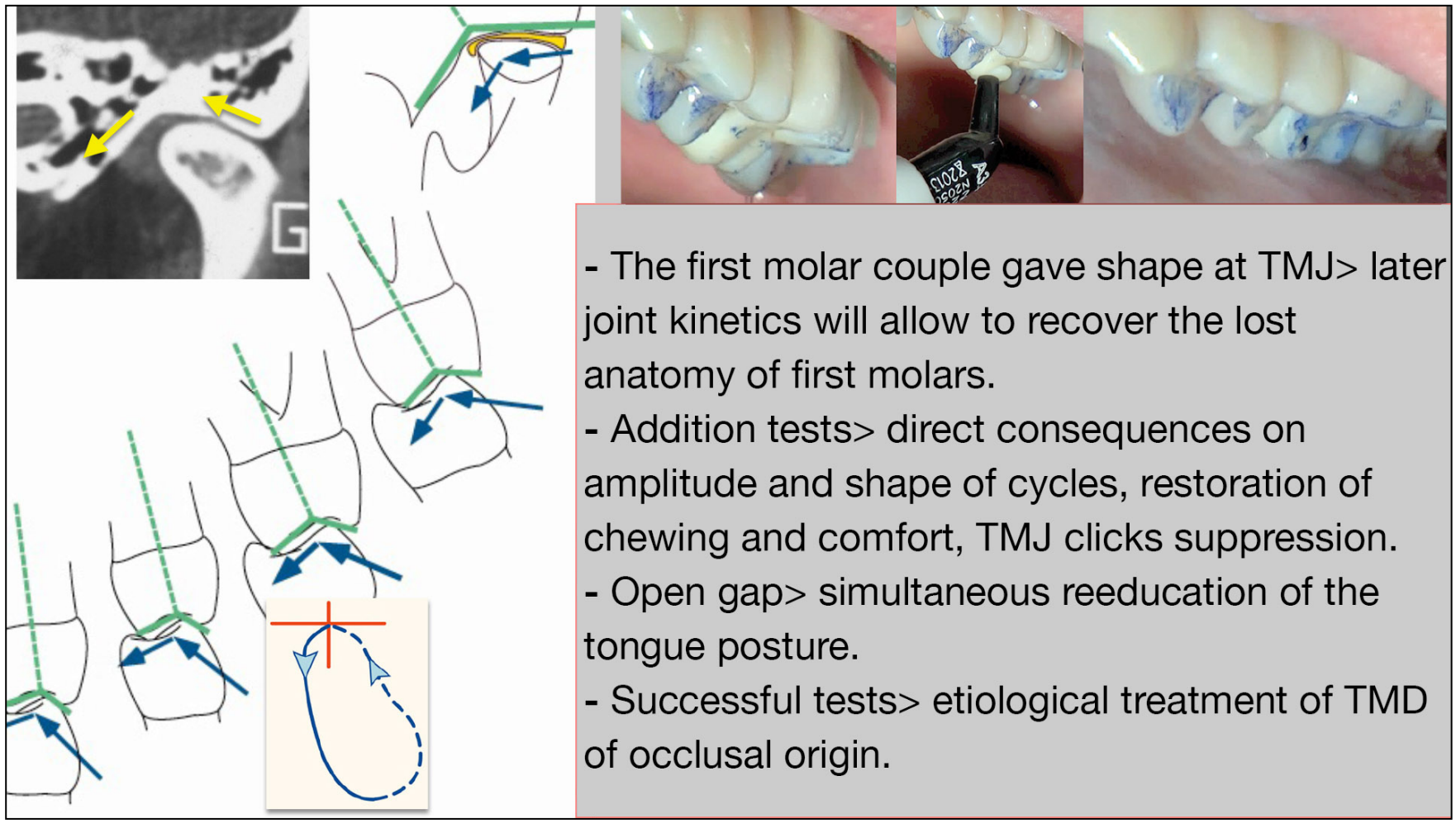


Figure 4-8: Occlusal and TMJ anatomy must be paired in an optimal way, to allow the patient to describe the limit of the envelope chewing cycles, in dental contact.

-a- -b- -c- -d-

Figure 4-9: a: enamel treatment; b: a compule allows easily to make composite-up; c: a micro brush soaked with adhesive allows to easily sculpt composite cones; d view of the cones before closure

Evolution of our natural model is wearing and dilapidation, without regeneration capacity. In these conditions, how to rebuild occlusal surfaces of a patient, when his own anatomical references are lost ?

During the growth, the occlusal anatomy and its functional kinetics have been used as guides in the completion of the shape of the joint, first in the sagittal plane and then in the frontal plane. Its transversal dimension, in particular, is multiplied by 2.5 between 5-6 years and adulthood (Nickel 1988). In addition to the genetic determinism, the anatomy and the articular kinetics, depends on the occlusal anatomy of teeth and on the envelope limit of motion enabled, when they are in static or dynamic contacts.

T.M.J. is the only joint in the human body, whose functional envelope is limited by a rigid structure: the contact of the teeth in occlusion (Mc Neill, 1993).

The fact that the axis of dentoalveolar inertia and arcades center of gravity passes through the maxillary and mandibular first molars in the frontal plane, show a balanced relationship of arcades certainly of functional origin (Treil and Casteist, 2000).

When the occlusal anatomy is lost, the memory of this anatomy that is fossilized in the shape of the joint will help us restore by addition the lost occlusal faces. Beginning with the first molar, because the occlusal scheme in the adult, has itself been built from this tooth and also, considering this position on the arcade, the most relevant tests of restoration, must be made at this level. When the coordinated operation of the TMJ-M_1 pair is restored, it will serve as a reference to gradually reconstruct the occlusal anatomy of the neighbouring teeth. By first integrating the 2nd premolar, the 1st premolar, then the canine* and ending generally with the 2nd molar, more delicate to balance, but very important for articular guidance in case of TMJ noise. If necessary, the rehabilitation can even involve the incisors, so the whole hemi-arch, in order to restore the optimal masticatory efficiency of the affected side.

When the coordinated functioning of the couple TMJ and M_1 is restored, it will serve as a reference to gradually restore the occlusal anatomy of all the neighbouring teeth.

*Regarding the canine, if it is under-guiding, it should be integrated into the chewing pattern of the M1. If the laterality movement is requested later (with a different muscle recruitment: contralateral PLI) it must ensure the disocclusion of the arcade alone.

This adjustment is very fine and must be carried out until the recovery of the optimal limit envelope of the cycle proper to each patient. It is sometimes repaired on a final retouch of the composite, of the order of 20-30µm, made with very fine grain diamond burs and/or polishing cups. The very fine perception and the information transmitted by the patient is decisive in obtaining the optimal balance of this first couple.`

These tests aiming at restoring the wedging and the guidance of the occlusal surfaces are currently carried out with micro or nano composites featuring a wearing modulus similar to the one of natural enamel (Lambrechts et al, 2006). They can be thus considered as permanent restorations. On natural teeth, the addition is very often appropriate, while for fixed restorations, addition and/or subtraction must often be associated.

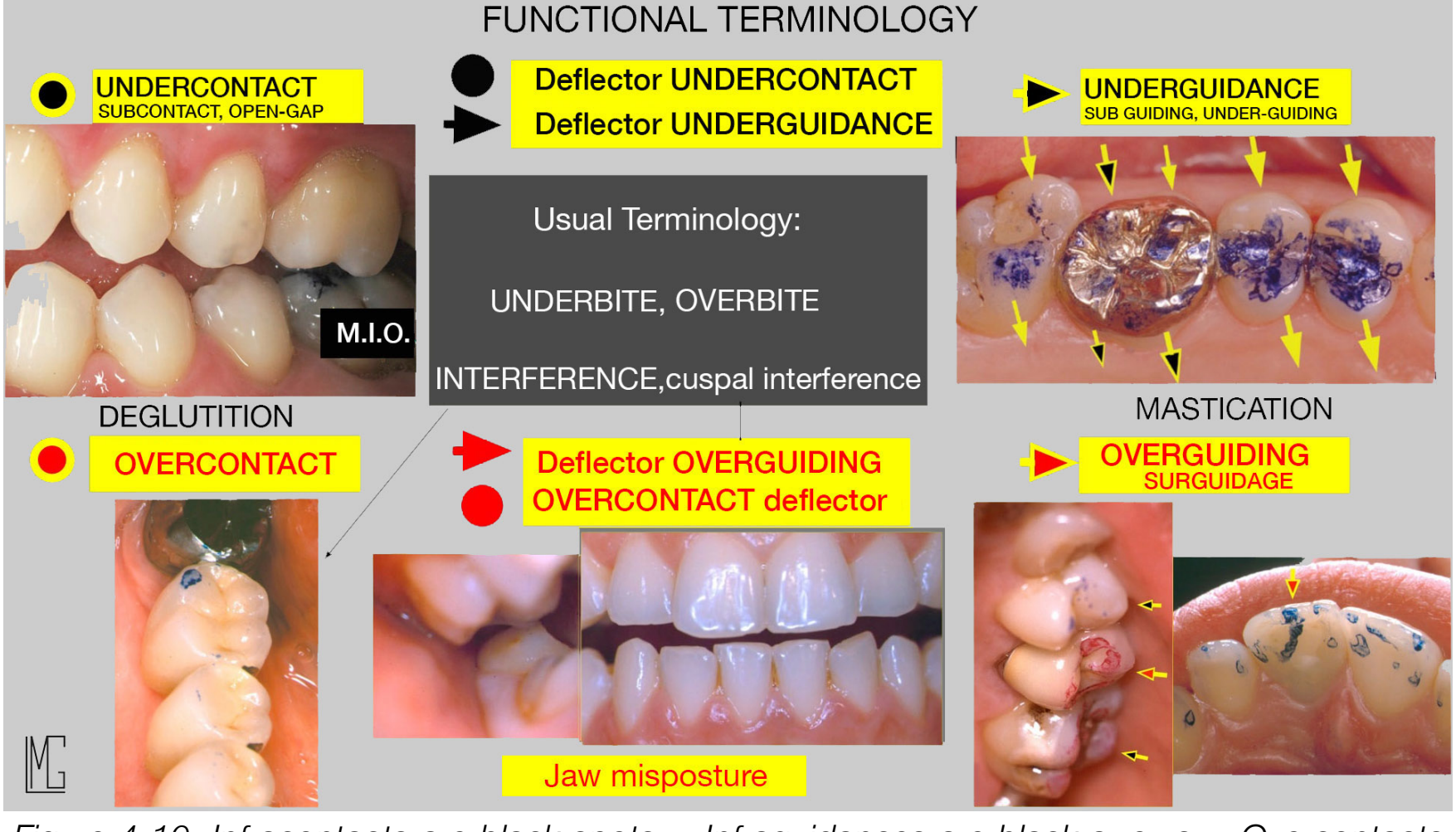


Figure 4-10: Infracontacts are black spots, Infraguidances are black arrows, Overcontacts are red spots, Overguidances are red arrows

Taking mastication as a reference a change in classical protocols are required. Indeed, posterior anatomical interactions, related to guidance and cycle pattern, had never been considered before, under this angle, it has been necessary to propose a new terminology to describe them, because it don't existed (Cycle inputs, cycle outputs, Cycle input supports etc).
See Video Youtube: https://youtu.be/wWxgCe0NHNc
Likewise, as occlusal anatomy is not self-repairing, and that it evolves progressively toward the lost of its initial characteristics and the destruction of the optimal functioning model, it has been necessary:

- to propose rebuilding technics to restore the functional capacity, of teeth
- to reduce at the minimum, selective grinding procedures that worsen it.
- it has also been necessary to introduce a new terminology considering negative interferences or malocclusions, that must be balanced by adding, without any subtraction on the next teeth. They can concern occlusal supports of swallowing as well as mastication guides. The figure 4-10 is a summary:`

- Occlusal Equilibration by Addition or Subtraction: Indications

Objectives: rehabilitation of chewing guides that shape the cycles and ensure the effectiveness of chewing, in a non-mutilating way, increasing if necessary the vertical dimension:

- **On the natural teeth** subtractions are prohibited***.**

****Exceptions*** *(if orthodontic recovery is impossible):*
Retouching of extruded teeth, or in malposition is allowed to tend to restore the Wilson and Spee curves, during the restoration by addition of the antagonist dental volumes.
Similarly, during the equilibration of the closure path it may appear premature contact responsible for deflection of the mandible. It can be retouched by careful subtraction, after checking that the arch is not in almost complete under-occlusion (under contact) which should be corrected by generalized additions.
In the presence of flattened occlusion relationships, with no indication of an increase in VDO, the furrow bottoms can be deepened and reprofiled, so as to be able to increase the volume of the cusps of the opposite tooth and vice versa (remember that retouching the cusp tips, levels the occlusal anatomy).

Because They are assimilated to mutilations on teeth whose progressive natural wear, natural or abnormal, is not compensated by any regeneration. Additions should be favoured to

reconstruct the lost volumes of natural teeth, using composite-up tests (reversibles) or others. With two levels of rehabilitation:

-Either the balanced restoration of the **input and output surfaces** of cycles,

-Either the optimal restoration of **surfaces and guide rails**, first molar couples.

- **On fixed restorations on natural teeth**, the principles remain the same, but apply with more flexibility. Occlusal retouching is possible and the return to the laboratory allows to make and adapt the necessary additions.

- **On implant-fixed prostheses,** the principles remain the same when osseointegration and peripheral bone adaptation are already obtained. But, depending on the case, the progressive adaptation of the peri-implant bone should be favoured. In situations of immediate unitary prosthesis, or in the presence of mediocre bone, a temporary prosthesis must be worn for several months. Otherwise the initial contacts and guidance of the permanent prosthesis should not be dominant during the installation. Interposition of a 15-20µm film sliding between implant restoration and its antagonist makes it possible to avoid the over-contacts and to stimulate the progressive adaptation within bone. In this case the natural wear of the neighbouring teeth (Lambretch et al 2006) and the extrusion of the antagonists, allows the progressive return (which must be controlled) of contacts and guides well distributed between all the teeth.

- **Clinical practice and protocols.**

The use of bonded composite, micro or nano-charged, whose wear is of the same order as that of natural enamel (Lambrechts et al 2006), is the preferred way to restore volumes and lost guides, as tests reversible. The control of the shape and balance of the limiting dental envelope, of chewing cycles, can be optimally achieved by chewing a very fine coloured film (15 to 30 µm) which allows the patient to maintain the perception of the slightest malocclusions, while the chewing of a thicker food, even chewing gum, does not allow such a fine coordination.

The presence of defects or excess of guides, even minimal, often limits the transverse amplitude of the cycle by the activation of TM-Joint protection mechanisms, that even reduce it to a simple shear. As soon as the balance of the guides is restored, in harmony with the kinetics of TMJ, the patient spontaneously describes the limit envelope of the cycles without

any learning. All cycles with interposed foods will then be located inside this envelope, without always reaching its maximum limit.

Attention in implantology, there is a great disparity between the discriminating capacities of the patients. Some patients have the same proprioception on implants as on natural teeth, but for the majority it is very reduced on implants. They chew on the malocclusions because they do not perceive them and the forces transmitted to the bone are then greatly amplified by the immobility of the implants.

- Clinical videos

See videos Youtube: https://youtu.be/dfgOq-Eoem8

and: https://youtu.be/OB9t3sYEazw_ Clinical case fig. 4-12 à 4-14

- Class I Relationship

Human occlusal anatomy has been selected to work with maximum efficiency in Angle Class I relationship. They are the inverted 3D image of each other. So just rebuildt the cusps of the maxillary and/or mandibular first molar, by “composite-up” at the same location and in compliance with the occlusal curves. It's easy. If the Spee and Wilson curves are not optimal, the choice of volumes to be reconstructed (maxillary or mandibular) should tend to restore the

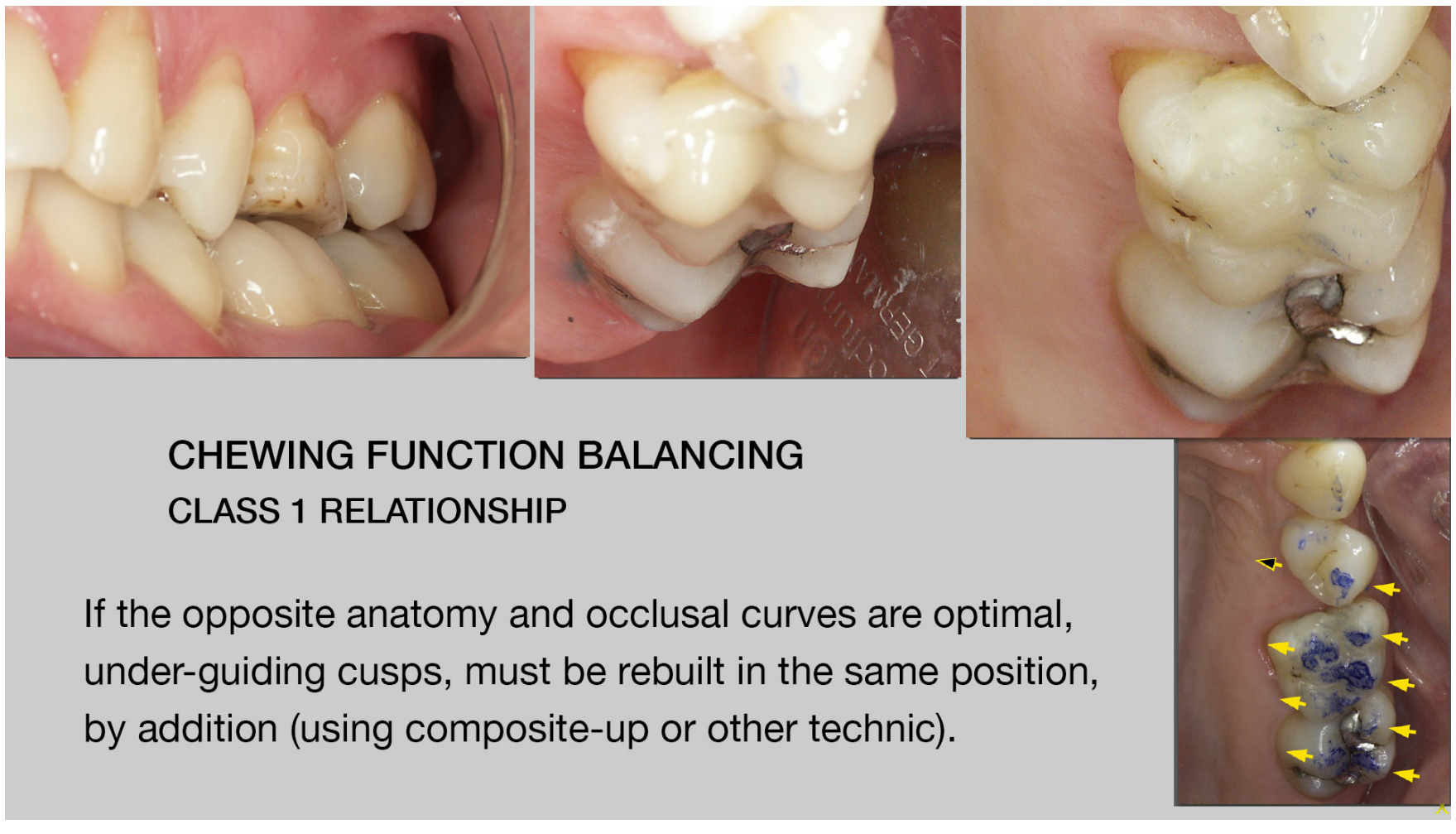


Figure 4-11: Rehabilitation of a class 1 molar occlusion, under-guiding, without any loss of VDO and with an optimal opposite occlusal anatomy.

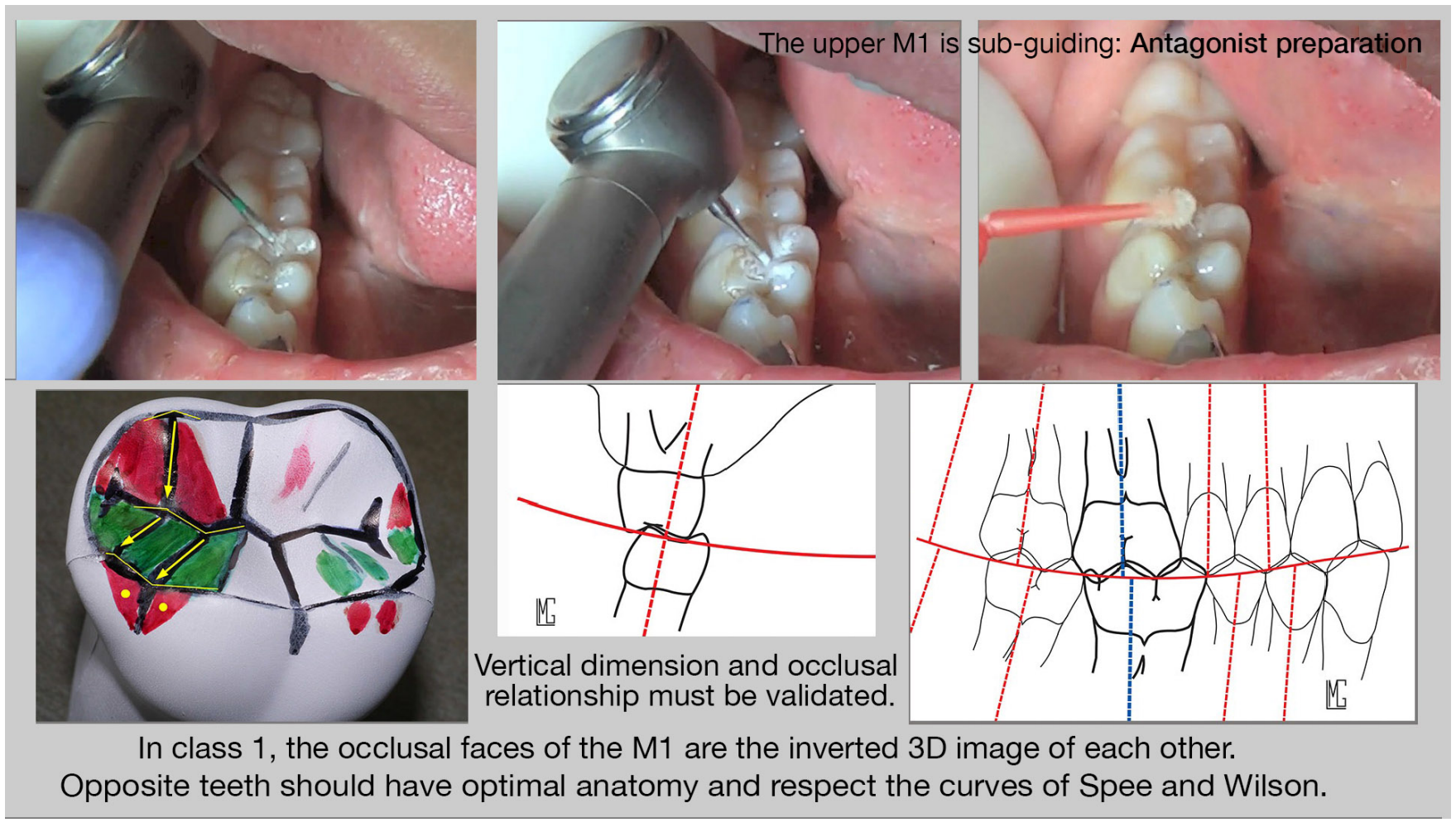


Figure 4-12: Summary: occlusal optimization of the mandibular first molar by carving in the composite and building up one cusp, mesio-buccal. It will be followed by the opposite rebuilding of maxilla first molar.This dual restoration has two objectives: to align the teeth along occlusal curves and restore the occlusal functional anatomy, the couple first molars

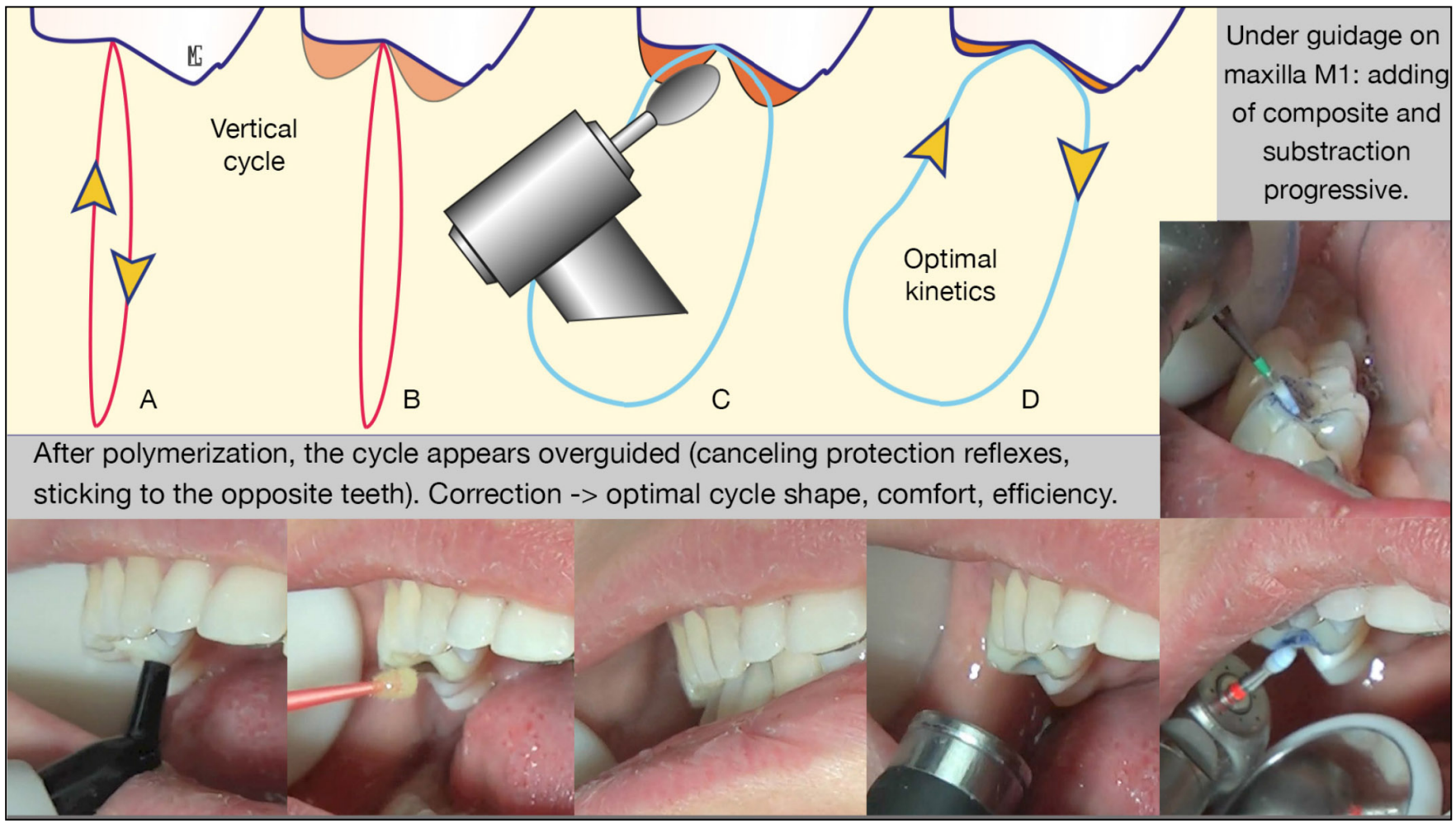


Figure 4-13: Now the under-guiding upper first molar will be rebuilt. Before the composite hardens, the cycle keeps the initial vertical cutting shape. After polymerization, the protective reflexes are instantly canceled, and the cycle tries to expand. The composite additions appear to be excessive. An adjustment by subtraction must be performed with great care up to the functional balance and the optimal shape of the cycle are reached, in according with the patient TMJ kinetics. It's why the patient's feedback must guide the practitioner and is so important. See the movie above

curves in their natural orientation. Because during the growth, it is the chewing dynamics on the M_1 couples which imposed the situation of the following teeth on these curves.

The surface of composite additions must be coated with a bonding liquid, in order to avoid salivary contamination, and the sticking, with opposite teeth, during closure. It is generally not necessary to already ask the patient to simulate chewing, because as long as the material is not polymerized, chewing is reduced to a vertical shearing movement (Fig. 4-13 A,B).

The hardening of the composite sets new marks and cancels the joint protective reflexes. A chewing simulation and the patient's perception, allows then the progressive coordination of

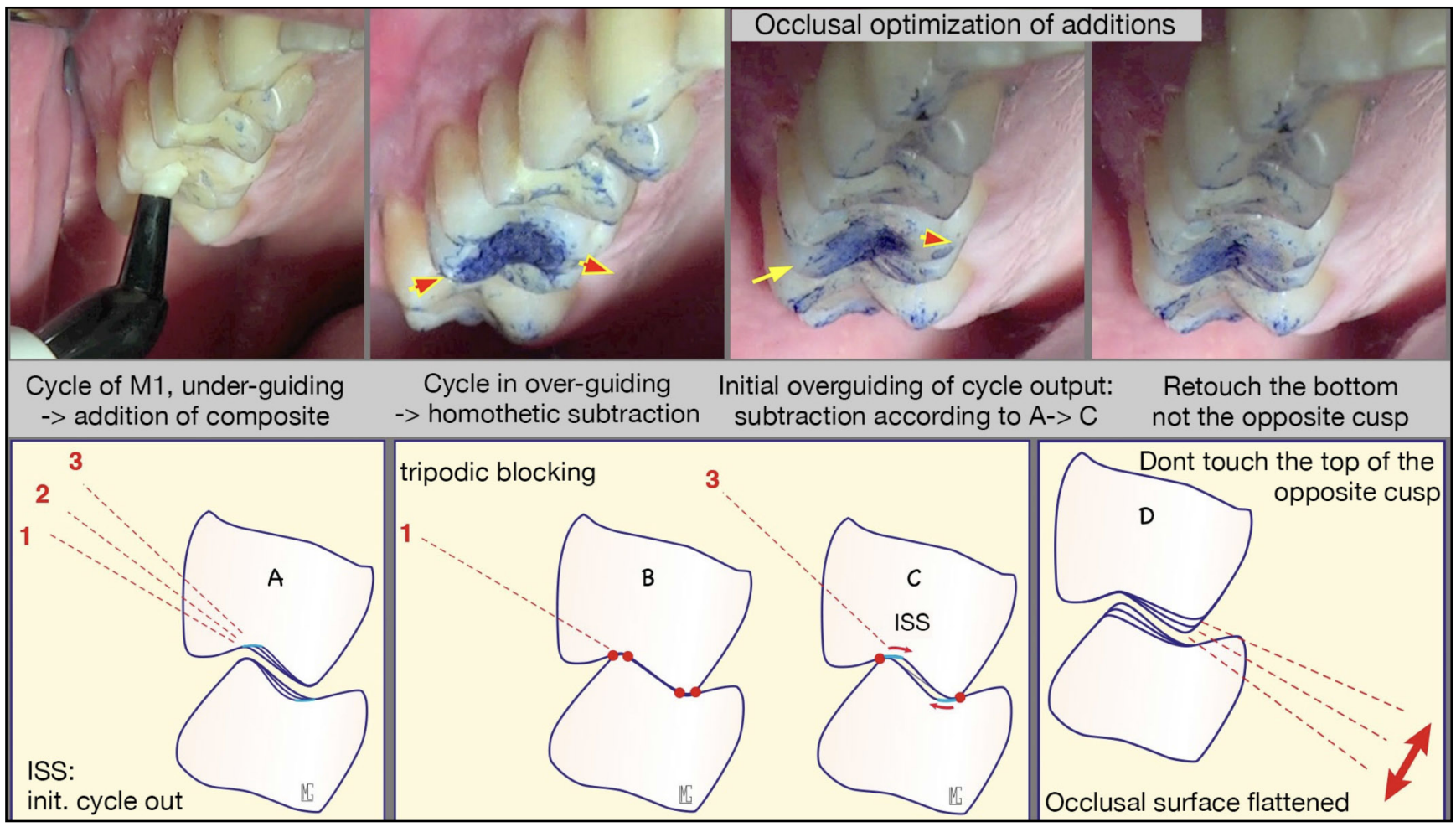


Figure 4-14: Some advises for composite-up: privilege alterations in the bottom of a fossa (A), rather than on the top of a cusp, risking to flatten the cusp (D). You must maintain a personalized immediate side-shift, between cycle-out slopes (functional interplay, naturally present, allowing the cycle to pass through MIO without any stopping (C). The tripodic relationship of gnathology do not respects that rule. It's why tripodism only exist on the schemes (B) of occlusal books, but not in the mouth of the patients…

the guides, up to the cycle and comfortable feelings are restored. This stage, must be carefully completed and sometimes it is long. The restoration of the main guiding rail must be favored. It is performed without any difficulty, if the opposite anatomy is optimal . This procedure can be also applied to ceramic, with a specific primer.

When finished, an impression of the tooth can be taken, to create a new identical crown. Which may be obtained either by means of a conventional impression, or using an optical impression.

If occlusal relationships are not established in class I, the occlusal reconstruction must be adapted to the actual occlusal relationships, modifying the occlusal anatomy so as to restore guidance, harmoniously matched to the real kinetics of TMJ and to obtain a kinematics of cycles similar to class I. The following Youtube video is detailed in the figures 4-12 to 4-14:

https://youtu.be/OB9t3sYEazw

- Class II Relationship

BALANCING OF MASTICATION: CLASS 2 OCCLUSION

In class 2 and even more in partial class 2, the cycle input guides are reduced and the cycle output guides do not exist. The simplest solution is to move the occlusal anatomy of M1 mandibular by creating a cusp antagonist internal side of the maxillary M1, disto-buccal cusp, to allow them to chew as a class 1.

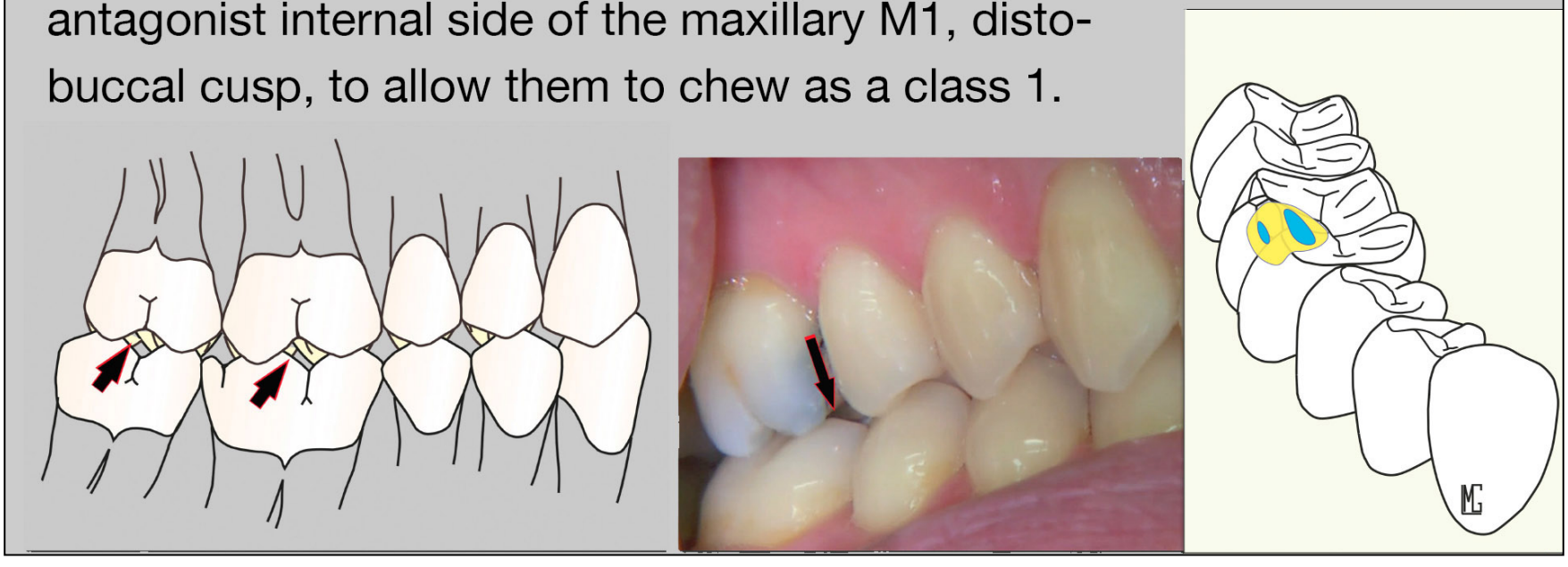


Figure4-15: When the teeth can't be moved, the solution consist to modify the occlusal anatomy by addition to restore optimal class 1 cycles.

In the sagittal plane, the distal shift of one cusp of the first mandibular molars, establishes a class II molar occlusion. The consequences are often unstable occlusal relations in MIO and a significant deficit in input and especially in cycle output (fig.4-15 and 4-16). These deficits of wedging and guiding are even more important in class II partial, with cusp points in opposition

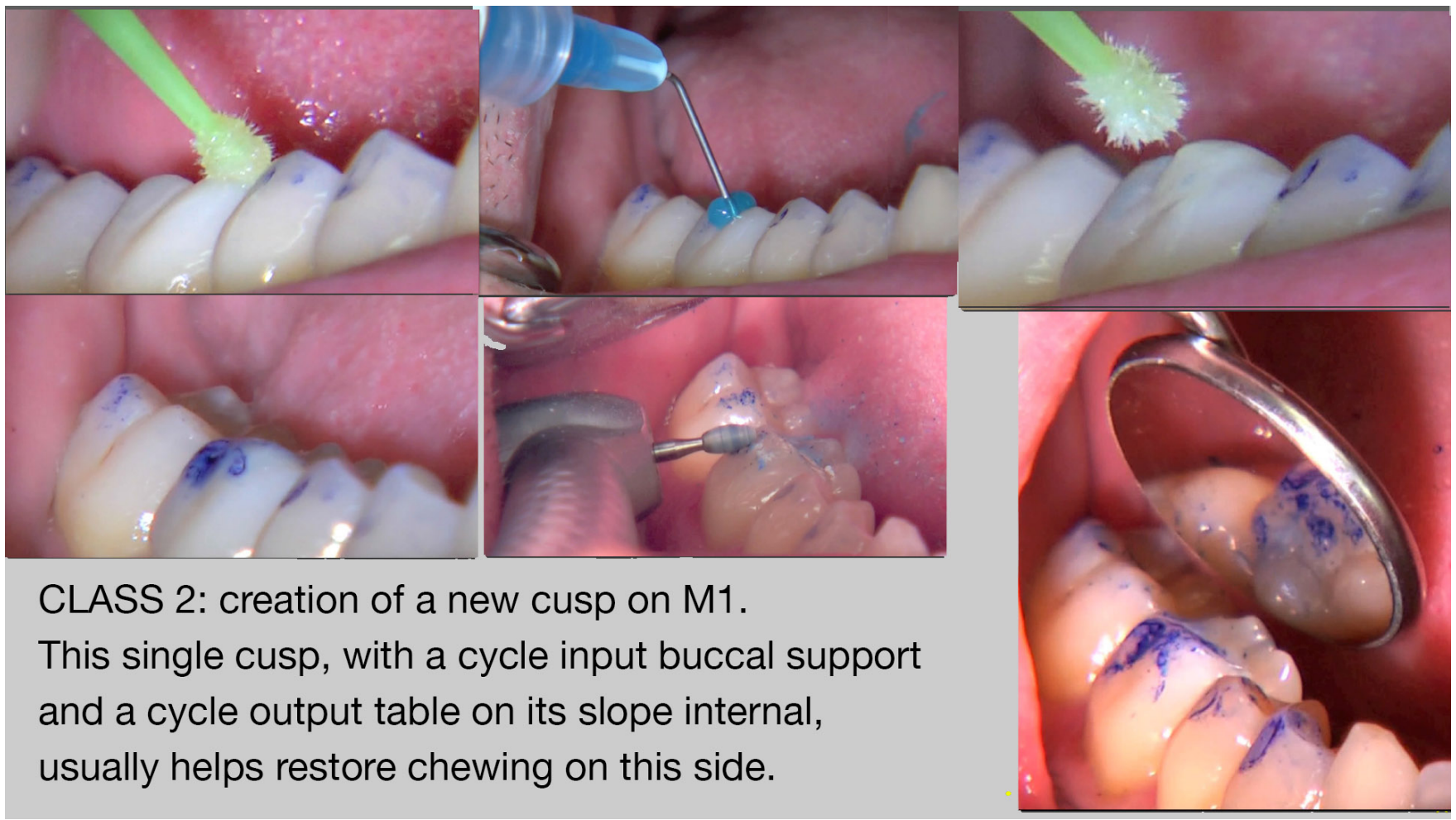


Figure 4-16: The patient is a dental practitioner. On right side, the breadth of the cycle is almost acceptable, because second molar and second bicuspid partially compensate the missing guides on first molar couple. At the end of composite-up, the breadth of the cycle has been improved with better guides, and the patient feels more comfortable, He even notices that cycle-out is well guided, without any touch, in the palatal concavity of upper incisors, as before.

and non-existent output cycles, because in total sub-guiding, which are responsible for dento-articular dyskinesias.

There is a large area of vacuity between the occlusal surfaces and chewing is often reduced to a simple, inefficient vertical shear. The simplest solution is generally to modify the occlusal

Figure 4-17: See Youtube video (cl2) silent video-clip+ text in English: https://youtu.be/2GAsyxStD0Q or in French: https://youtu.be/kVeKaONT0mw

Swallowing contacts were checked prior to chewing. The antagonist area, of the maxilla M1, disto-buccal cusp is prepared by etching to receive the new cusp. The composite is put and shaped with a “microbrush” soaked with adhesive liquid. After one or two closures, it is polymerized. The closure shows a buccal and internal over guidance. They are gradually retouched with a fine-grained diamond bur. Firstly the contacts of swallowing have been balanced, chewing balancing, has followed. When the patient sensation is good and the cycle regained, the composite restoration is carefully polished with non abrasive silicone cups. In a later session, if necessary, the nearby teeth will be integrated into the new occlusal scheme.

anatomy of the first lower molar by creating an artificial cusp opposite to the inner side of the maxillary Disto-Buccal cusp. This new cusp, with a buccal cycle input support and an output table on its internal slope, installs contacts and guidance generally sufficient to stabilize the MIO and restore chewing on balanced guide facets. But the guide rails are often difficult to be restored in these situations. These rails are significant in children during growth, but their role is less important in adults when the function is shared over several teeth. When it is impossible to move the teeth, it is possible to move partially their occlusal surface, by addition.

- Class III Relationship

CHEWING FUNCTION BALANCING

CLASS 3 RELATIONSHIP, REVERSED OCCLUSION

In Class 3 few pathological consequences are observed and clinical situations are diverse and personalized.

The surfaces to rebuild must be choosen to restablish at the better, cycle-in and cycle-out

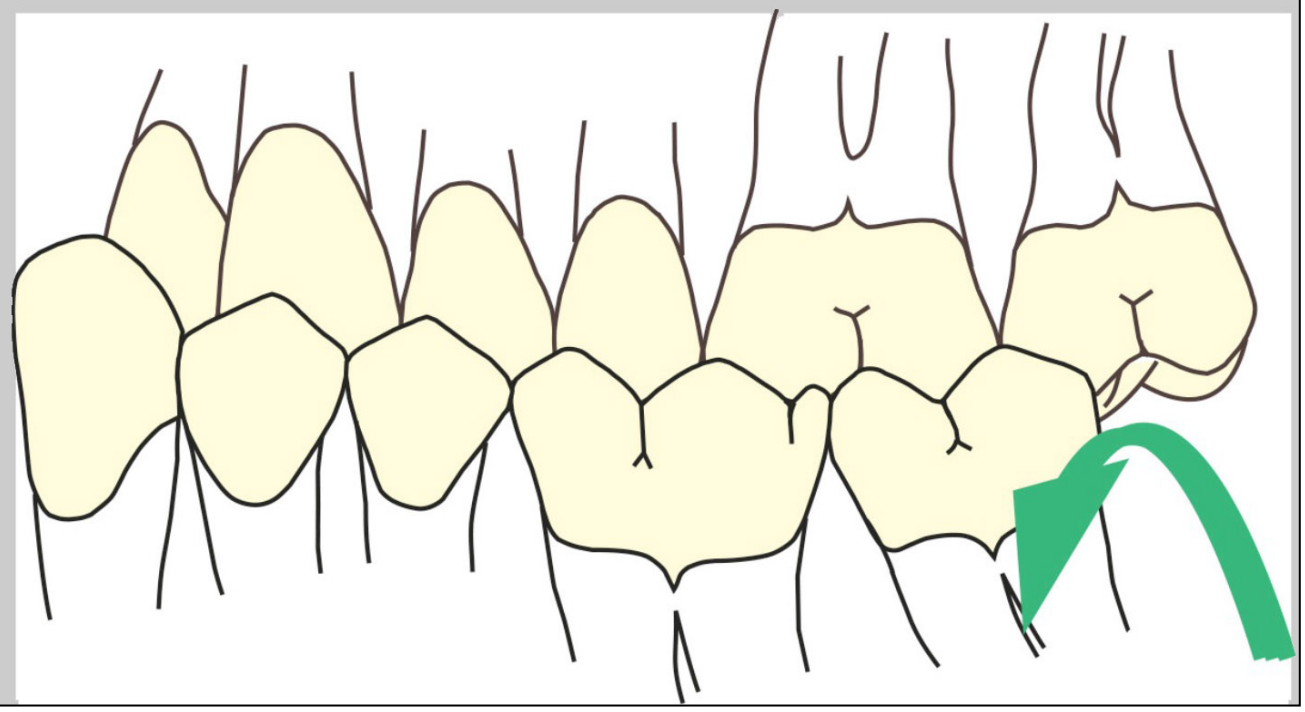


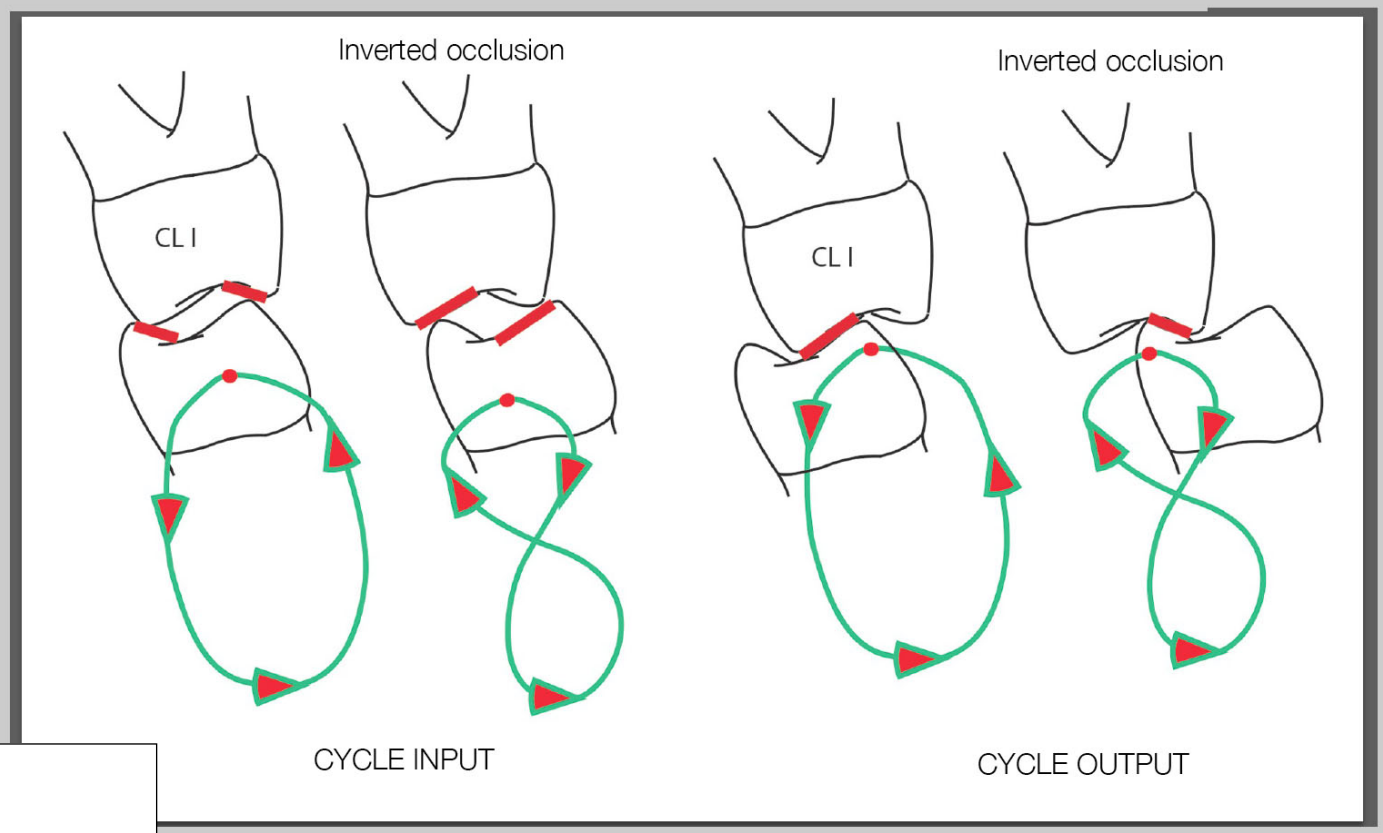
Figure 4-18: in class 3 occlusion the mandibular M1 cusps are mesially displaced by a cusp. This is often associated with partial or complete reverse occlusion: above.

In the sagittal plane, the mesial shift of one cusp of the first mandibular molars, establishes a class III molar occlusion. Multiple custom clinical situations are observed, ranging from inverted or cross bite relationships in the frontal plane. Nevertheless, classes III have very few pathologies probably because TMJs are not in posterior compression on the retro-discal lamina. The great variability of the cases does not make it possible to release a single rule. The choice of surfaces to be rebuilt must allow balance to be restored and shared cycle inputs and outputs between several teeth and to find the efficiency of mastication.

- Cross Bites, Inverted Bites, Cycles in 8

REVERSED OCCLUSION, CYCLES SHAPED IN 8

The guiding surfaces must be potentially reformed by addition/substraction to increase the guidance



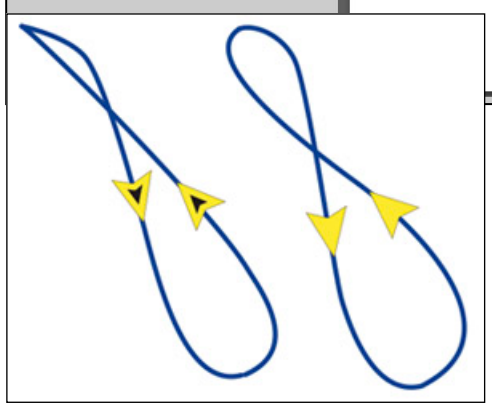


Figure 4-19

Cycles rotate in opposite directions. Guiding surfaces often need to be reconformed for a better efficiency.

In the frontal plane:

- Normality: the buccal covering of the mandible by the buccal cusps of the maxillary arcade. When the molar relations are in class I, in the sagittal plane, the cycles are physiologic.
- Inverted Occlusion: buccal covering of the maxillary by the buccal cusps of the mandible. The cycles are in the form of 8. It may be necessary to reconfigure the guide surfaces, by addition, subtraction, to ensure balanced operation, as the cycle inputs become outputs and the outputs become inputs.
- Cross-bite: The teeth intersect at closing, sliding without occlusal wedging, with +/- continuous egress-ion. Chewing is reduced to a sliding vertical shear. If orthodontics repositioning is not possible, it is a possible surgical indication.

- Multiple intermediate and personalized clinical situations. Sometimes one, two or three teeth of a lateral sector are in inverted or in cross bite and the others in normocclusion. It is the teeth with the strongest guides that prevail. Depending on the case, the cycle can be 8, normal or locked vertically.

• Open Bite secondary to lingual dyskinesia

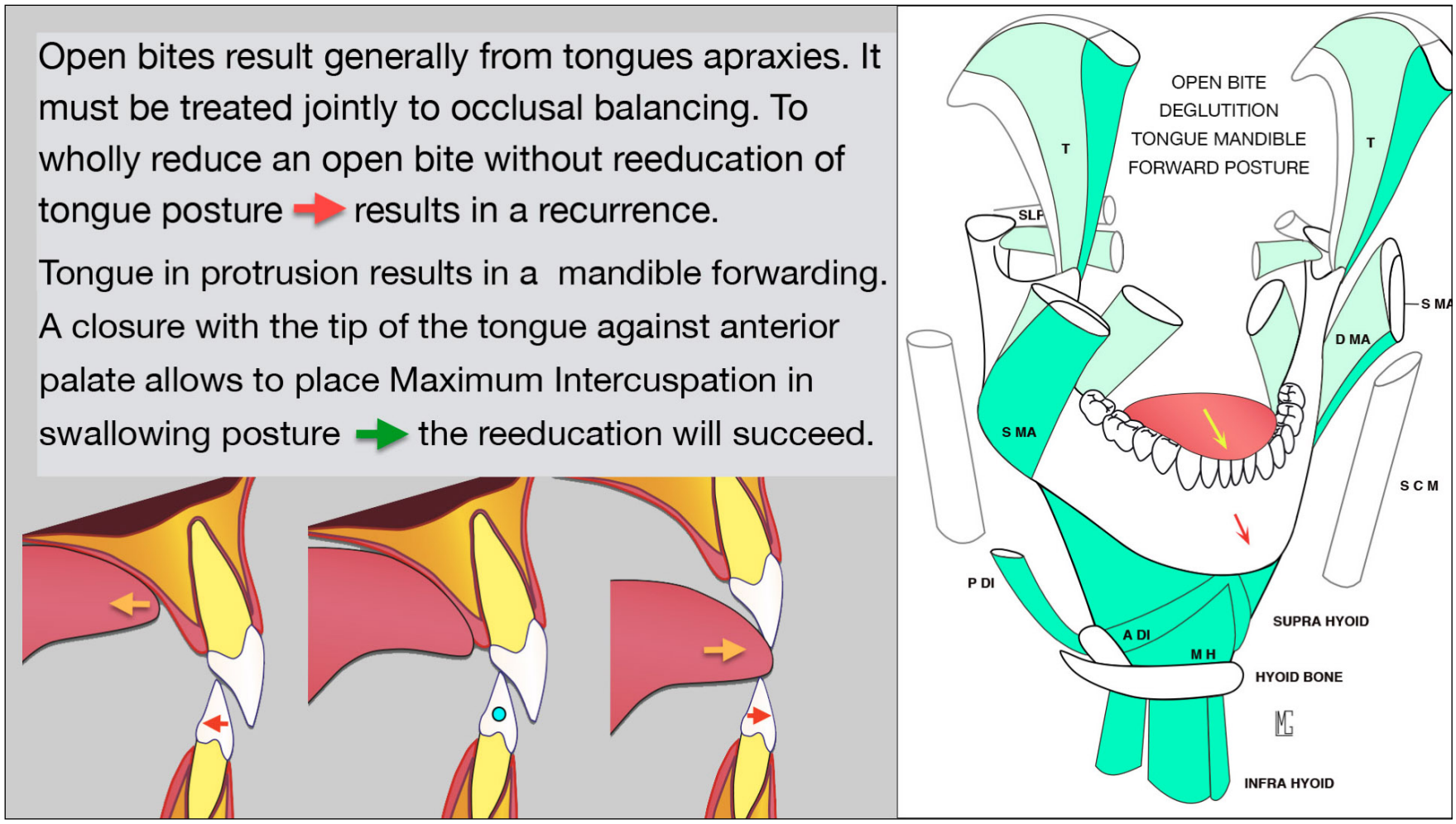


Figure 4-20: The change in lingual posture has a direct impact on the position of the mandible, thus occlusion relations. See Figure 8-2. In the case of open bite, the occlusal imbalance often has a direct relationship with the appearance of the open bite and its evolution.

Vertical and horizontal open bites result generally from tongues apraxies during swallowing.

The multiple variants observed result in clinical pictures where the occlusal contacts sometimes exist only on one side (with contralateral interposition of the tongue), or symmetrically on only one pair of posterior teeth on each side (anteposition of the tongue).

They must be treated and stabilized prior or jointly to occlusal balancing. In an adult to reduce an open bite without reeducation of tongue posture results in a certainty of recurrence

However, during rehabilitation with the repositioning of the tongue tip, in contact with the anterior palatal papilla, the mandible follows the movement of the tongue in the same orientation, the position of occlusion changes slightly and can be uncomfortable. It is essential

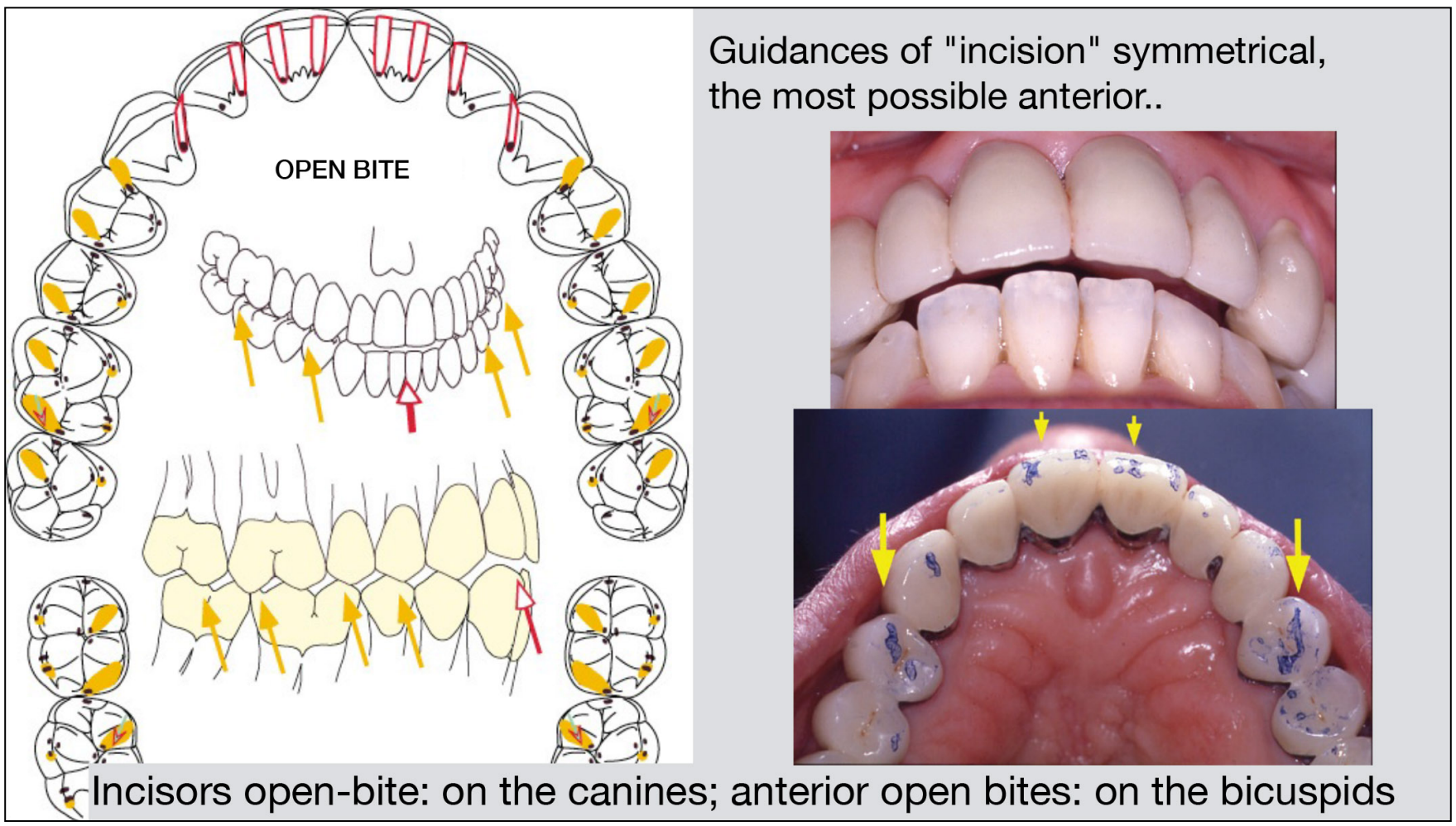


Figure 4-21: In open bites one must try to obtain guidances of "incision" symetric and the most anterior that is possible. On incisors open-bite: on the canines. On anterior open bites: on the bicuspids.

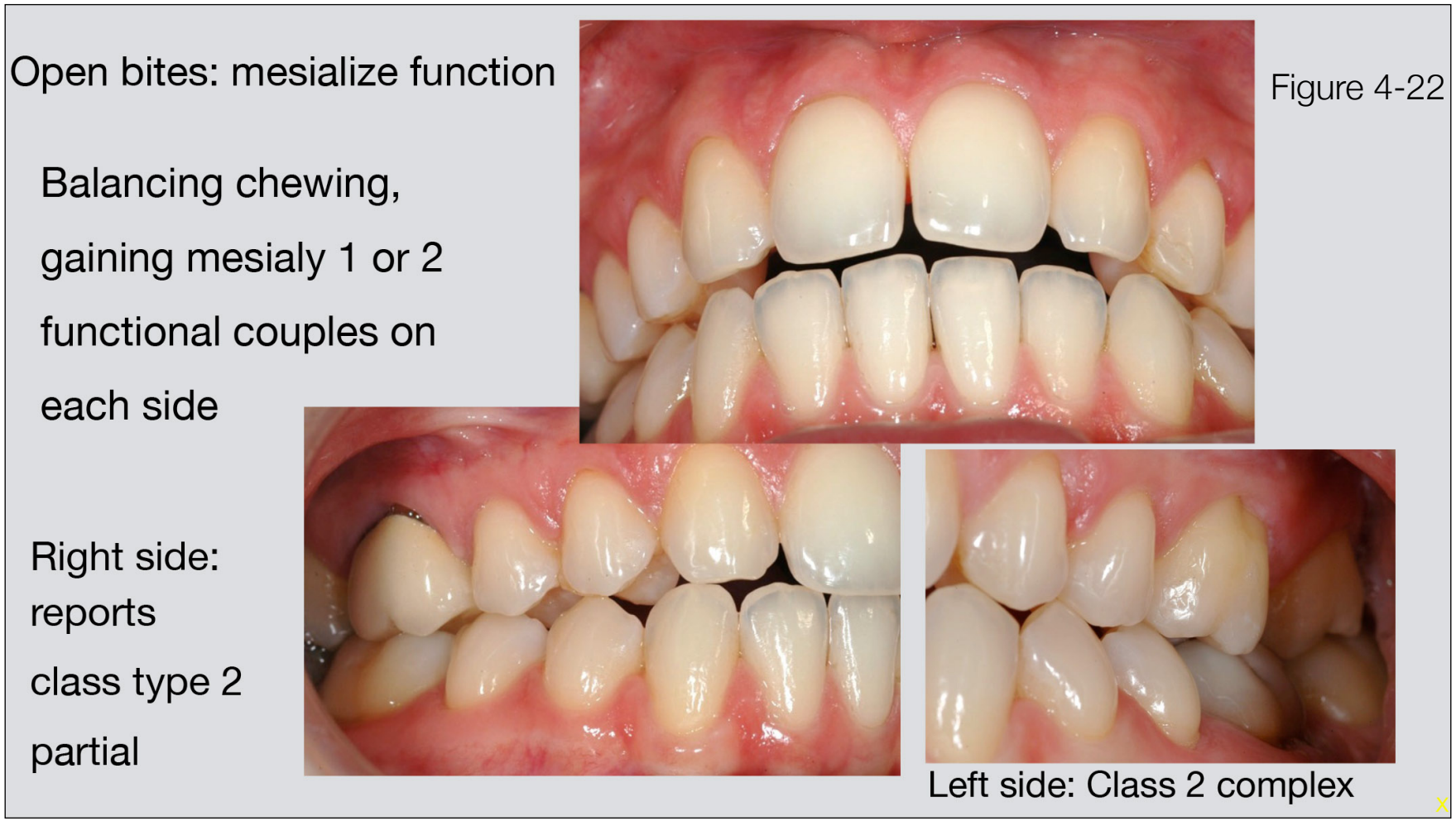


Figure 4-22: In this case of open bite, in addition to lingual rehabilitation, MIO was first checked using a modified anterior jig, before any other decision.

Figure 4-23: It was decided to make an additional cusp on the two mandibular M_1 to support the MIO and to realize the cycle input and output by advancing the function of a pair of teeth of each side, which will also be able to guide the incision.

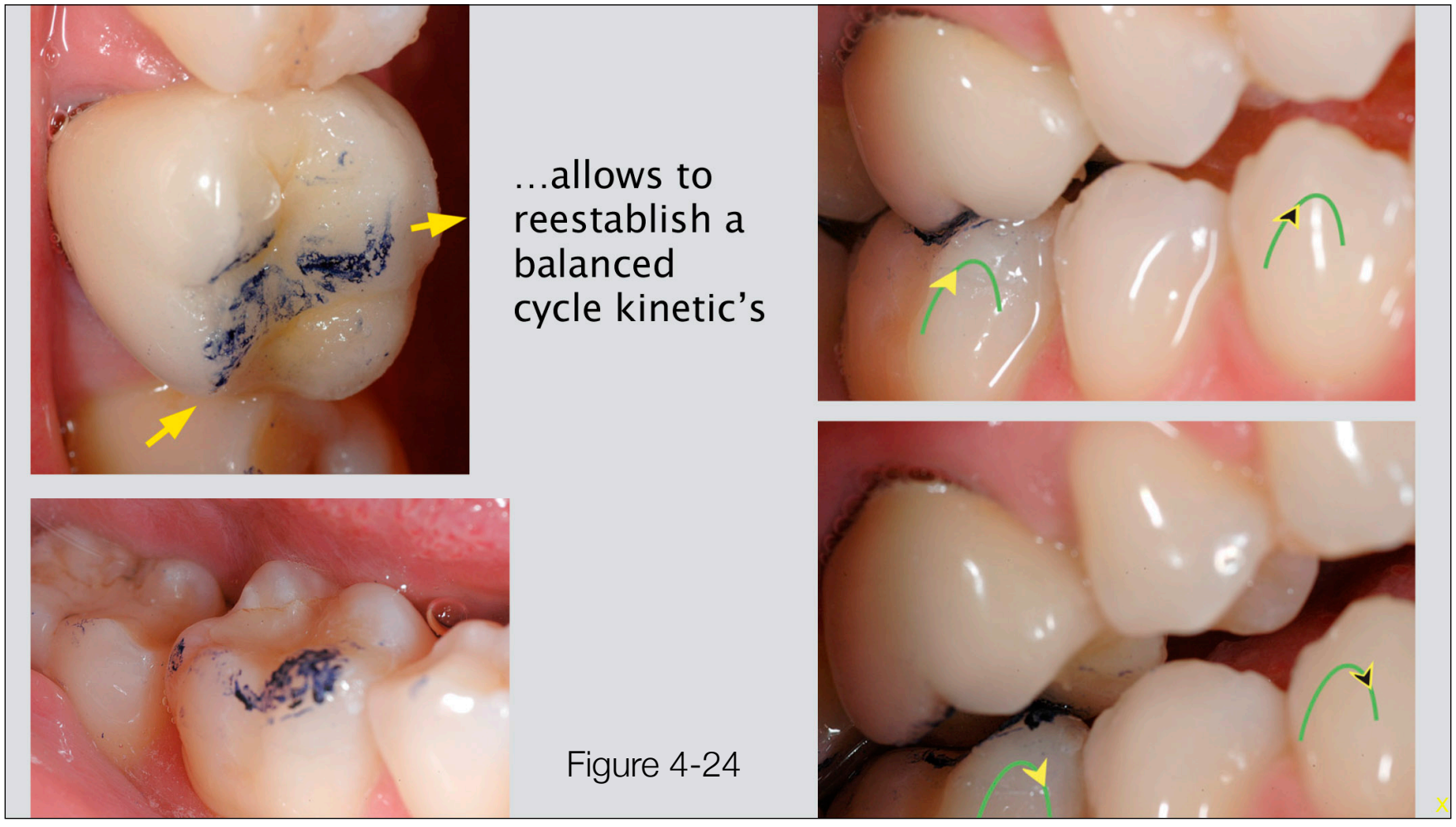


Figure 4-24: View of the balanced chewing guides, on the right side M1 couple. The M2 pair must also be balanced by addition of composite.

to balance the MIO in this new position. Otherwise the rehabilitation will fail because the mandible will return to its former position of comfort with the tongue and mandible in anteposition.

The rehabilitation of the lingual posture and the occlusal equilibration will have to be simultaneous.

With the tip of the tongue maintained in anterior palatal support, the treatment principle consists in progressively restoring the posterior contacts of MIO symmetrically balanced, or in mesializing the function by integrating one or two additional pairs of teeth, on each side (depending on the importance of the open bite and if possible symmetrically). In a deferred session wearing an anterior jig (if possible) associated with the lingual posture will verify the balance obtained. Never attempt to completely close an open bite, without a prior lingual rehabilitation, simultaneously to an equilibration of the MIO and the chewing.

Lingual reeducation and occlusion are the keys to the stability of lingual open-bite treatment. But other etiologies may exist: poor ventilation, macroglossia, trisomies, polyarthritis etc.

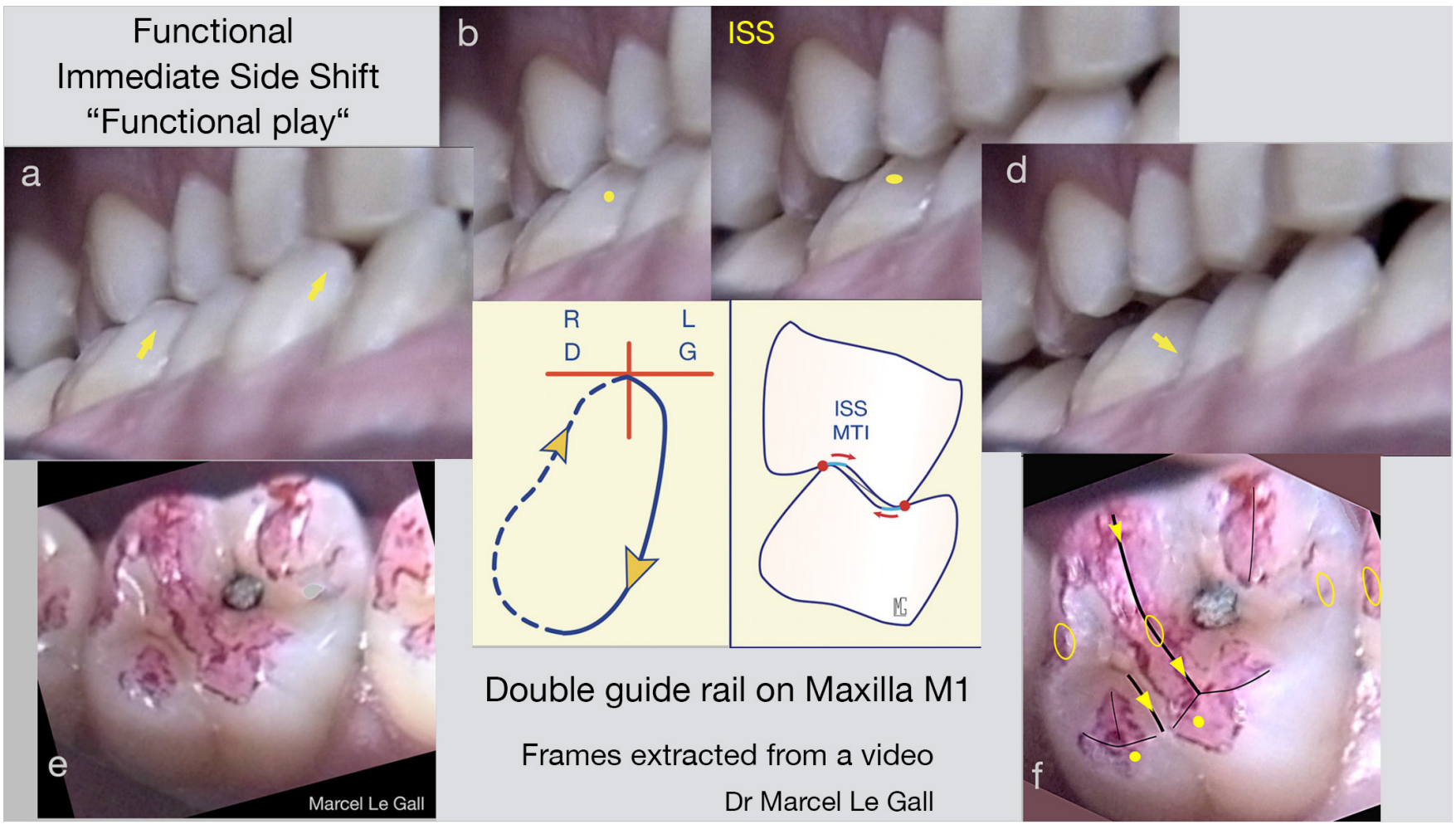


Figure 4-25: On all video clips, we observe that there is a functional game at the passage of chewing cycles by Max Intercuspation. Similarly, when the anatomy is intact, the presence of rails can be observed on the occlusal surfaces of the M_1. It is observed that the ISS is mainly carried out in support of relatively flat marginal crests, with a small functional game between the cycle output tables.

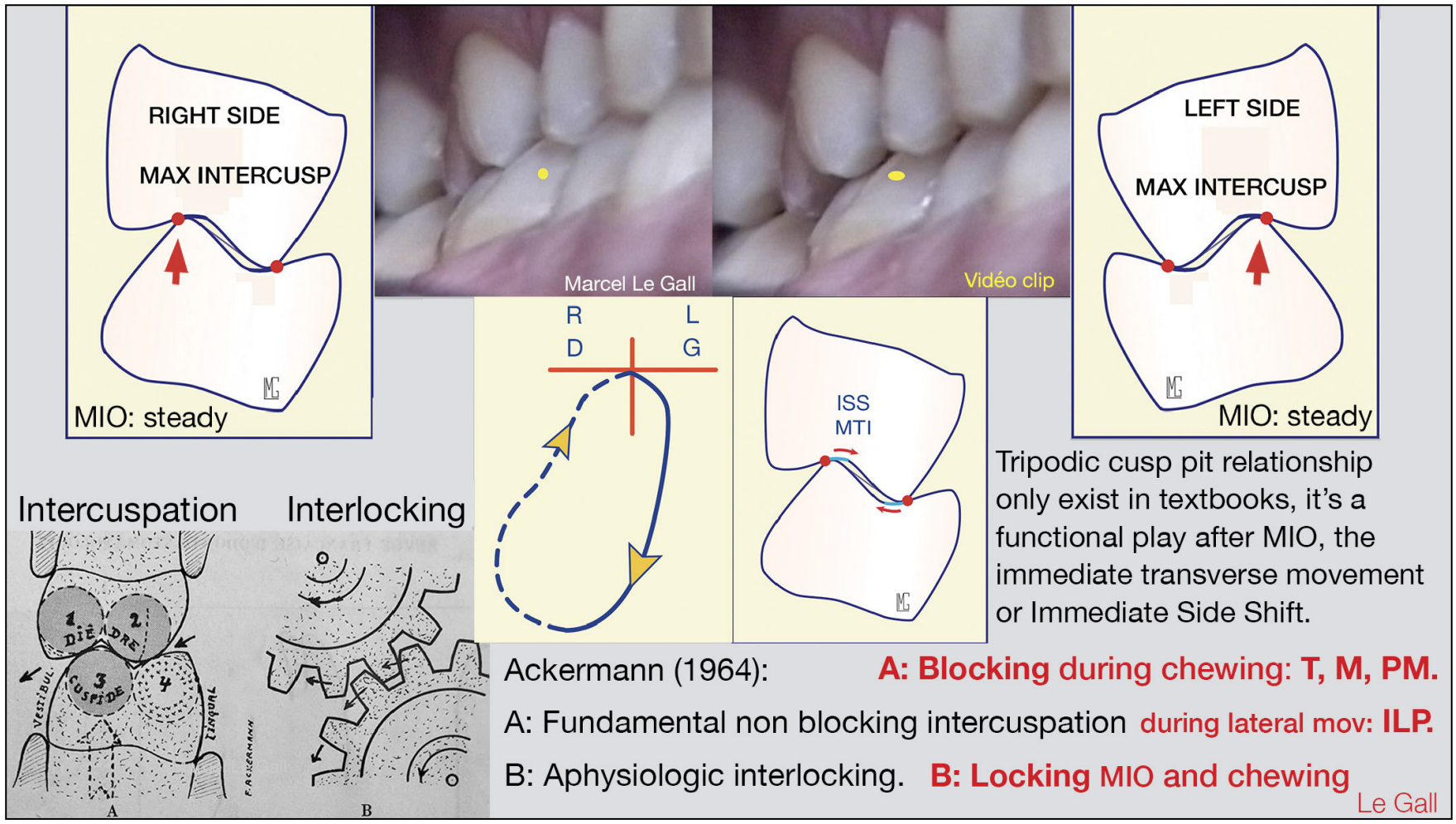


Figure 4-26: The first observations of the mandibular kinetics were made during the laterality movements, inverse of the chewing, without occlusal pressure of the elevating muscles. During centripetal chewing, under pressure of the elevator muscles, the tripodic relationship classically described in the manuals, blocks chewing. The observations show the constant presence of a functional game at the moment of the passage in Maxi Intercuspation: the ISS (immediate side shift). It allows the passage of the cycle by the MIO without any blockage. This ISS exists on the chewing side, because the non-chewing side is not in contact (no muscular recruitment except the Anterior Temporal weakly, at the end of cycle). While when closing in MIO the contacts are symmetrical with vertical contacts well established on the maginal ridges and a small functional play between the cycle exit tables.

- Complex Cases

The clinical situations are multiple. All complex cases, residual dysmorphosis, open bite, overhang, traumatic suites, cleft palate ... must be treated by applying the same principles, but personalized according to the clinical situation. Do not hesitate to install relay functions, such as a cycle input on a tooth and an output on its neighbour and to distribute the guides on several posterior teeth, to restore the balance and the best possible effectiveness of chewing.

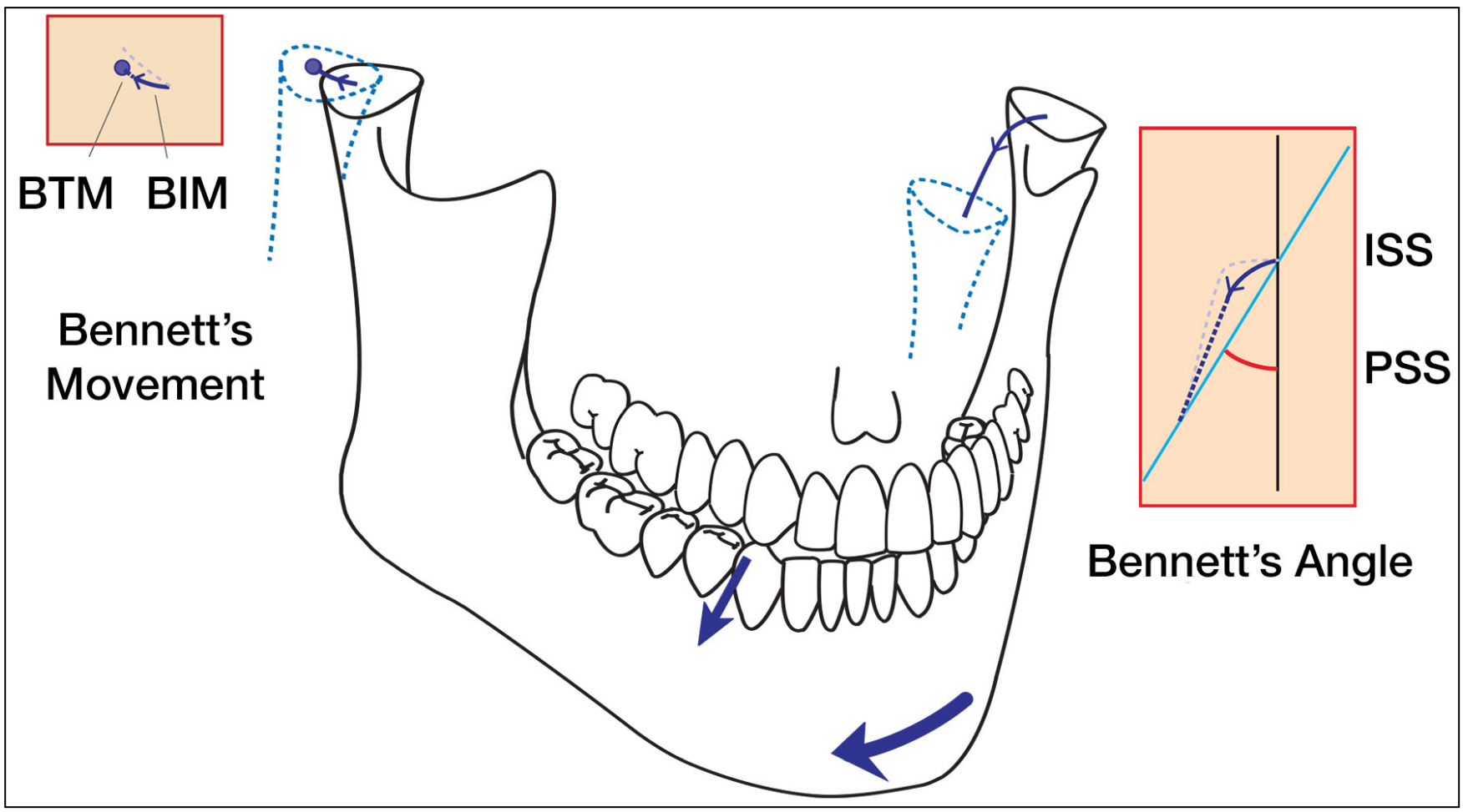


Figure 4-27: Laterality movement occurs without occlusal pressure. On a gnathological articulator, the angulation of the Bennet movement is limited to 17°, on the "working" side. On the “non-working“ side ISS and PSS (Bennett angle) are below their limit envelope.

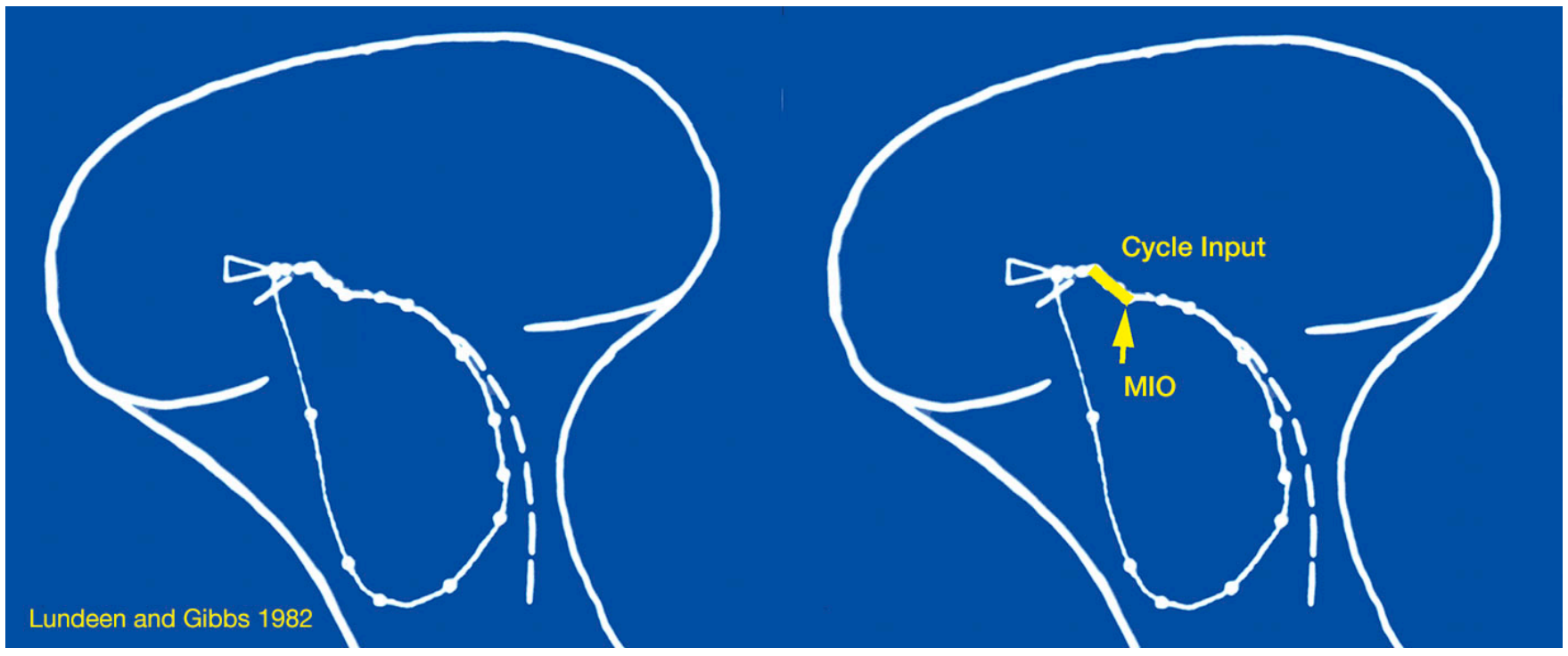


Figure 4-28: Condylar kinematics, on the chewing side: MIO and cycle input (Replicator).MIO and articular cycle input are to be related to the angulation of Lauret's movement of Figure 4-29.

- Functional movements and Articulators

Figures 4-25 and 4-26 are illustrated with images taken from a video clip viewed frame by frame. This video is available at the following Youtube address:

https://youtu.be/5i9cUZRwNns

The mandible forms a "solid" of which all the dental and articular components move simultaneously. It is the limit envelope of dental guidance which determines that of the articular movements, of which all the displacements are located within this maximal envelope. This is why the description of condylar kinematics during function (Lundeen and Gibbs, 1982) and the terminology that refers to it can be copied to the different sequences of the dento-dental phase of chewing cycles. Taking into account four essential parameters:- the orientation of the Spee curve towards the TMJ, in the sagittal plane, - the orientation and the progressive accentuation of the Wilson curve in the frontal plane, in correlation with the opening and the progressive change of orientation of the occlusal gutter of the teeth towards that of the joint, which is the most open and the highest (fig.4-30b), - the different axes of rotation of the TMJ. -and especially the impossibility of bringing the posterior teeth closer, on the models mounted on

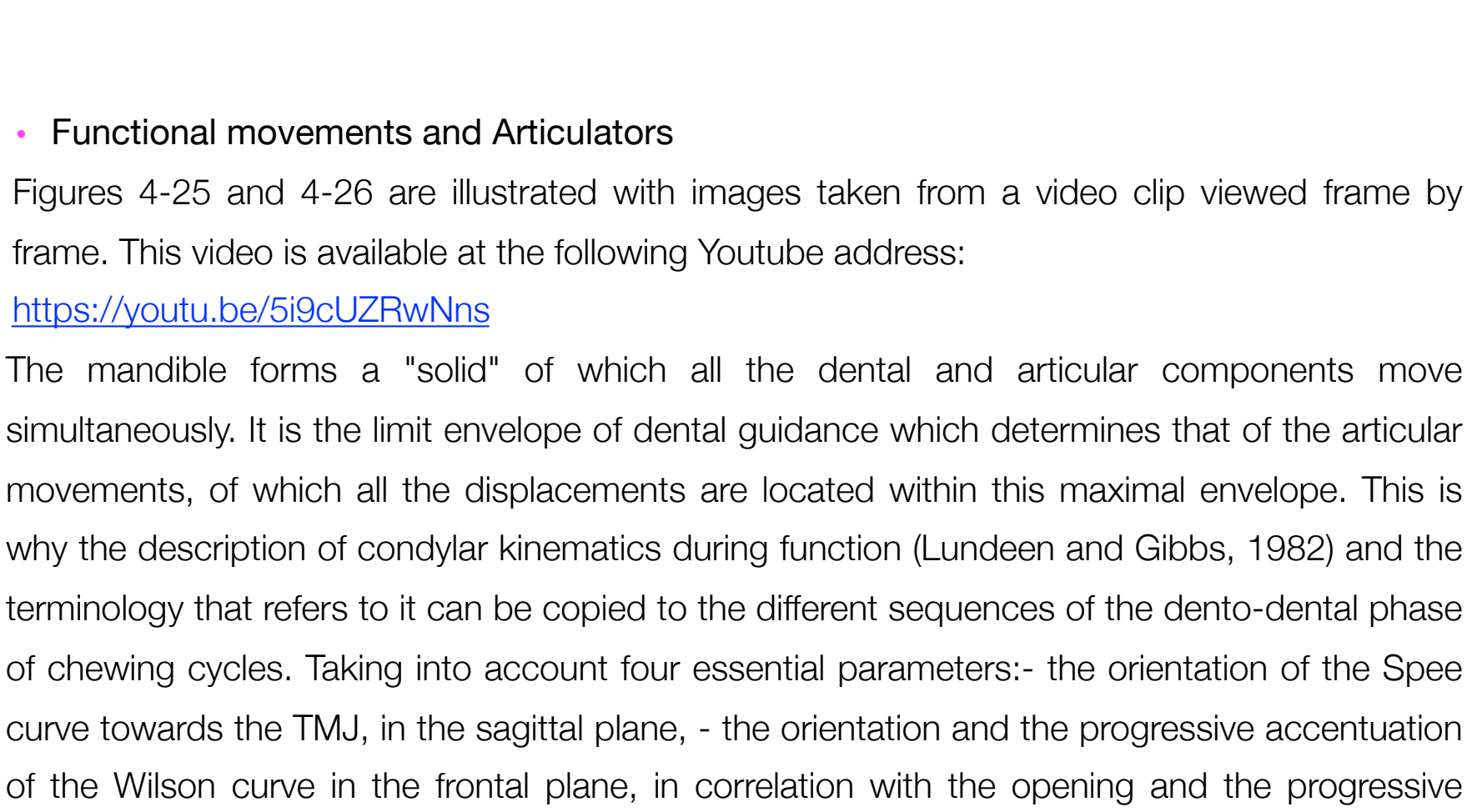


Figure 4-29: Under the pressure of the masticatory muscles, the postero-anterior angulation of the cycle entry must be able to be adjusted up to 40-50 ° on the articulator, which must also have a compressible articular box, in order to allow the contact between the posterior teeth. These functional settings are only possible on a virtual articulator, provided that it is modified. On the non-chewing side the articular head moves below its limit envelope.

articulator, which does not allow to reproduce the diagonal kinetics of the cycles of the maxillary M1, guided by the rail of the enamel bridge in class1 of Angle.

- **During cycle input,** the chewing condyle describes a centripetal trajectory, the Lauret's movement, from a posterior elevated position, to an anterior and lower position. At the dental level, Lauret's movement follows the rail from the Disto-Buccal cusp of the M_1 maxillary to the MIO, marking the end of the cycle input with a mesial inflection, as a coma. This functional movement was described in the opposite direction by Bennett during the voluntary centrifugal laterality (Fig. 4-27). With respect to the bicondylian axis, the angulation of Bennett's motion is much less marked than that of Lauret's functional movement. The condyle, on the non-chewing side, describes a movement which remains below its limit envelope and without dental contact. This parameter is generally impossible to adjust on the gnathological articulators, which are limited to 17° for Bennett's movement, whereas in Lauret chewing input, it would be necessary, depending on the case, to apply an angulation of up to 50 to 60 °, with a coordinated approximation of the occlusal faces of the posterior teeth (Fig. 4-29, 4-30).

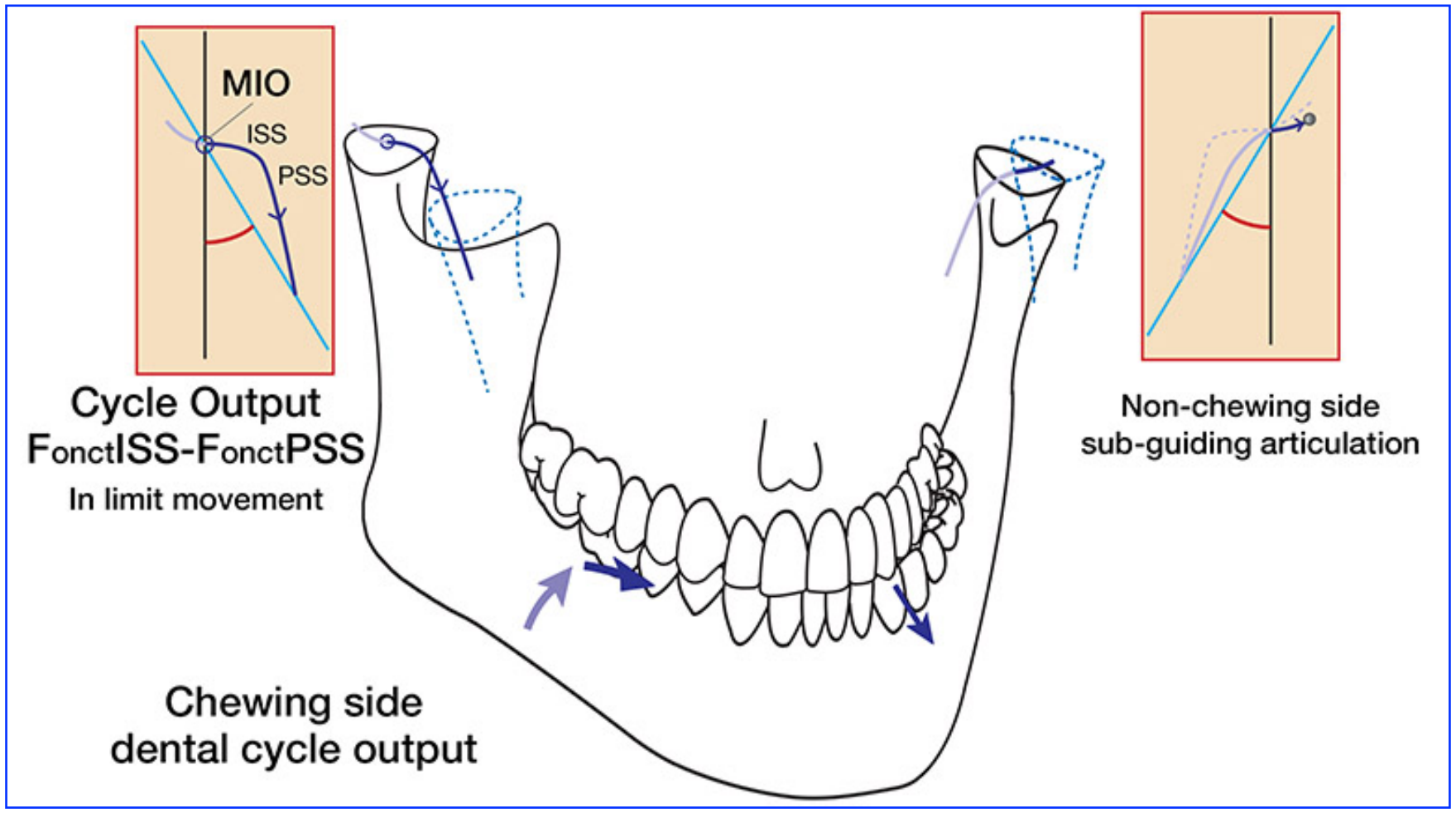


Figure 4-30: During the cycle exit, the immediate and progressive transversal movements describe their limit envelope, determined by the occlusal contacts and guides (M_1). Articular cases must be set to this limit value. In the mouth, all cycles with interposition of the bowl are within these limits before reaching direct contact in the last cycles before swallowing. This kinematics is impossible on articulators whose condylar spheres are not compressible.

- **During cycle output,** after passing through the MIO, the posterior occlusal surfaces continue to guide the movement and the condyle moves transversally on the articular slope of the temporal, by describing a centripetal diagonal trajectory that can be subdivided into two phases:
  - **a beginning of cycle output**, during which a small centripetal functional game is observable in a constant way on the video clips passed in frame by frame. This small initial horizontal inflection, with a mainly transversal component, is guided by the enamel bridge and called the Functional Immediate Side Shift (Funct.ISS). The contacts between the horizontal marginal ridges, and the top of the opposite cusps, allow this small displacement, provided that the cycle output surfaces are not in immediate direct contact. This transverse game is specific to each patient. The setting of the Functional ISS is possible on second-generation semi-adaptable articulators, thanks to a specific adjustment fin (Fig. 4-30).
  - It is followed by the **cycle output** itself, the Functional Progressive Side Shift (F-PSS) following the M1 palatal rail, towards the contralateral canine with the sliding exit tables in contact with each other more rectilinear. The fact of lowering their volume puts in sub-guidance, these cycle output tables and rails (Youtube: https://youtu.be/mGbML6YvK3A) and can result in dominant contacts on the non-chewing side (on the internal slopes of the buccal cusps) and / or between the palatal concavity of the maxillary incisors and the free edges of the lower incisors, which they cross transversely during the cycle output (video in French: https://youtu.be/_Hw02D5BEik). While normally, on the non-chewing side, only one or few contacts are usually seen at this stage, on the inner slope of the maxillary canine area. The different shape of the arches gives the cycle exit angle of the M1 a more or less important value, which is more accentuated on the posterior teeth and less on the anterior ones(Figure 4-30). F-ISS and F-PSS are the functional decomposition of the cycle output, which can not be reduced to the simple angulation of straight motion on the masticating side (Figure 4-30).The condyle on the non-chewing side remains below its limit movements, because the posterior teeth are not in contact.

At the centrifugal laterality of this same side (fig. 4-27), this angulation can be compared to the angle of Bennett described in reverse on the "non working" and its decomposition into Immediate Side Shift and Progressive Side Shift. But, in the functional context, Fonct-ISS and Fonct-PSS are often more accentuated than "ISS-PSS" because made

under the pressure of the masticating elevator muscles. The Bennett angle, under composed, was set on the “non-working side“ on the first-generation of semi-adaptable articulators, and its two components on those of second generation. At the time, a debate largely opposed the mechanistic practitioners, supporters of the simple angulation (Slavicek) to those who favoured its decomposition into two parts. This debate was very obscure, in the minds of many professionals of the 1970s. I was a young graduate at that time and I could never have a satisfactory answer to my questions on this subject. It was much later, watching the chewing videos, played in frame by frame, that I finally could understand the role of this functional game, in the passage of the cycle by the MIO, without any blockage (fig.4-25, 4-26) therefore indispensable for physiological chewing. (Le Gall and Lauret "Occlusal function" Chapt 5: Articulators: uses and limits p .179). Functional-ISS is a clinical reality.

To simplify English terminology, we will also use the same terms, adding F in front, so F-ISS and F-PSS at the outputs of chewing cycles, because it is in this context that they find their true justification.

On the articulator, the average general angulation that must be displayed in relation to the sagittal plane. typically ranges from 0 (very rare) to 25 degrees (Lauret, 1988) and is customizable by adjusting the orientation of the inner fin of the cases.

However, the test of time makes it necessary to recognize that the reproduction of mastication by the gnathological articulators could not be satisfactorily obtained. It is probably the recording of the individualized programming functional parameters and their transfer to the articulators which posed the most problems. Verification and final balancing of the occlusion of natural teeth and restorations must therefore always be validated in the patient's mouth, by addition to the natural teeth combined or not with the subtraction on the prostheses. The solution to this problem will come quickly from CAD/CAM, provided that we change the operating model and get rid of the surviving gnathological articulators of a twentieth century occlusion theory whose foundations are invalidated by the acquired data of science.

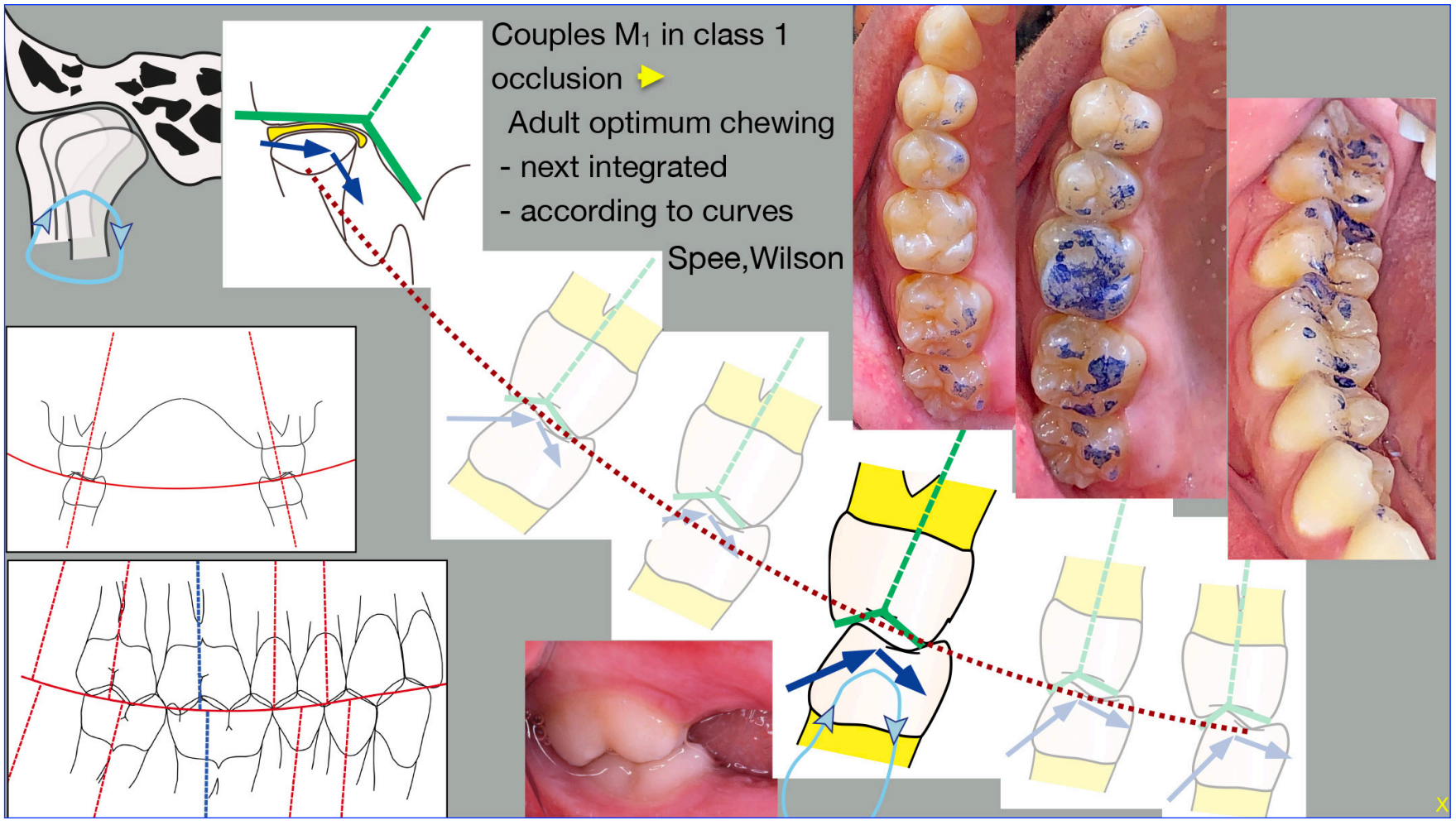


Figure 4-30b: One can see the gradual opening of the occlusal gutter toward the buccal side, until the last molar and then at the level of the temporal fossa upward and backward. The TMJ functions as a flexible fourth molar, slaved to the dental guiding, during chewing.

TEMPORO-MANDIBULAR DISORDERS
TOOTH TMJ DYSKINESIAS

Chapter 5

What are the consequences of applying the main occlusal concepts of functional efficiency and the pathologies that can affect the masticatory apparatus?

We have seen in Chapter 5 of Part 1 (The canine 60 years after d'Amico myth or reality?) that the treatment of TM-disorders by applying the principles of the usual model of occlusion result in a very high failure rate and have created doubt amongst many authors about the involvement of occlusion in the aetiology of TMD. It is therefore this natural model that will serve as a reference and therapeutic objective endpoint.

At the same time, the introduction of a new Functioning Model of Occlusion based on the physiology of mastication (Lauret and Le Gall 1994) and then more progressively that of swallowing (Le Gall et al., 2010 and its application to the treatment of TMDs has shown high success rates that were observed that there was indeed a direct relationship between occlusion and a significant proportion of TMDs. Without neglecting the multifactorial origin of a part of TMDs, it appeared that the systematic wearing in first intention of an occlusal orthosis was not necessary and that it was far preferable to make from the start reversible equilibrium tests of swallowing and chewing, to treat immediately the patients with occlusal aetiology. Which allows, in case of failure to request quickly, additional tests and if necessary to reorient the patient more rapidly, depending on the suspected aetiology. Figures 8-39 and 8-40 summarise this approach undertaken for more than 30 years.

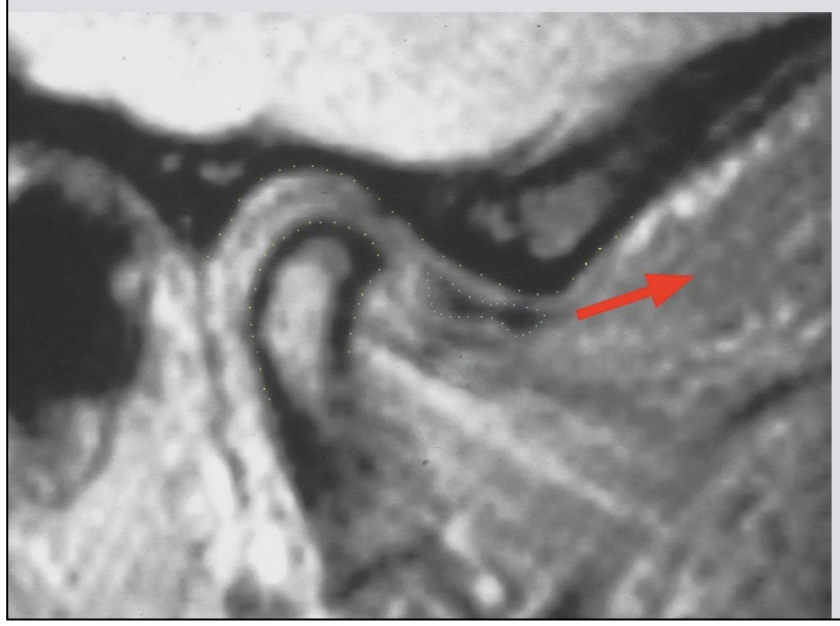
See the following Youtube video: https://youtu.be/wWxgCe0NHNc

TEMPOROMANDIBULAR DISORDERS*

Various and crossed etiologies (arches, muscles, joints, posture, CNS)

The initial triggering factor can be:

- -a malocclusion
- -a joint injury
- -an imbalance: muscle, posture
- -a behavioral disorder
- -a pathology of central origin



Possible secondary interactions.

Dental occlusion is almost always involved

*" It is probable that LINKS can not be established between the OCCLUSAL CONDITIONS and the D.T.Ms. that by studying the functioning of the occlusion during the ORAL FUNCTIONS"***

*Le Gall.,Lauret Cah. Prothèse 98 ** Okeson, J. Réalités cliniques 1996

Figure 5-1: TM-Disorders: disc anterior dislocation, without visible deformation, it can be recovered.

TEMPOROMANDIBULAR DISORDERS*

The initial triggering factor can be:

- a malocclusion
- a dyskinesia or joint injury
- an imbalance: muscle, posture
- a behavioral disorder
- a pathology of central origin

Various and crossed interactions:

Balancing the occlusion first

If failure of occlusal therapy: additional examinations adapted

*Le Gall andLauret Cah.Prothèse 98; Le Gall and Lauret 2011

Figure 5-2 Under guidance = correction by addition of composite

In the presence of Tooth-articulation Dyskinesias, with or without pathology, the objective is the same: Restore first the physiology of swallowing and chewing by focusing on non-mutilating techniques.

Figure 5-3: Clinical examination.

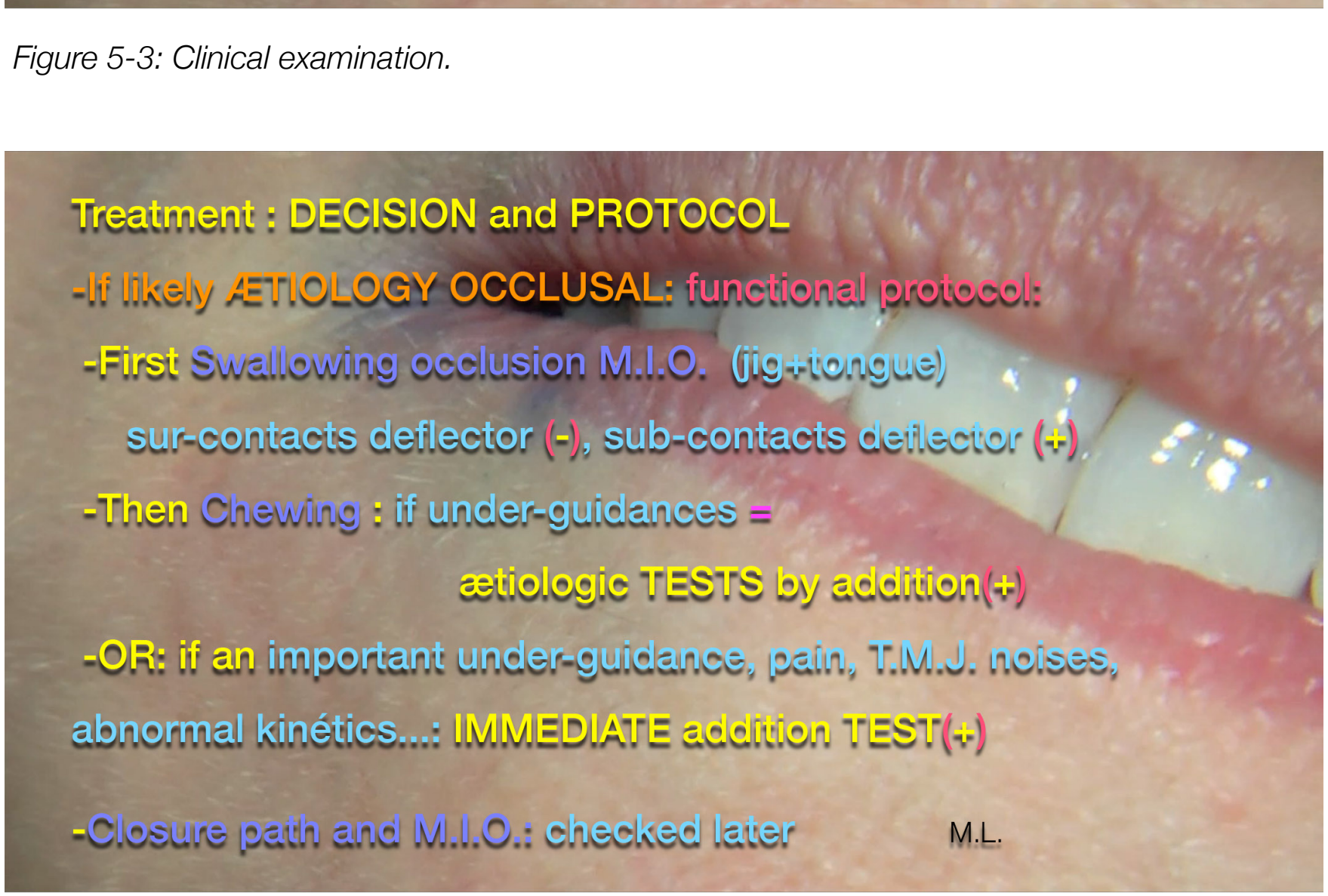


Figure 5-4: Decision Tree

In Part1, Chapter 5, we mentioned the high success rates obtained by applying this new protocol during training. It is possible to further refine the figures quoted:

Regular clinical demonstrations in "live" have been systematic since the beginning of the 2-day clinical trainings, in 2003. The dates and places of these trainings are kept up to date on my curriculum. The number of participants was in principle limited to 10 maximum. In fact it varies between 10 and 14.

During these trainings, each participant must realise a modified jig on his binomial and vice versa. I personally oversee the checking of contacts in MIO first and then chewing. If necessary I make the adjustments and additions needed live, to balance chewing. For a little less than 16 years, 196 cases have been balanced, in 74 clinical 2 days formations of practitioners. The very positive feedbacks indicate a very high success rate, more than 90%. The many cases treated in private practice, since the introduction of functional occlusion, should logically be added to those treated live, but they are impossible to list exactly. However, it is possible to observe some trends and to make comparisons with practical work. The vast majority of colleagues attending clinical training are young practitioners. In these groups, the occlusal controls requested by the participants for joint noises and various TMDs originate mainly from young women who have undergone orthodontics treatment. The teeth are healthy and well aligned but the occlusal faces are mismatched and the vertical cycles indicate various malocclusions (partially corrected Class 2, avulsions of premolars, occlusal surfaces under-guiding ...). These cases respond very well to the addition therapy, because as soon as the posterior functional equilibrium is restored, the disks are generally spontaneously reintegrated between the articular surfaces. At this stage, there is still no or few structural lesions of the articular disks. This suggests that when the balance between the masticatory cycles of the posterior teeth and the same chewing side TMJ is reached, the internal tensions applied by the muscles inserted on the capsule and the disc are considerably reduced, if not totally. Because the articular surfaces, unable to withstand stresses, are then protected by the dental guide limiting envelope, which allows undistorted disks, still young patients, to spontaneously re-enter their functional position between the articular surfaces.

In contrast, in office-treated patients, the range of age groups was much wider and the discs distorted and injured, seen in much greater numbers in older patients. The recovery of these discs has sometimes proved impossible, but against all odds some discs, with a poor prognosis, have returned, thanks to their adaptive plasticity. That's why we continued to systematically perform functional equilibration tests by addition, in these cases. And all the more so in the situations of non-reintegration of the disc, the patients concerned have always

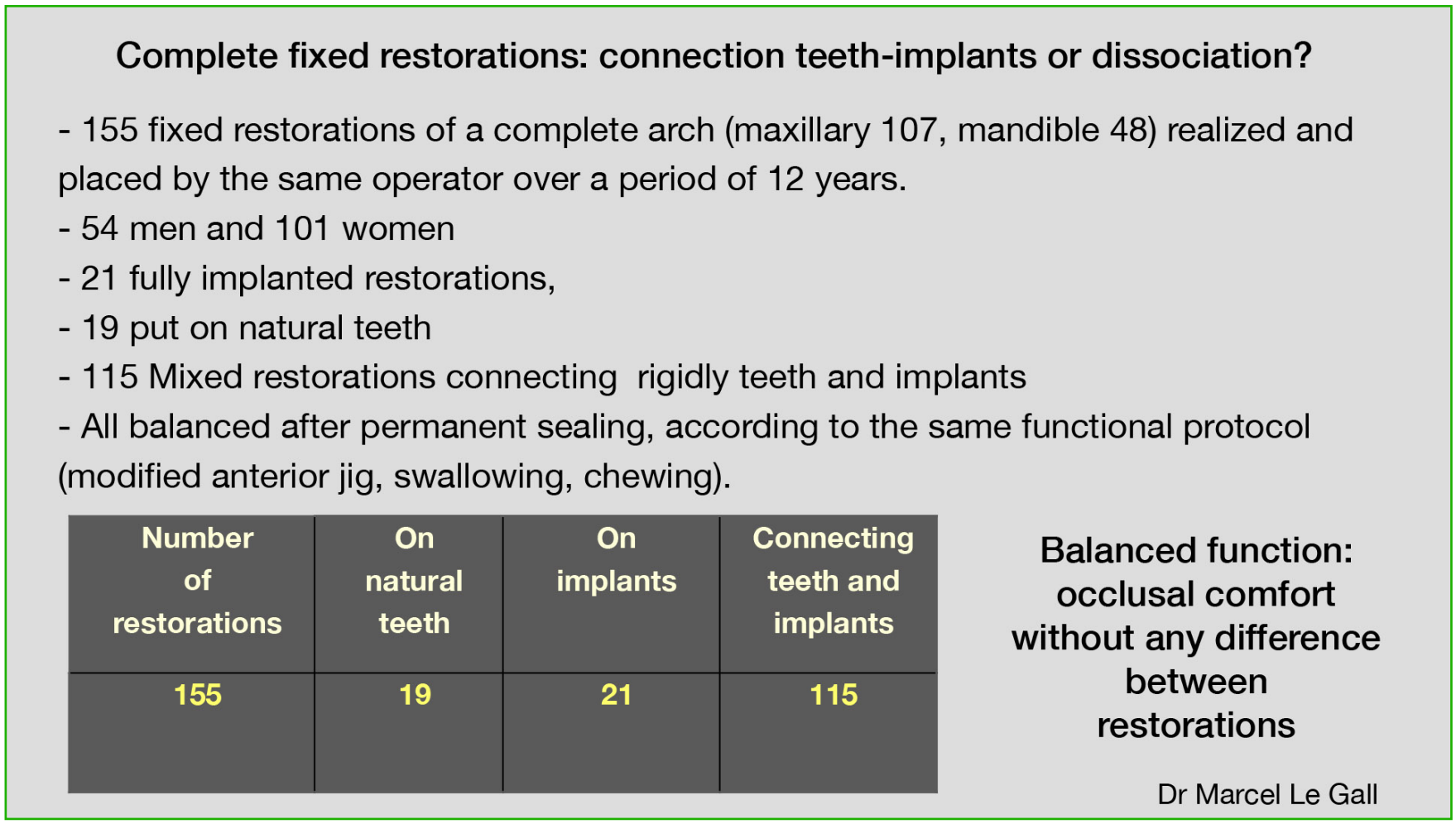


Figure 5-5: All these complete restorations are monobloc. They were all sealed with a permanent glass ionomer cement. Their realization was the subject of a functional attention in the choice of the VDO and during their installation, the equilibration of the mastication was finalized, with if necessary a return to the laboratory for additional additions. Before and after sealing, the closing path was verified using the protocol of the previous jig, self-determined and the mastication and incision guides finalized and polished carefully.

refused the withdrawal of composite additions that was proposed , because the occlusal comfort was still very much improved.

It already appears that the occlusal treatment of TMDs must be carried out as quickly as possible to avoid irreversible damage to joint structures, which would no longer allow the reintegration of the disc. However, additional comparative observations should be made at the beginning and the end of either the prosthetic treatments or either the orthodontics treatments.

If our preliminary observations were confirmed, and the current classic occlusal approach, applied to the prosthesis or orthodontics, appeared to be responsible for a considerable increase in TMDs, it would be necessary to abandon the gnathological model, so that these treatments would not be considered a loss of opportunity for patients, especially as the following study will show that by adopting the natural functional model, there is the virtual disappearance of Tooth-TMJ-dyskinesia, after treatment.

Indeed, we have interesting and complementary data on complete fixed restorations performed in private practice. These data were published in the 2011 edition of "The occlusal function" (Le Gall and Lauret 2011).

Previous TMD	Previous Occlusal imbalance	Previous bruxism TMD or no	Subsequent TMD	Subsequent bruxism No TMD
25	96	18	1*	12

After rehabilitation: no case of TMD or occlusal imbalance was observed in time, during regular checks.

Comfort and functional efficiency are restored.

The case with essential trigeminal neuralgia saw the seizure frequency divided by 10 with a significant decrease in pain. The widely spaced residual seizures are unexpectedly associated with episodes of anterior bruxism. The night wear, of a modified anterior jig sealed on a splint * makes it possible to stop the contractures.

Another case has evolved to rheumatoid arthritis.

Twelve cases of bruxism continued parafunction, but 6 cases stopped.

Conventional orthoses with balanced contacts in MIO + CPO do not seem well suited to controlling bruxism. Modified anterior jig seem to be an alternative or complementary solution.

Dr Marcel Le Gall

Figure 5-6: The results indicate that the choices of VDO and Intermax. Relationship have been made with relevance and that recovery and equilibration of chewing have solved all occlusal problems and TMD. Only some of the cases of bruxism remain active. They are majority controlled by the night port of a jig supported by an orthosis. The case of trigeminal neuralgia has been an unexpected success. He is always accompanied, because there remain episodes of bruxism, during the crises of essential neuralgias, which are controlled by catches of paracetamol and wearing a modified jig or an orthosis supporting an anterior jig.

A continuous group of 155 fixed restorations, of a complete arch, (107 in the maxilla, 48 in the mandible) were delivered and placed by the same operator over a period of 12 years from 1995 to 2007. They were then followed for several years, (some patients passed away during this process) f:

- 54 men and 101 women
- All have been balanced according to the same functional protocol (abutment, swallowing, chewing) by the same practitioner.

At the start, 25 patients had TMDs of various origins,

96 patients had occlusal imbalances

18 patients had episodes of bruxism,

1 case with severe trigeminal neuralgia was implanted to try to remove the dental triggers.

Twenty-one restorations were supported by implants, 19 were placed on natural teeth, 115 restorations were mixed, rigidly connecting natural teeth and implants. All restorations were permanently sealed.

After rehabilitation: no case of TMD or occlusal imbalance was observed in time, during regular recalls. One case was hospitalized twice in psychiatry for obsessive disorders related to chronic alcoholism. The case of essential trigeminal neuralgia (Fig. 8-70) saw a 10-fold decreased in seizure frequency with a significant decrease in pain, which led to discontinuation of Rivotril® and morphine (Skenan® 100). The widely spaced residual seizures appear to be caused by the activation of mucosal trigger zones. They are associated unpredictably and infrequently with episodes of bruxism between the anterior teeth. Another case has evolved to rheumatoid arthritis. Twelve cases of bruxism continued the parafunction, but 6 cases stopped. Eleven conventional occlusal splints with balanced contacts in MIO + OPC were performed, only 5 were worn regularly, because the others caused recurrences of bruxism and were pierced regularly.

Two anterior jig sealed on an occlusal splint, worn at night, have prevented bruxism, especially in the neuralgic patient.

In the presence of dyskinesia between teeth and TMJs (TTD), the usual techniques advocate in first intention, the systematic wearing (Fg 5-7) of a conventional orthosis. In functional

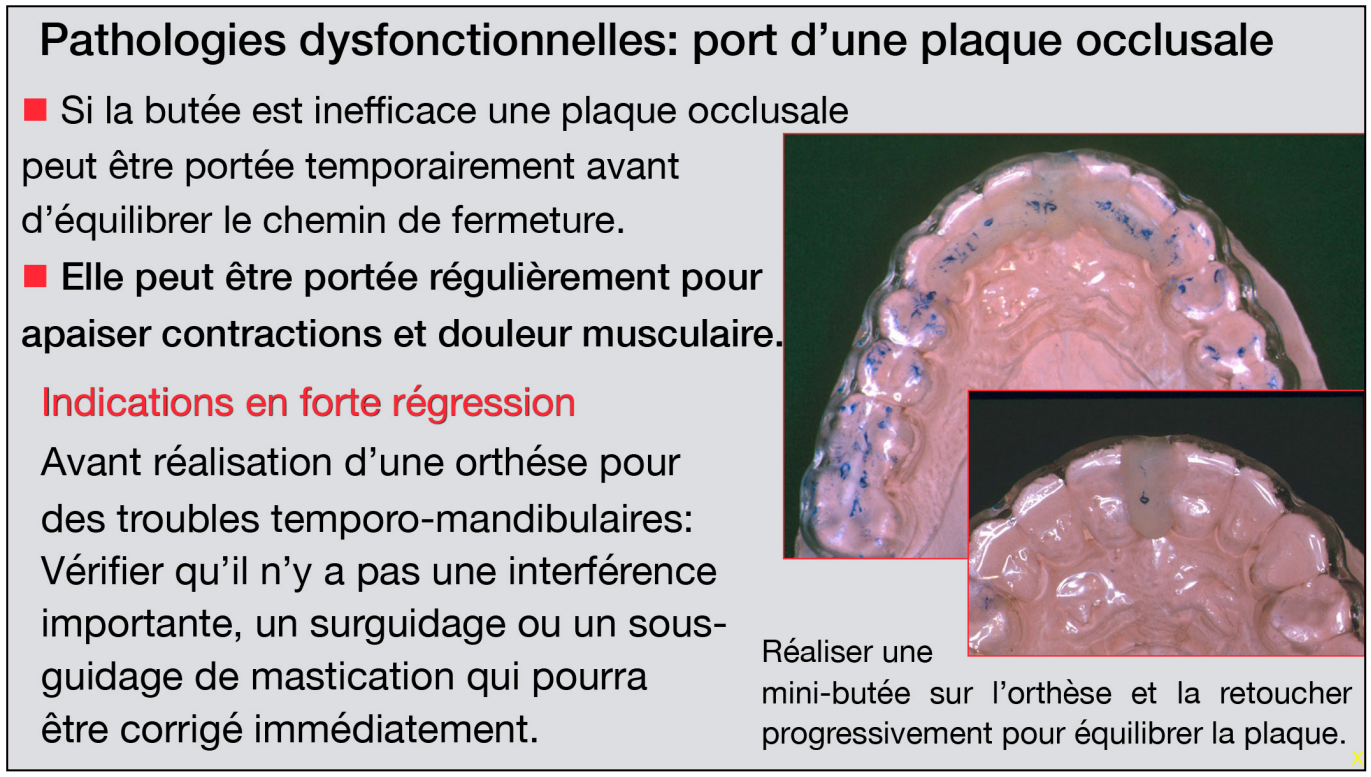


Figure 5-7: Le port d'une orthèse occlusale, limité à quelques jours, peut compléter l'action décontractante d'une butée antérieure, si celle-ci s'avère insuffisante.

Le port d'une orthèse

This is in French

complète nocturne pour déprogrammer un bruxisme d'origine centrale, sans malocclusion, se révèle souvent inefficace, car les mécanorécepteurs parodontaux restent actifs et le patient continue à grincer des dents sur la plaque, qu'il perce généralement en quelques semaines. Le réglage d'une orthèse occlusale obéit à un protocole précis. Dans un premier temps faire une mini-butée antérieure qui permettra d'équilibrer les secteurs postérieurs en retouchant progressivement la butée antérieure. Ensuite, il était classique de régler la propulsion et les latéralités. Plus tard, nous avons commencé à faire des réglages fonctionnels sur les plaques, au niveau des molaires, pour abandonner ce type d'orthèses et faire directement les tests d'adjonctions réversibles sur les dents du patient.

Une orthèse doit être parfaitement équilibrée car dans le cas contraire, si elle est portée au long cours,

occlusion, this approach has been abandoned for a long time, favouring the control of the closing path, using an anterior jig, followed by the direct equilibration of chewing guides, by the addition technique. This makes it possible to directly carry out the etiological treatment of the vast majority of TTD cases. It is only in the event of failure of this protocol that the complete analysis and the complementary examinations are undertaken. However, in the presence of bruxism, the nocturnal port of an orthosis is recommended in order to protect the occlusal surfaces from any deterioration. In this context, it appears that there is not a complete universal solution. Indeed many patients continue to parafunction on conventional orthoses that they do not support and that wear-out very quickly, or that are not even worn. In these situations, wearing an anterior jig sealed on an occlusal plane, is an effective alternative

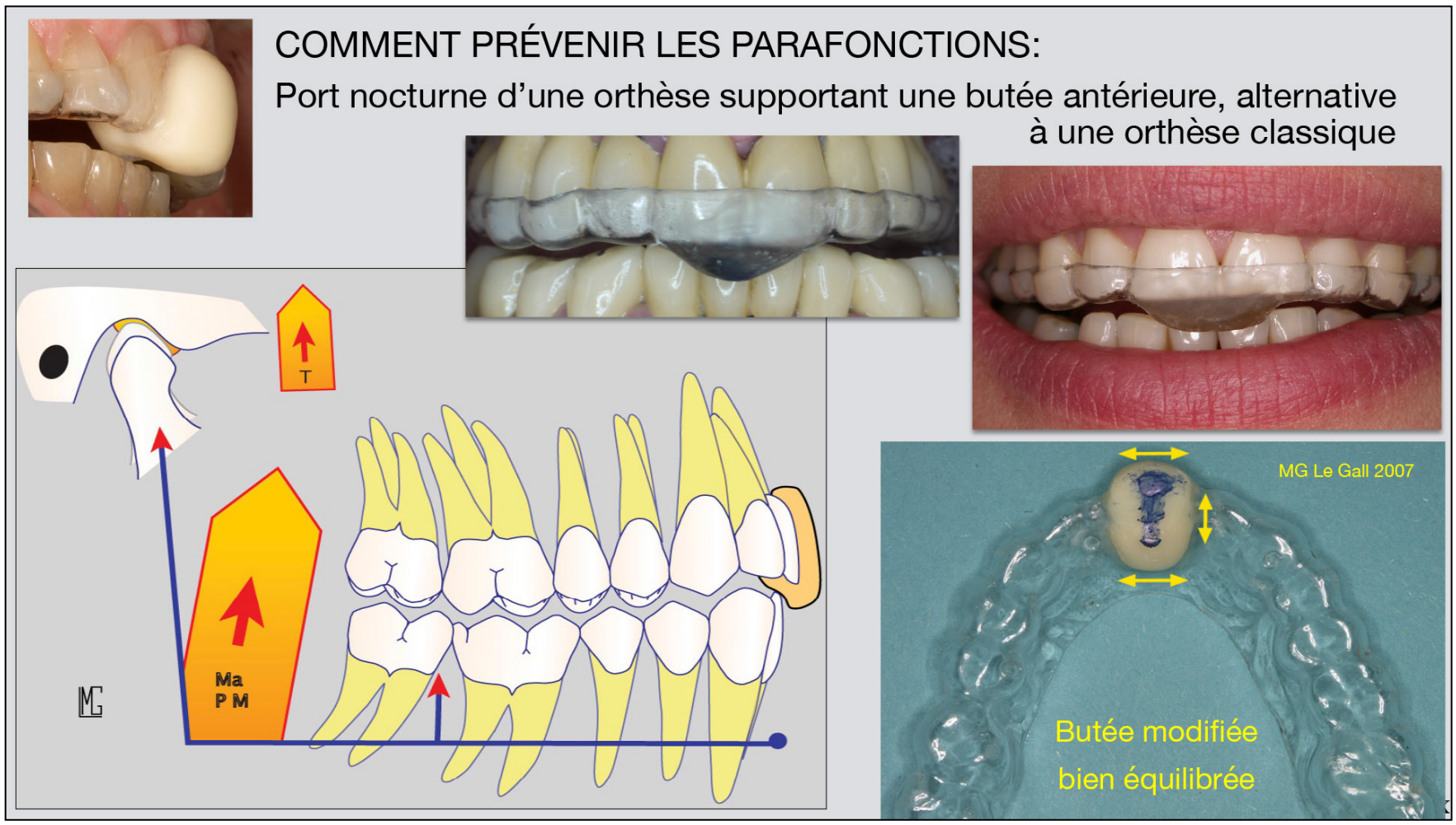
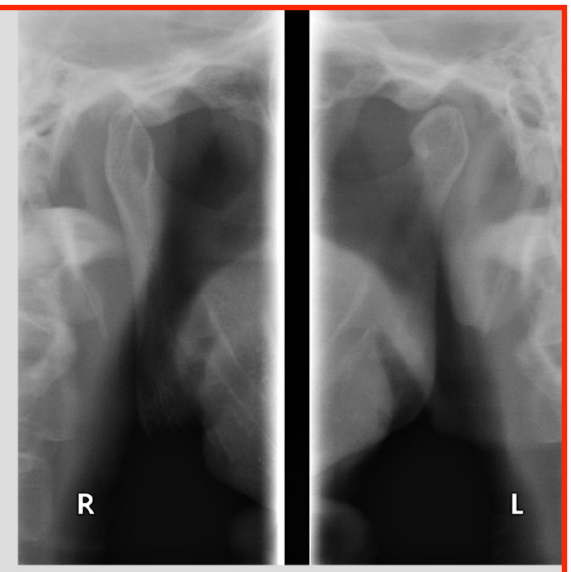


Figure 5-8: On an extended or complete fixed restoration, a modified jig made on an occlusal plane can also be worn. It will avoid the tensions of the elevator muscles, responsible for bruxism, by preventing posterior contacts. This indication is interesting because it temporarily removes the posterior contacts, so all the proprioceptive information they transmit. If the patient tries to bring the molars together, he puts the joints in compression, which causes a reflex opening. However this jig plate should not be worn more than 8 hours per night. It is contraindicated on patients with joint compressions.The jig is performed maxillary on a thermoformed plate of 1.5 or 2mm thick, leaving a buccal side return of 2mm high on the teeth, to ensure its holding and the contention of teeth. If the mandibular teeth are fragile or mobile, it is necessary to put on the lower arch, a simple plate of contention similar to the one of the top, but of a thickness reduced to 0,5 mm



Bilateral subguiding: Right maxilla M_1, M_2, Left jaw, M_1, M_2
Painful muscular contractures on the right, discomfort.
Permanent and painful clicks at the opening.
Right, painful muscle contractures, permanent and painful clicks at the opening.
Irregular and painless left clicking at the opening.
The maximum opening is limited to 30mm and deviated to the right.
Conventional treatment by occlusal orthosis failed.
History: pathological signs installed for more than 10 years.

Marcel Le Gall

Figure 5-9: This patient had already been seen in consultation 7 to 8 years previously, without having followed up on the same treatment,still proposed then.

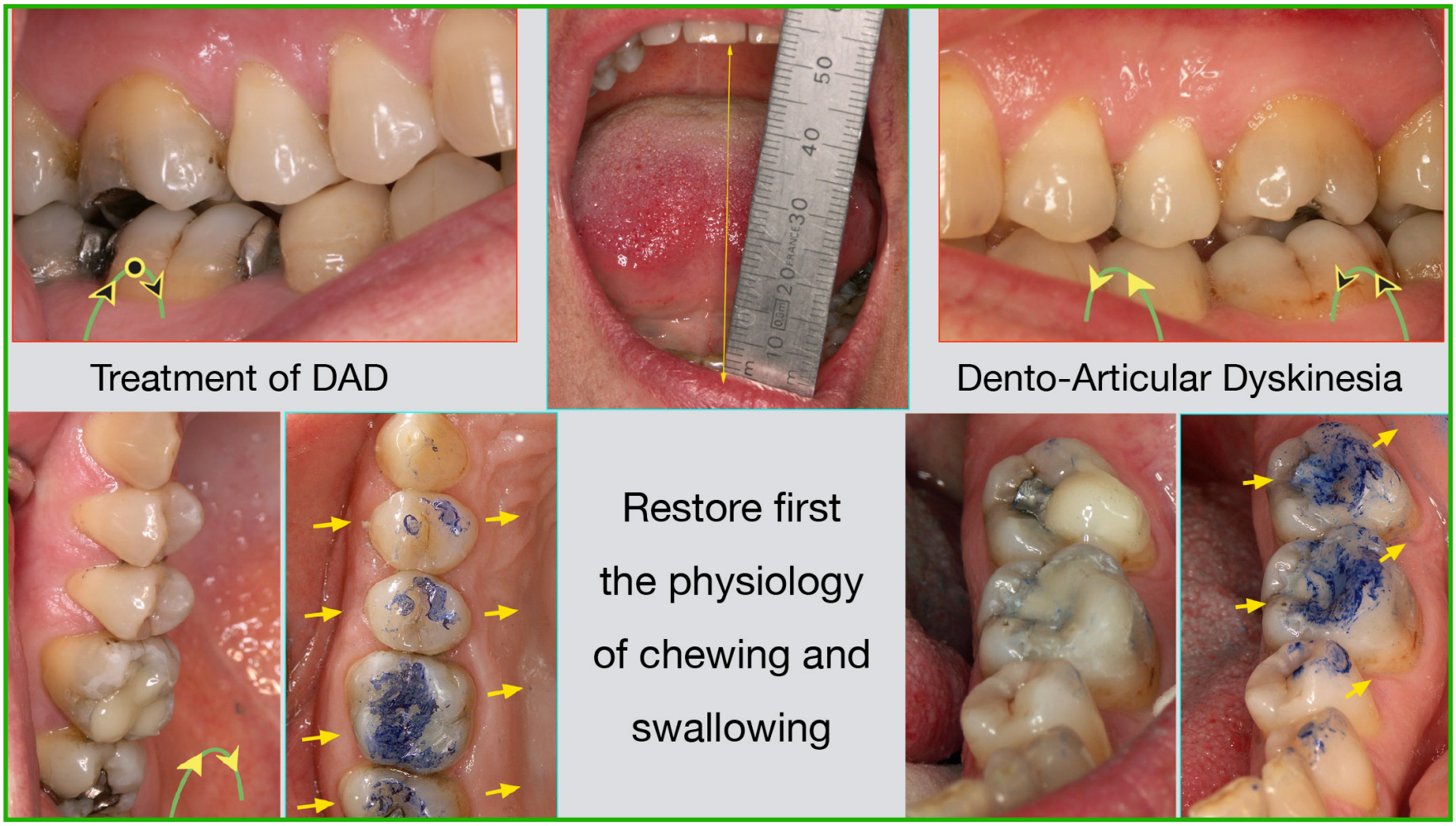


Figure 5-10: Rehabilitation of posterior guidance in July 2006. ***Immediate and total disappearance of TM-noise and pain****. No detachment of the composites. Control in May 2007: not any pathological clinical sign:"occlusion is forgotten" Maximum opening, not deviated:* ***53mm***

solution, except in the case of joint compressions.

The case presented in Figures 5-9 and 5-10 is a very common situation of Teeth-Tmj-Dysharmony. She was a patient who had been seen in consultation 8 years ago, but preferred to start treatment in another office. The conventional treatment performed in this practice (wearing a classical orthosis balanced in "canine protected occlusion") was a complete failure.
During this new appointment, the right side was rehabilitated first, by addition. The chewing was restored, the right joint click and pain disappeared immediately and comfort was found. The patient then insistently requested the same treatment on the left side, which could be done on the same appointment. Chewing has also been restored and the left click has also disappeared. At the end of the appointment the pathological signs were nonexistent and alternated chewing was again possible. Two appointments, one week and 10 months later confirmed the results. The composites did not peel off and the maximum aperture went from

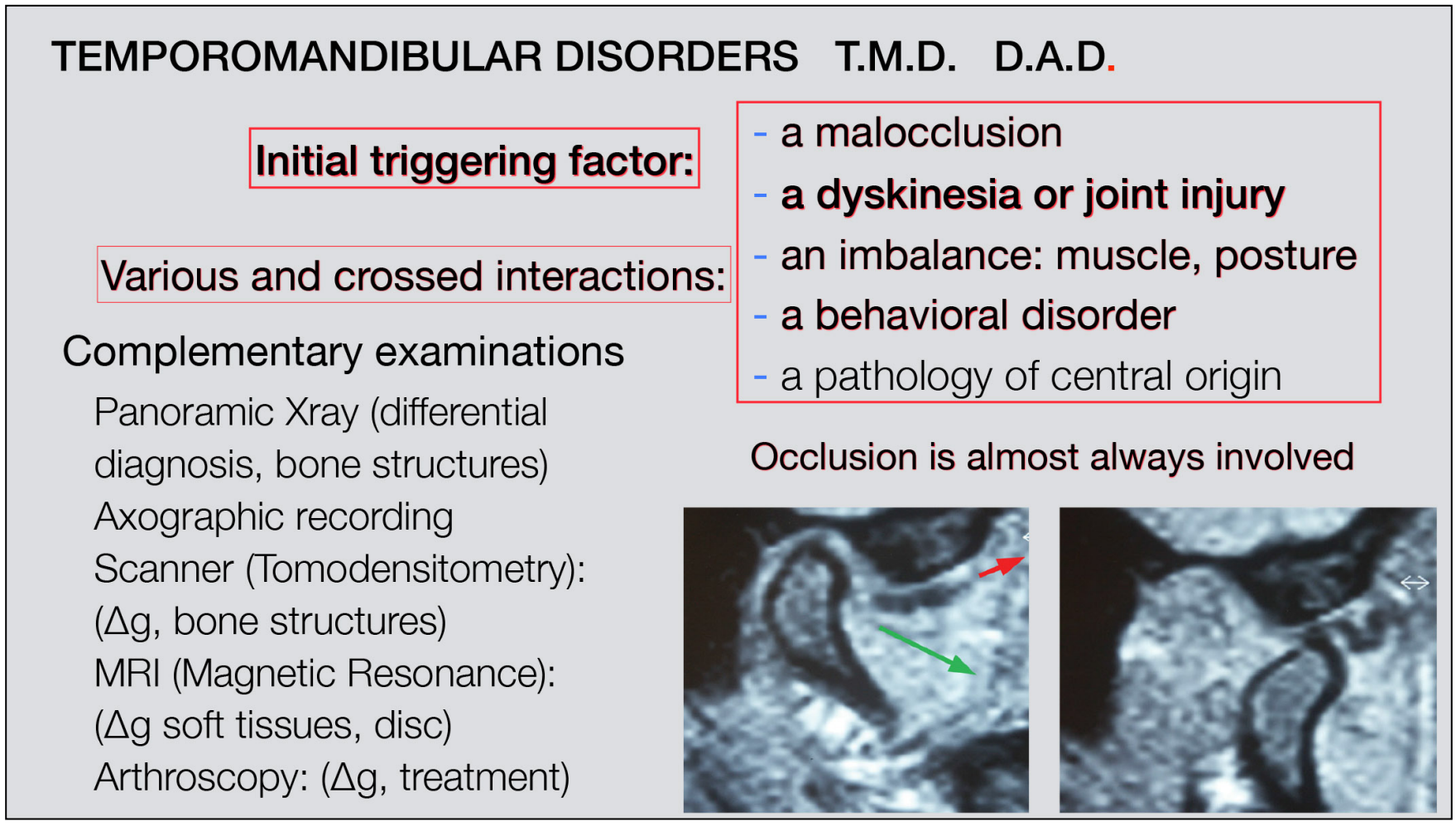


Figure 5-11: Left, favorable prognosis of recovery of the disk. What is impossible on right. Disk insertions of elevator muscles and cycles, see in tome 1 figure 5-56 and 5-59

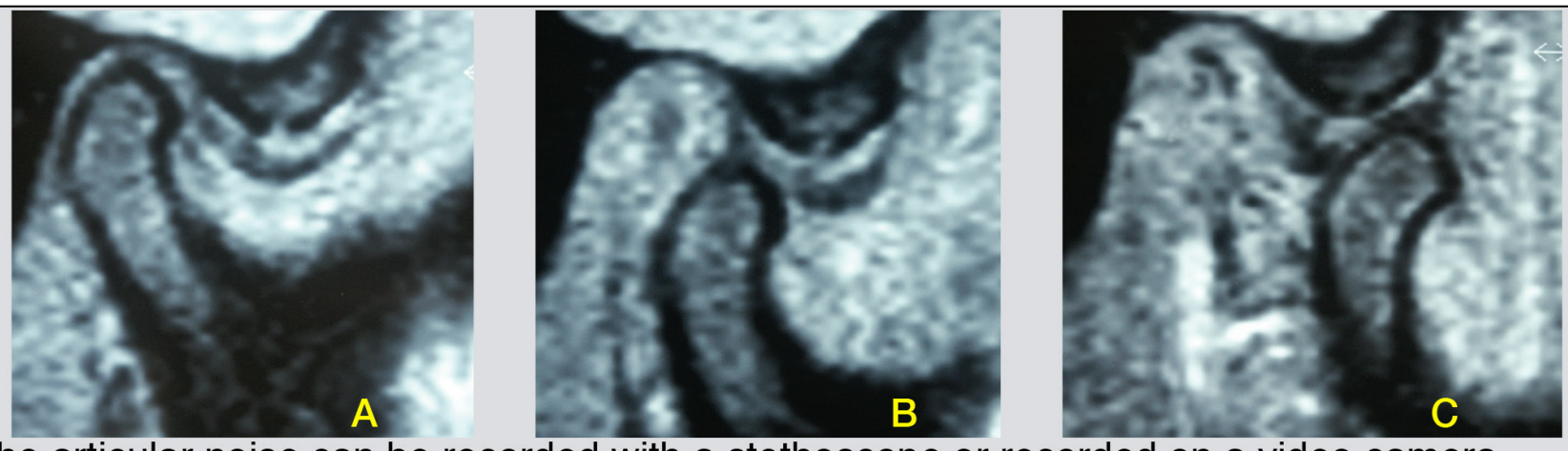
30mm to 53mm. This situation has been maintained over time.
These cases are typical, they are not surprising because they restore the physiology of mastication . The deglutition is installed before birth and the establishment of the adult

mastication is done, during the first contacts in occlusion of couples M1, the envelope of dynamic movements guide the coordinated finalization of the anatomy of the condyles. So whatever the severity of the case, with or without painful contracture, the objective is the same and the dental means to achieve this obey the same rules of physiology recovery. The restoration and coordination of dental chewing guides with joint kinetics allows the reduction of the Lateral Pterygoid spasms and the spontaneous return of the disc between articular surfaces. The optimal pattern and the efficiency of the masticatory cycles are then restored naturally.

Which is absolutely not the case of the RC and CPO that are totally decoupled from swallowing and chewing, that's why there are so many failures.

Vidéo Youtube: https://youtu.be/-QBFdJZcWKc

When the chewing equilibrium is restored and that the TMJ does not return to its normal functioning, even if the comfort of the patient is improved, it must be admitted that there is at least a partial failure of dental therapy whose cause can be articular, because **all the obstacles to the mobility of the disk prevent its spontaneous return between the articular surfaces and its natural functioning**.



The articular noise can be recorded with a stethoscope or recorded on a video camera which makes it possible to appreciate its sound characteristics, to locate it on the opening path, or on the kinematics of a cycle.

The click can be unique, or reciprocal, it can be a creak, a rumble or a rustle. A crackle indicates joint degeneration. A dry snap indicates a frank dislocation, if it's smothered, an alteration of the disc.

An early click and close to MIO at the opening, indicates a favorable prognosis of recovery. The later it is, the more the prognosis is reserved. The absence of noise may indicate an irreducible dislocation.

Figure 5-12: Dislocation in anterior position of a disk, reintegrated at the opening. Favorable prognosis of early dental treatment, performed before the presence of structural lesions of the disc.

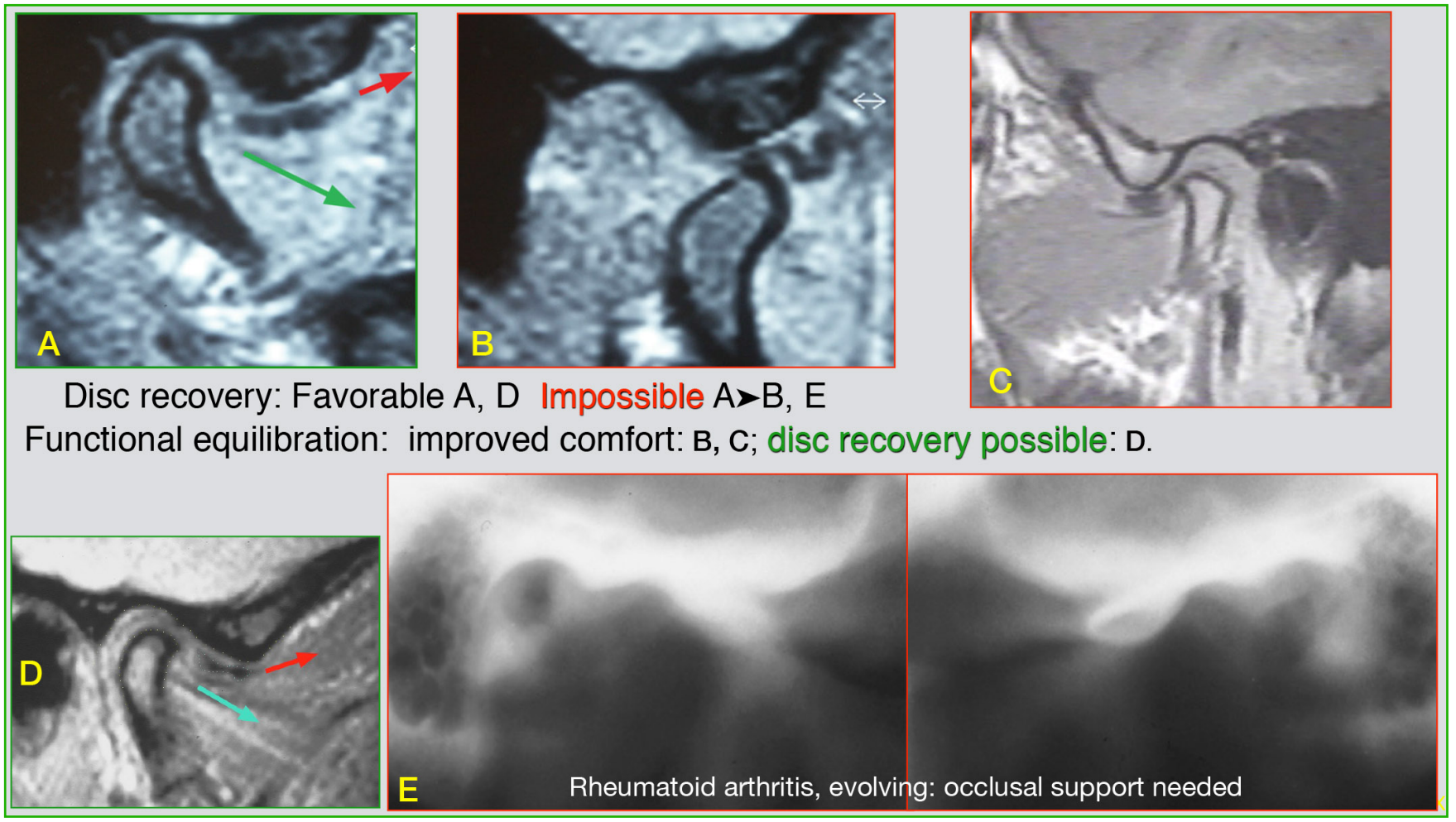


Figure 5-13: In case A-B the disc folded accordion following the wearing of a soft gutter in a young man of 25 years. The presence of flanges during degenerative pathologies such as rheumatoid arthritis (E) has progressively evolved towards the welding of the mandibular condyle head with the temporal fossa. In this case followed for more than 20 years, until death, this weld was accompanied by a fracture of the two condylar necks and the installation of scarred pseudarthroses which allowed the opening closing and chewing with a slow evolution towards a progressive posterior retraction and the appearance of an anterior open bite.

Recall that the disc has the shape of a biconcave lens, surrounded by a peripheral bead twice more developed posteriorly than in its anterior part. The posterior part protects the thin and fragile temporal fossa. The disc is integral with the condylar process, by the anterior SLP of which it forms the insertion tendon, and the temporal bone by the upper insertion of the retro-disc bilaminar. The whole constitutes a complex "condylo-disco-muscular" inseparable (Lezy and Princ 2004). According to an author the disc is, by nature, susceptible to remodelling during physiotherapy called "disc eviction" (Bonnefoy 2009). It is fibrocartilaginous consisting of collagen fibres oriented in the 3 planes of space in order to resist the forces imposed on it by the masticatory muscles (M, MP, T), while it ensures the coordination of the articular surfaces, with the synovial liquid playing the role of lubricant. Its compressive strength is between 180 and 220 Kg per cm2 (Bonnefoy et al 2013). But if the disc is no longer interposed between the articular surfaces and/or if there is a disharmony between the articular kinematics and the molar chewing guidance, which therefore, no longer protects the joint of excessive stresses, the system becomes protective and the chewing forces are reduced (Johnsen and Trulsson 2003, 2005), in order to limit the stresses borne by the articular surfaces. As soon as

coordinated and balanced guidance between teeth and TMJ is restored and stresses are reduced, the shape of the cycles and the power of chewing are spontaneously restored.

In case of failure of the dental solution, complementary examinations will help assess the condition of joint structures and disc.

- A panoramic Xray is systematically taken during the first appointment at the office. It allows analysis of the bone structures and make a differential diagnosis with deformations, bone lesions, condyle neck fractures, old or recent, degenerative diseases such as rheumatoid polyarthritis, or others.
- This examination will be completed by different more precise MRI cuts.
- Axiography, which has long been the only clinical method for quantifying condylar kinematics, before the introduction of MRI and current 3D kinesiographs, and which remains an interesting diagnostic tool when it is available.
- But only magnetic resonance imaging will be able to see the soft tissues and the articular disc and evaluate its state of deformation, lesion, fracture, alteration, degeneration, rheumatoid arthritis etc.

Disk dislocation: What treatment?

Arthroscopy: if the pathology is old and the disc seems unscathed, there may be flanges that limit its mobility and are invisible, even on MRIs. Only arthroscopy will allow to see them and release the disc by cutting the flanges during a joint wash.

During growth, the shape of the TMJ is finalized thanks to the multiple functional demands of which it is the object. Especially those of chewing. TMJ and chewing are interdependent and their physiological functioning is coordinated. They are mutually affected by their pathologies. However, conventional treatments (CR and CPO) have recommended:

- The wearing of a classical bite plane, or an interlocked orthosis in protrusion up to the threshold of reintegration of the disc, followed by a progressive recoil of the mandible to slowly bring the recaptured disc towards the MIO. This uncomfortable classical protocol dissociates, from the operation of the teeth, the attempts to recapture the disc, which is an error.
- Heavy surgeries that are largely abandoned today in favour of very limited and minimally invasive surgeries (Fig. 5-17 à 5-19).

Tooth-TMJ Dyskinesia (TTD) or joint injury

In the presence of the dislocation of an articular disc, secondary to a dyskinesia of the functional guidance between teeth and joints:

Restoration and coordination of chewing guides with joint kinetics have the following direct consequences:

- lifting of contractures of capsule-disc anterior muscular insertions,
- the return of the disc between the articular surfaces, thanks to the elasticity of the retro-disc blade causing its spontaneous recoil,
- and restoring the shape and efficiency of masticatory cycles.

All obstacles to disc mobility prevent his spontaneous return.

Deformation, lesion, fracture, alteration, degeneration, rheumatoid arthritis, flanges ...

Figure 5-14: it's important that this treatment will be done early, because if not, the risk of irreversible degradation of the disc increases.

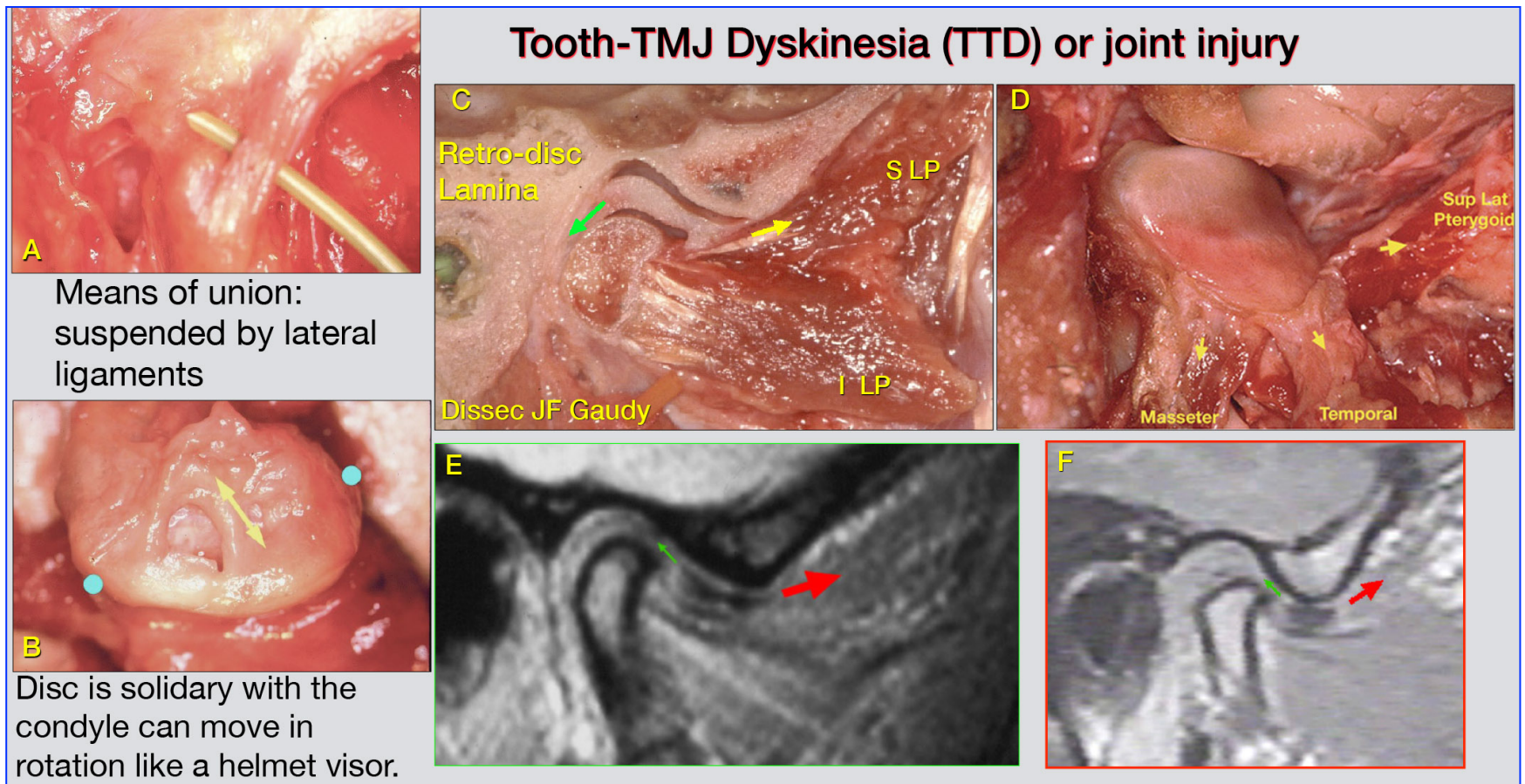


Figure 5-15: When the coordination of the dental and articular kinetics is reestablished and allows the relaxation of the anterior insertions of the disc, the elastic recoil of the retro-discal lamina allows the spontaneous repositioning of the disc. With aging the retro-disc lamina loses some of its elasticity, especially since the disc has long been dislocated in ante-position and this lamina becomes fibrous. If the retro-discal lamina is very fibrous and retracted, the disk can be dislocated in post-position during the mouth opening, and chewing cycle outputs.

Now it is becoming more and more clear that it is the functional imbalance of the posterior teeth which is the main aetiology of disc malpositions.

- The reversible etiological tests, by addition of composite, confirms it, with the large proportion of positive results that are obtained by restoring the functional coordination of the posterior teeth with the TMJ. However, their exact impact on the movement of the disc is quite difficult to anticipate. But they are not mutilating and their reversibility makes it possible. These occlusal restorations are considered today as the etiological treatment of functional dyskinesias between teeth and joints. In the presence of dislocation, if the imaging does not show lesions of the disc and if its reintegration is not done, an arthroscopic examination may allow to objectify the presence of flanges, that a joint wash will remove, to restore the mobility of the disc and its possible re-insertion.

Muscular imbalance

- Local: Open bites: induced imbalances

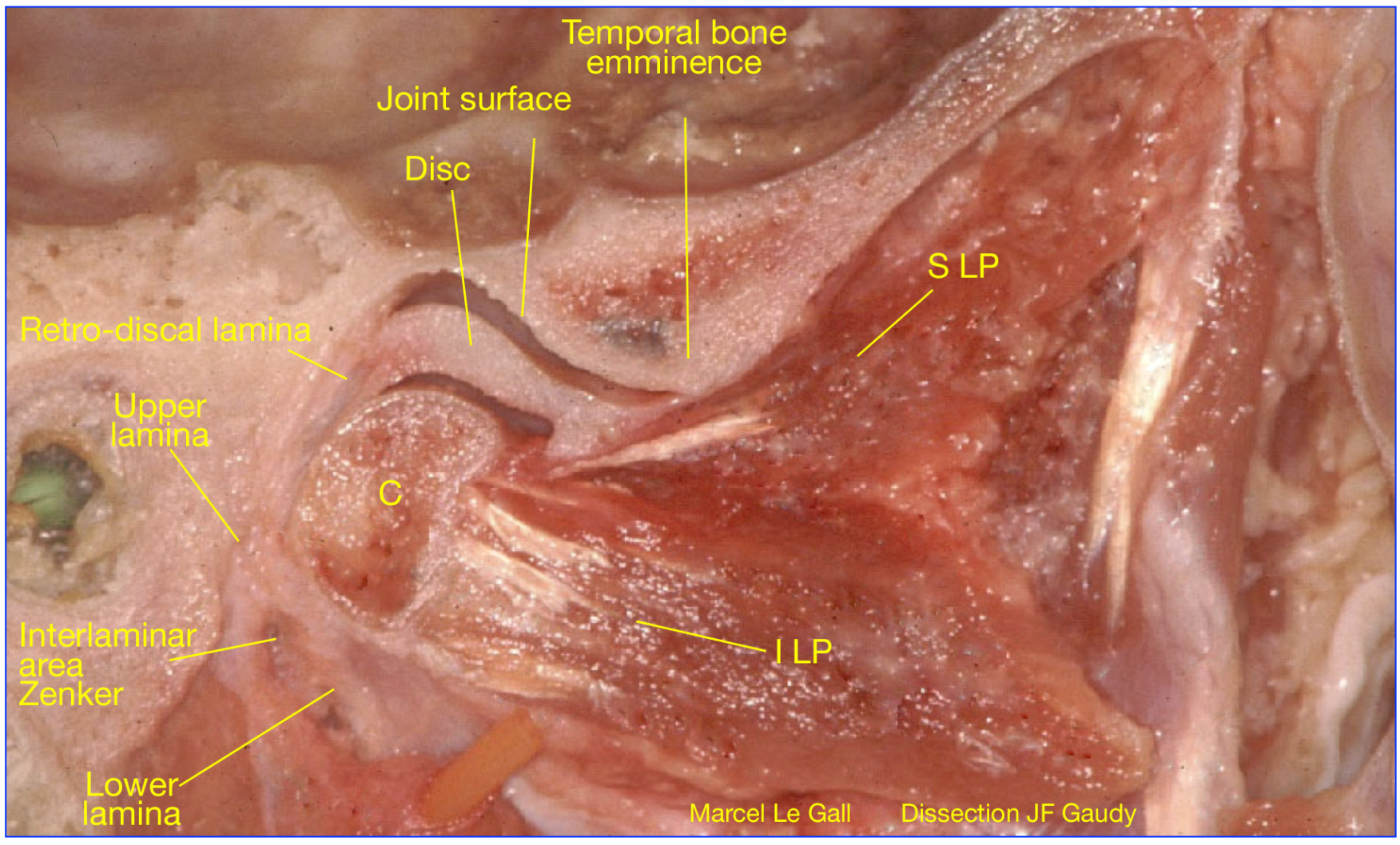
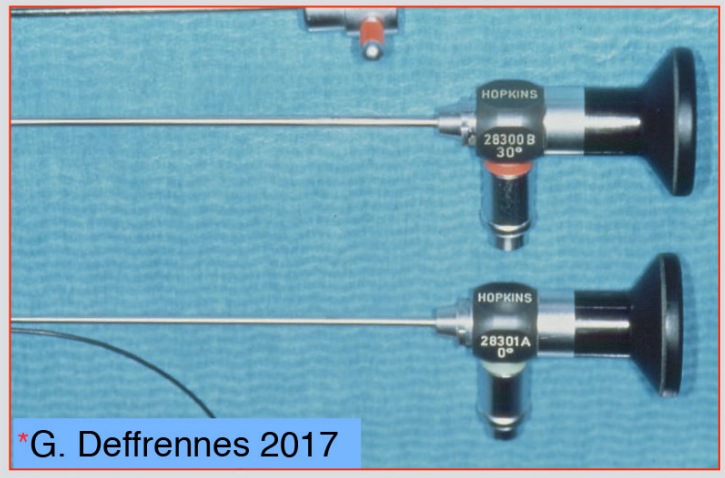


Figure 5-16:*The posterior part of the disc continues with the retro-disc lamina; which has a spontaneous recoil capacity (passive hydraulic return frenum). The upper temporodiscal frenum of this lamina is attached to the temporal in the area of the* tympano-squamous fissure*. While the lower condylo-disc frenum is inserted on the posterior part of the condylar neck.*

T.M.D. ADDITIONAL EXAMINATIONS: (failure of occlusal therapy)

Depending on the suspected etiology::

- **a joint injury**
- a muscle imbalance **(TMD)**



Interest of the TMJ ARTHROSCOPY

Examination and minimally invasive surgery

Observation of flanges invisible to other exams

Washing the TMJ and lifting the flanges (gluing and blocking the disk)*

Local anti-inflammatory

Additional equilibration: restoration of functional kinetics.

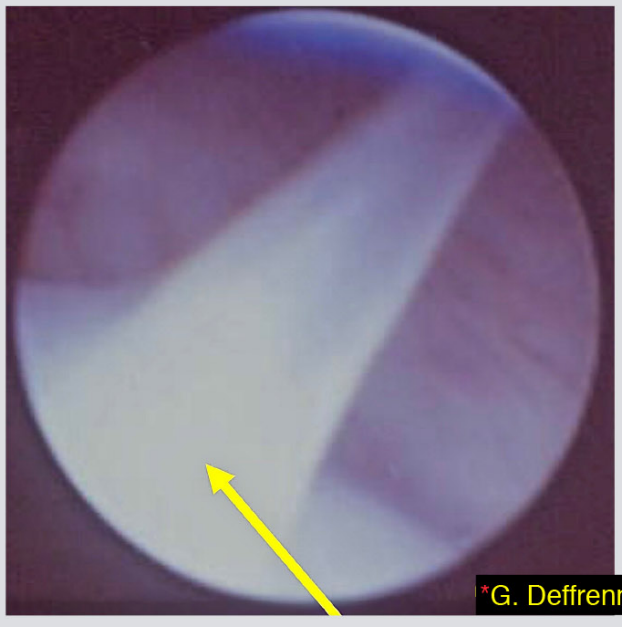
Figure 5-17: Arthroscopy is the only way to detect intra-articular flanges undetectable by other current imaging techniques.

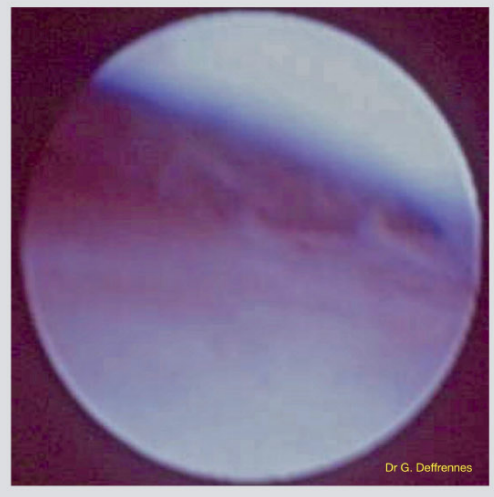
ARTHROSCOPY of TMJ: Examination and minimally invasive surgery

Observation of flanges invisible to other exams

-Washing TMJ and lifting the flanges blocking the disc*

-Release of the dislocated disc (posterior frenum section)





Lifting of the flanges: passage of the insert between the articular surfaces

Figure 5-18: Some flanges are slightly adherent, others are difficult to eliminate.

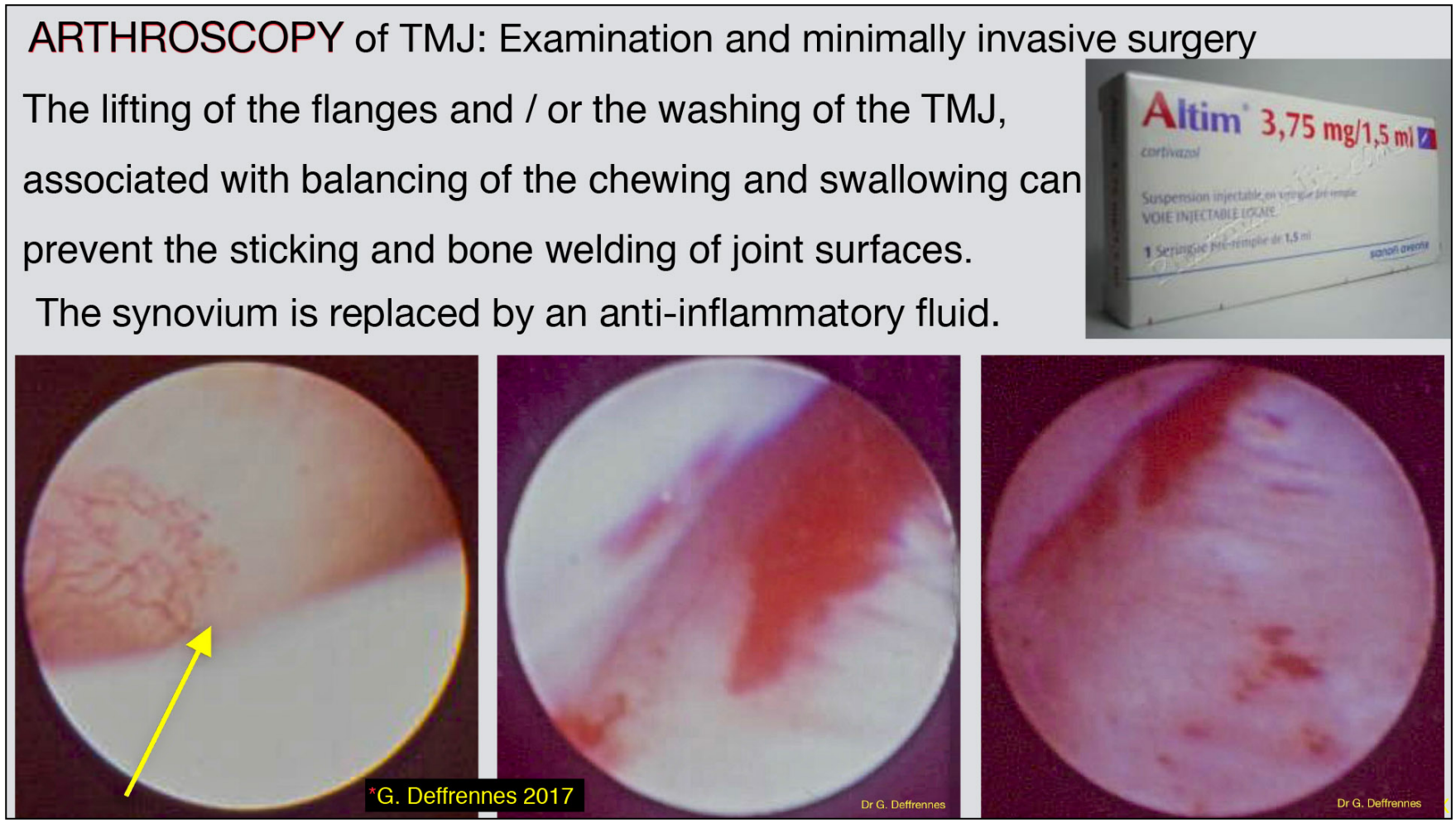


Figure 5-19: Lifting flanges must be accompanied by functional equilibration to restore mobility and disc function and to prevent the formation of new flanges.

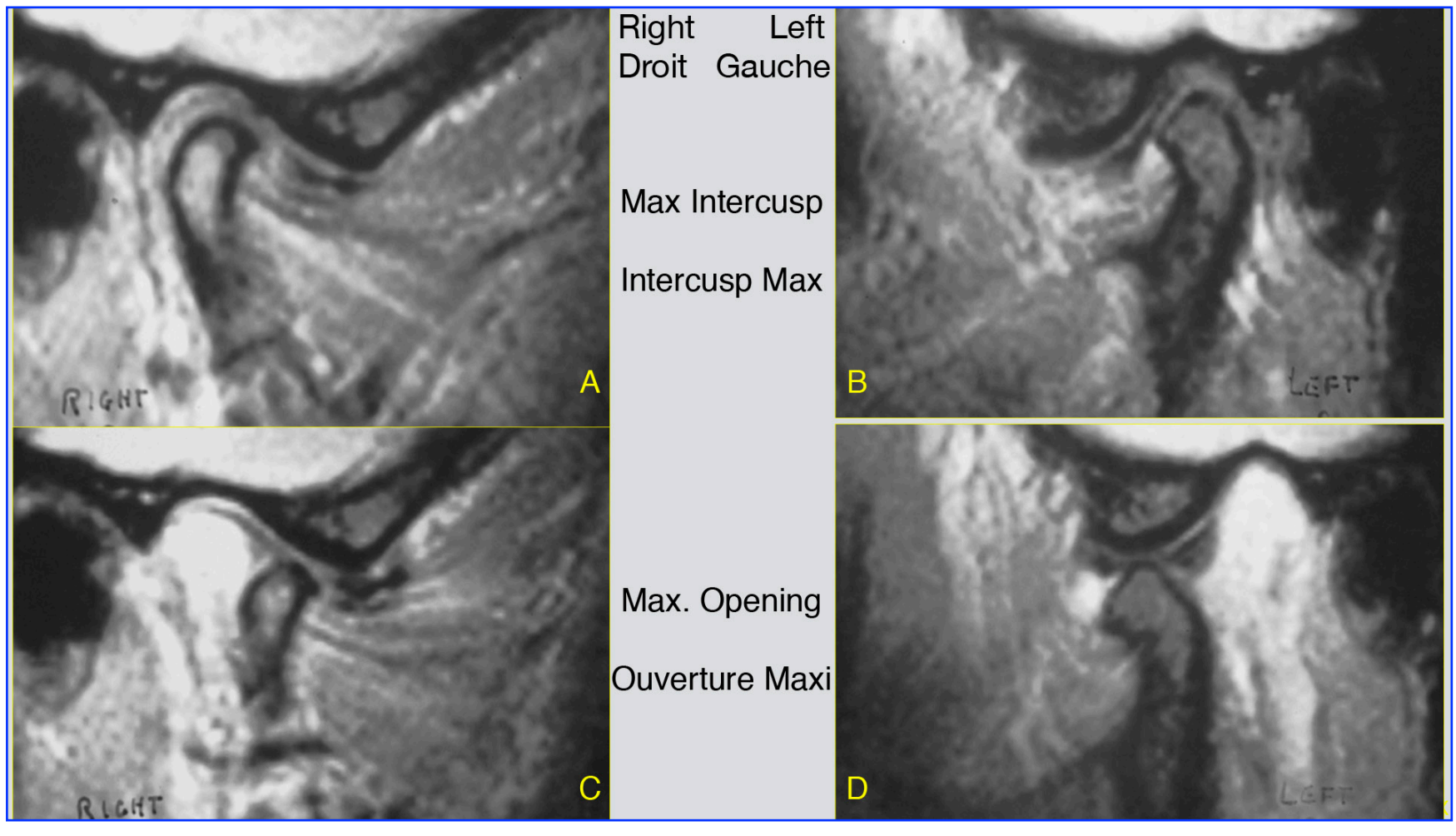


Figure 5-20: Patient seen in emergency for an irreducible anterior dislocation of the right joint disc, with an MRI and a surgical appointment for menisectomy at 15 days.

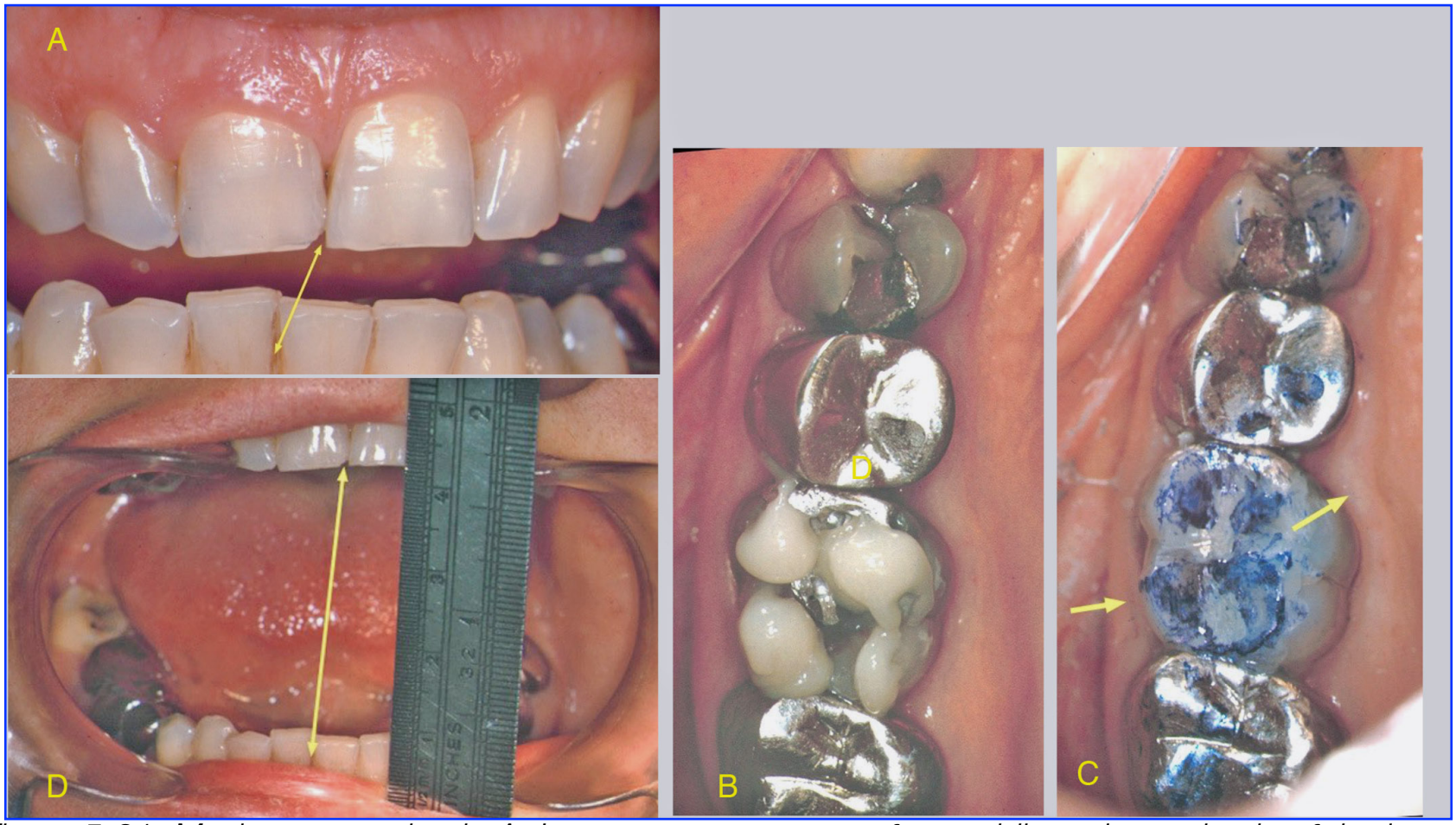


Figure 5-21: Maximum opening in A. It was necessary to perform a bilateral anesthesia of the lateral pterygoids to lift the contracture of the right PL and obtain the opening to be able to make the clinical examination. The extruded lower right M3 showed mesial premature contact which was retouched. The patient who was seen three days later had a maximum aperture of 35mm. The mediocrity of the mandibular prostheses necessitated the sculpting of the occlusal anatomy of the lower M1, which made it possible to restore by addition the chewing guides of maxillary M1. The patient, who was seen three days later, had a maximum opening of 50mm, with no deviation, indicating the spontaneous return of the disc between the articular surfaces. This made it possible to cancel the scheduled surgery.

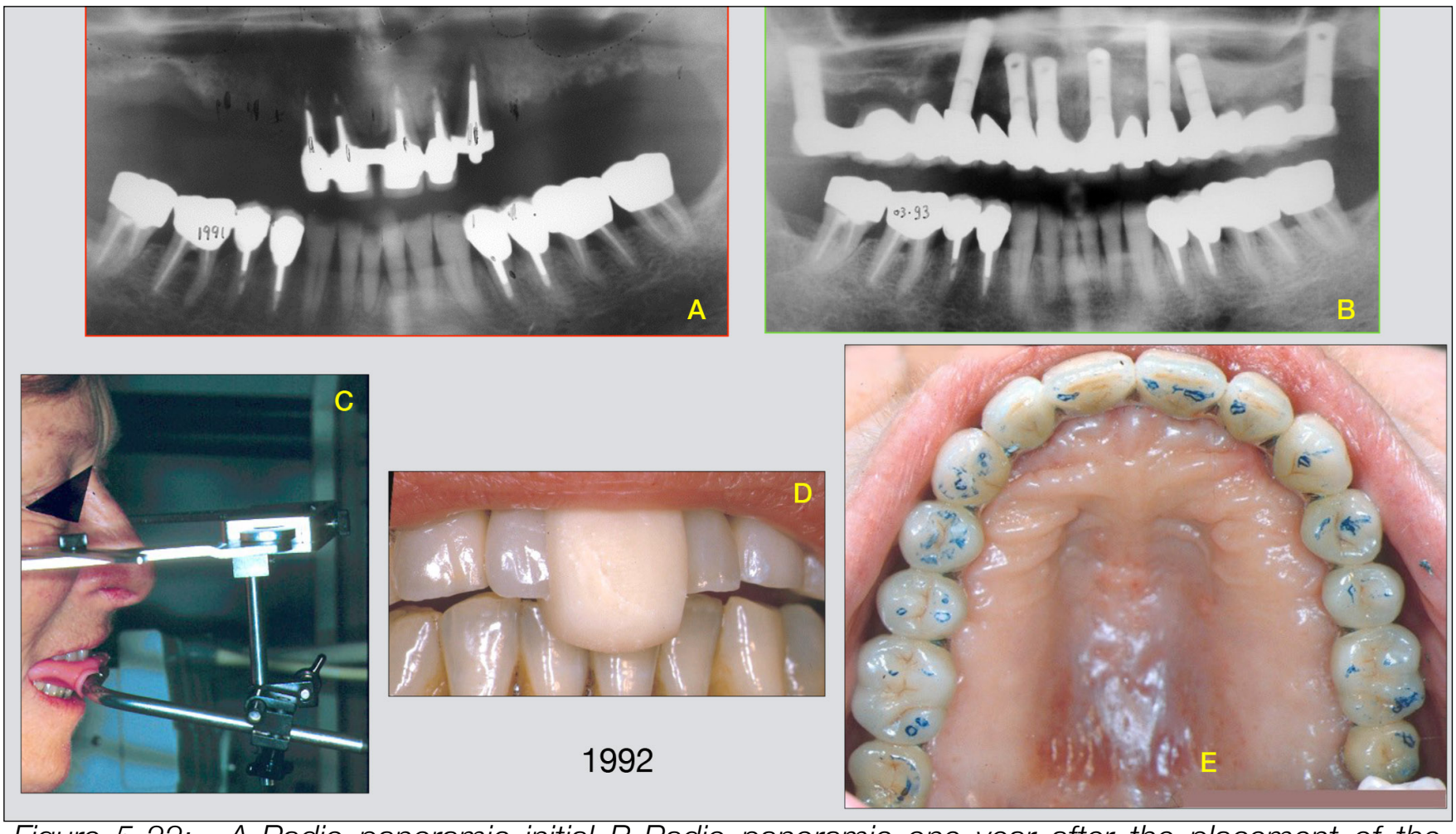


Figure 5-22: A-Radio panoramic initial B-Radio panoramic one year after the placement of the maxillary complete restoration fixed on 8 implants C-Placement of the face-bow, before prosthetic realization on a adaptable articulator Denar D5A D-Final check of the intermaxilla relationship, using an anteror jig, E- Balancing of MIO contacts.

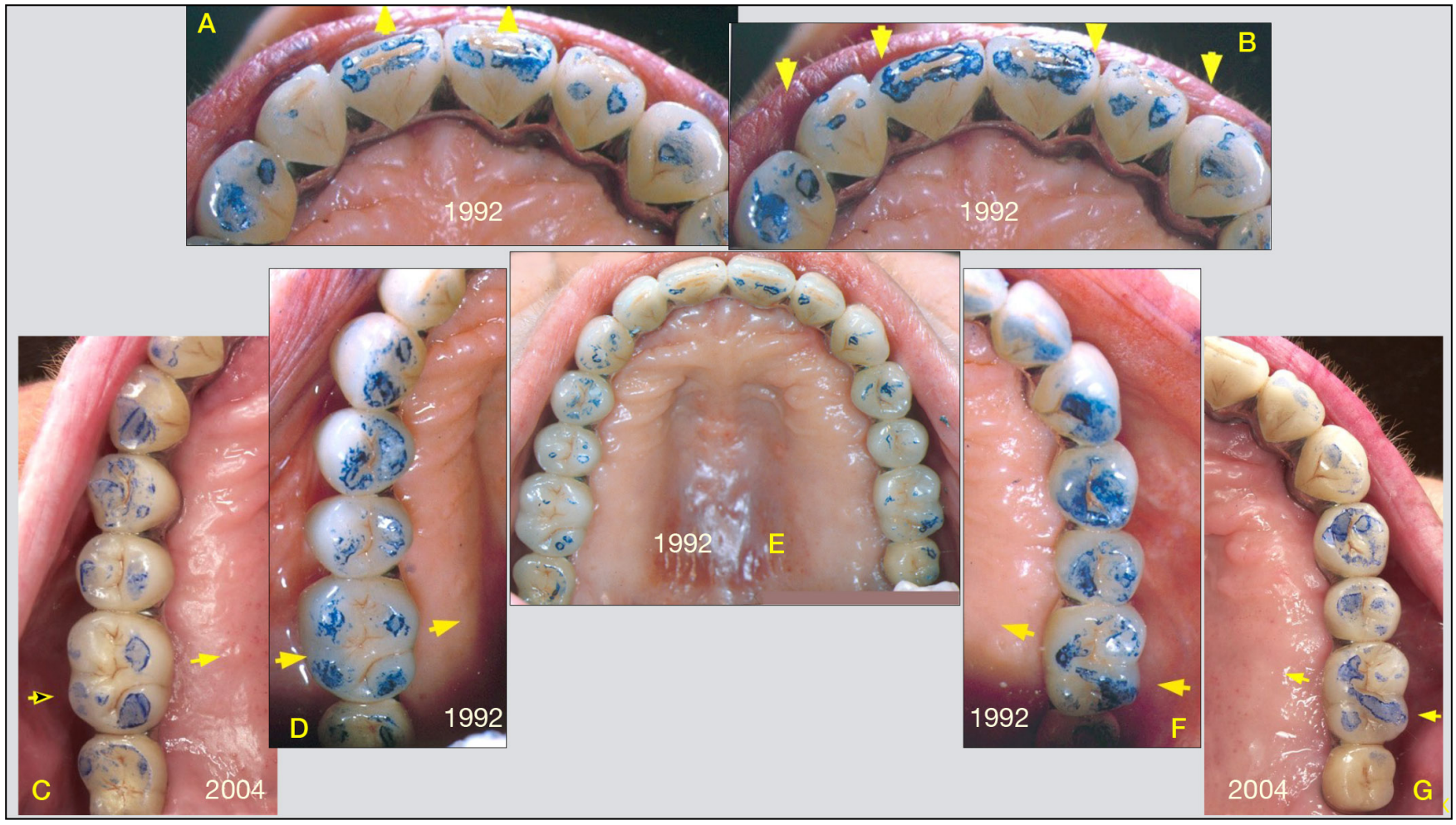


Figure 5-23: A,B- View of protrusion contacts and incision D, F- and right and left chewing guides, at the placement in 1992, C, D- During the 2004 checkup, the cycle input guides of left M1 and M2 are under-guiding, which is not normal.

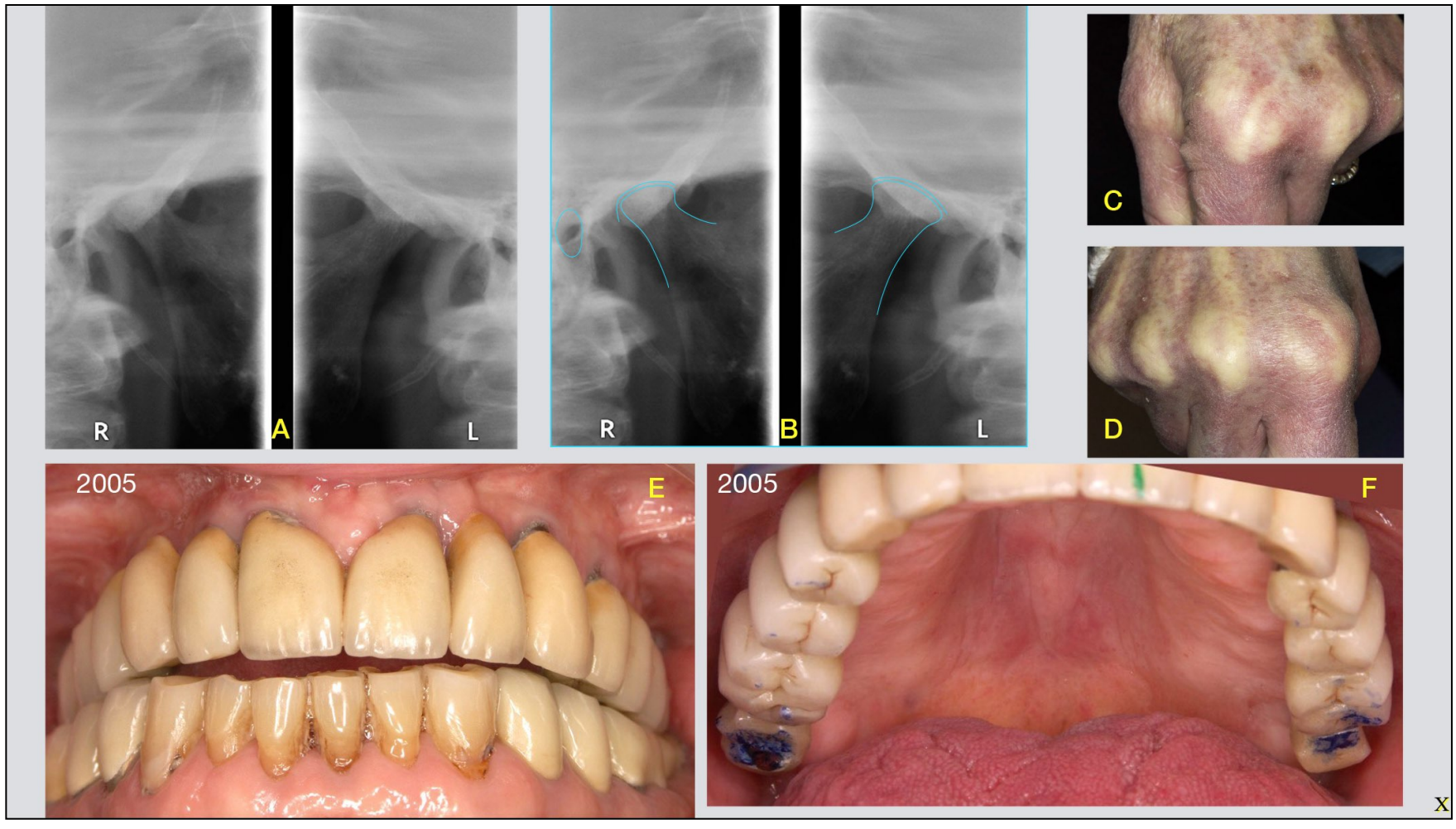


Figure 5-23b: 7 months later the patient returns to control, wiith a complete anterior open-bite. The only MIO contacts are located on M2 pairs. She shows me her hands, which are rapidly deforming, and tells me that they result from progressive rheumatoid arthritis. CT scans show the heads of the collapsed mandibular condyles that are responsible for the open bite, which is itself progressive.

Figure 5-23c: C, D- The jig wear indicates an asymmetrical mandibular malposition. The only contacts are backward. Overloading may cause rapid failure of posterior implants. Decision: make a dismountable mandibular bridge of 8 elements, which has been rebased regularly, until the death of the patient a few years later, according to the evolution of the disease.

ARTHROSCOPY of TMJ

Examination and minimally invasive surgery

Observation of flanges invisible to other exams

Washing the TMJ and lifting the flanges gluing and blocking the disc*

Section of the posterior frenum (TMJ blocked by dislocated disc)

Local anti-inflammatory

Equilibration to restore

functional kinetics

Synovial fluid is aspirated

The capsule is inflated to air for

allow examination.

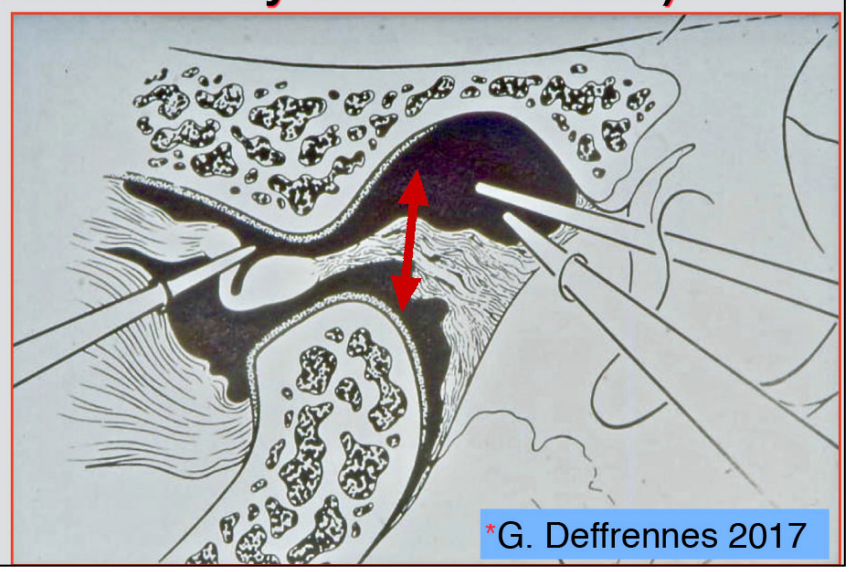


Figure 5-24: When the disc is too deformed and blocks the head of the condyle, the simple section of the rear frenum allows the disc to move forward and allows the mobility of the condyle.

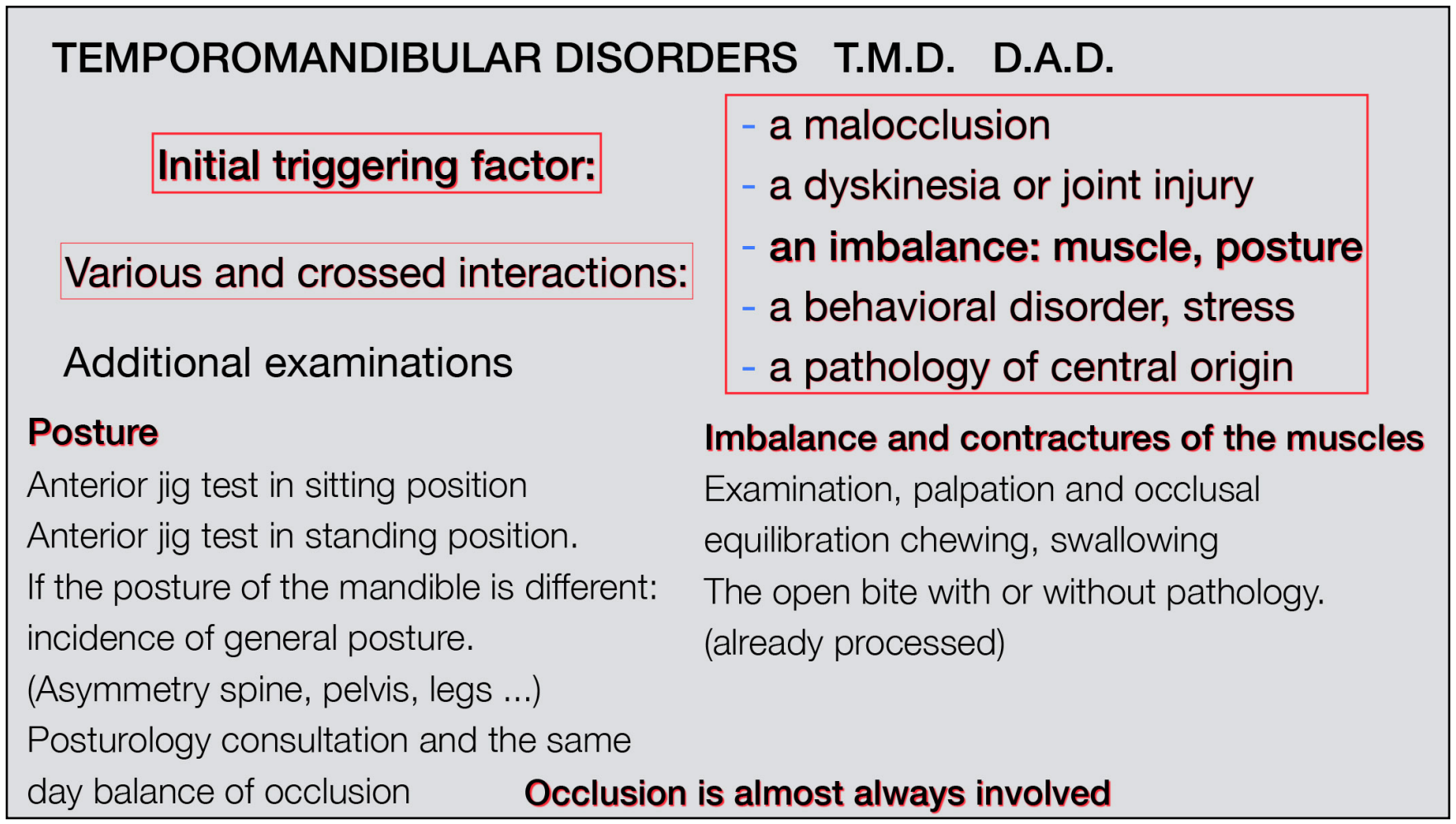


Figure 5-25: The relationship between posture and occlusion can not be evaluated satisfactorily, as long as the postural problems remain attached to the occlusal gnathological model. Only by associating postural problems with actual occlusal function can the relationships between posture and occlusion be evaluated satisfactorily. This has not yet been done by the vast majority of dentists and posturologists.

The presence of anterior open bite (Fig. 4-20 à 4-24) caused by atypical swallowing, or lingual imbalance (macroglossia) is likely to cause or maintain an occlusal imbalance and trigger an articular pathology (clicking, joint pain and muscle spasm).

- From a distance: Postural disorders

A disturbance of the body statics resulting from a poor posture spinal bone pathology, traumatic, or others, can lead the patient to seek a new postural balance of compensation. The change in the wearing of the head, that can result, may trigger deleterious muscle tension, change the clinical rest posture, and be responsible for muscle pain hypertension or fatigue. After a first check and if necessary a functional equilibration of the occlusion, these cases must be treated in collaboration with a specialized professional who can be a posturologist, osteopath, chiropodist etc, who will take care of the restoration of the general postural balance. before the patient returns very quickly in consultation at the dental office for occlusal control of the closing path and chewing. A significant portion of postural disorders are recurrent. They should not be considered a priori responsible for all occlusal problems, by practitioners unaware of the functions of chewing and swallowing.

There is a direct relationship between posture and occlusion, it's a certainty. The gnathological occlusal approach associated with the empiricism of certain postural approaches has not, so far, led to scientifically consistent data. Nevertheless, a frame is already planed to receive these data under the heading of **PWG**: **Posture** (bodily, lingual, mandibular), **Wedgin**g (deglutition) **Guidance** (chewing).

Oro-facial muscular palpation

When functional malocclusions are present, they are generally treated in first intention by functional equilibration. It is only in case of failure that a complete examination is undertaken, which includes muscle palpation.

The type of palpation depends on the palpated area. It can be soft, supple, supported, rolled, pinched…

The painful site is not necessarily the one that causes the pain. It can come from another location.

Muscle pain is labile, characterised by sudden onset, varying intensities, and recurrent effects. Usually it responds well to therapy unless it is of inflammatory origin (Bell, 1983).

Although **TMJ** has muscle inserts, **joint pain** is more stable, characterised by insidious onset and mild changes. It is persistent and resistant to therapy (Bell, 1983).

When pain is observed alone at the TMJ, the supra-articular area can be extremely sensitive to touch. The pain then makes one think of an inflammatory organic lesion of the capsule.

However, patients most often evoke diffuse pain that is almost always asymmetrical and stronger on one side.

Muscular pain is the result of muscle contracture (Schwartz, 1956). Painful irradiation can occur in a wide variety of locations that may be temporal, mandibular, occipital, cervical, neck, shoulder and arm or vertex, but may also occur in the tongue and / or or the pharynx. Painful or sensitive sites can be precisely located by patients who point to the painful area. They are evaluated by direct palpation and/or functional manipulation.

When structures are accessible, palpation is the best method for causing or stimulating muscle pain. Inaccessible areas are examined indirectly by functional manipulation (Bell, 1986).

Manual palpation, static and dynamic, is performed on accessible pain sites, TMJ, Temporal, Sub Occipital, Trapezius, SCM, M, DI (Bell, 1983, 1986). It must be practiced symmetrically, comparatively and codified.

The outer pole of the joint is directly accessible. The palpation is carried out by directly exerting a digital pressure on the external slope of the condyle, during the movements of opening, protrusion, laterality, incision and mastication. This examination indicates the presence of capsular pain and can provide information on joint movements and disc conditions (Bell, 1986). However, the joint pain must be differentiated from that emanating from the Deep Masseter which covers the anterior part of the joint capsule.
Digital pressure in the anterior portion of the external auditory canal causes or enhancesposterior disc pain, but joint pain must be well differentiated from atrial pain (Bell, 1986). The palpation of the temporal is done by pressure on the underlying bone. Pressure pain on the superficial vessels or the atrioventricular nerve must be differentiated from temporal muscle bundle pain (Bell, 1986).
As for the Lateral Pterygoid, involved in dislocations of disc, its palpation is hard or impossible for some authors. Only the method described by James Cyriax in 1976 allows a direct and proven palpation of the anterior insertions of Inferior Lateral Pterygoid. But the palpation is painful, with a decontracturant effect and hyperhémiant. But persistent dolors can last several weeks. This palpation of 10 to 15 seconds can have a temporary decontracting effect that should not be confused with an etiological treatment of dislocation. (what about resisted movement test for LP. Turp 2001 deemed manual palpation as unreliable and unstandardised)
Functional manipulation can be used for the Medial Pterygoid (Bell 1983), when palpable structures are asymptomatic (clenching on a hardwood wedge). The gene???, provoked or accentuated by a large mouth opening and a high pressure in occlusion, indicates a pain of the MP. But beside the muscular factor, the most important elements of analysis and diagnosis to observe are the facets of wear, interference, overguiding and especially sub-guides during chewing, because if their correction by addition test of composites has a direct impact on the restoration of cycle kinematics and pain sedation, it will be considered as the etiologic treatment of dento-articular dyskinesia and if not, it will allow a rapid reorientation of the patient..

Psychism and stress disorders *(Laskin psychophysiological theory)*

By developing muscle surges and hyper-contractions, emotional factors (whether familial, occupational, emotional, or other) can play a determining role in triggering temporomandibular disorders. The muscular tensions thus developed can serve as an outlet for stress and are generators of clenching of teeth and bruxism, without any dental cause.

Bruxism is often associated with the phenomenon of grinding of teeth occurring in the functional field or outside, but can be manifested by a phenomenon of clenching of the teeth in

TEMPOROMANDIBULAR DISORDERS T.M.D.

Initial triggering factor:

- a malocclusion
- a dyskinesia or joint injury
- an imbalance: muscle, posture
- **a behavioral disorder, stress**
- a pathology of central origin

Interactions limited to none:

Behavioral disorder:

Drugs, schizophrenia, delusions ...

At the slightest doubt, **to send to a psychiatrist, because outside the domain of dental competence.**

Occlusion is very rarely involved: caution

Stress ➤ bruxism without malocclusion

Relaxing therapies, night protection

Stress ➤ bruxism with malocclusions

Balance the occlusion rehabilitate the arches.

Can be a false bruxism

*Le Gall.,Lauret Cah.Prothèse 98; Le Gall et Lauret 2011

Figure 5-26: If the patient reports unobservable and inconsistent clinical signs, extreme caution is required. If a treatment is undertaken, it will be difficult to interrupt it.

BRUXISM has a central and behavioral origin(Laskin 1969, 1977).

- Stress is the primary etiological factor of bruxism. The central nervous system triggers a hyper-muscular activity, causing pain and dysfunction (Rugh 1994). The brain mechanisms that regulate the parafunction of dental squeaking are not yet well known...
- When the etiology of bruxism is only central, it is not a matter of dental treatment ... Prevention consists in using materials of moderate hardness whose abrasion in time, is similar to that of natural antagonists.

- Differential Δg of true and false bruxisms

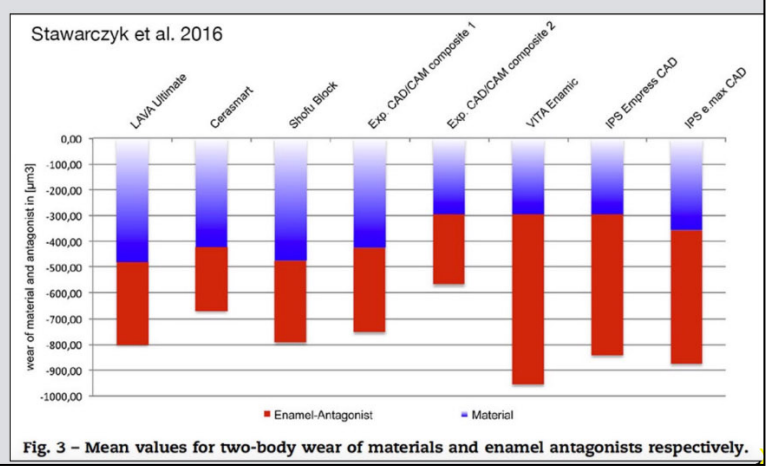


Fig. 3 – Mean values for two-body wear of materials and enamel antagonists respectively.

Figure 5-27: Use materials of moderate hardness and coordinated to that of the antagonists. Wear a conventional night protection orthosis, or supporting an anterior jig.

BRUXISM

- When central etiology is associated with important malocclusions, functional occlusal rehabilitation can reduce or even eliminate bruxism.

The three clinical expressions of gnashing one's teeth, are grouped under the name of bruxism (Rugh):

- **Clenching** : strong contacts between the teeth without movements,
- **Engaging** : strong contacts with small movements around the MIO,
- **Grinding** : or wide movements when gnashing.

Figure 5-28:

BRUXISM

Orientation of parafunctional movements of bruxism:

- In centripetal functional orientation: maximum muscle power
- In centrifugal orientation: the muscles work in reverse orientation, less power, but contractures and maximum muscular pains.
- Or alternating the two, or diagonally, or back and forth ...
- The theoretical maximum strength reaches 400Kg / cm2, in some bruxisms forces of 150 to 200 Kg were measured.

Be careful the qualification of behavioral etiology (without serious analysis) can serve as a screen for many medical and occlusal deficiencies.

Figure 5-29: The occlusal observations of the standard model are in centrifugal orientation. It would be surprising if bruxism escaped this rule. However, the measured forces are very high and can only be obtained by masticatory muscles working in their centripetal functional orientation. Whereas in the opposite direction centrifugal forces are much less but responsible for painful muscle contractures.

BRUXISM.

Treatment depends on the etiology of bruxism

- Behavioral etiology alone:

- The patient must be addressed quickly in specialized consultation.

The treatment of behavioral and central disorders is not within the competence of odontologists. If an accompaniment is requested, its objectives will be to relieve the pain, while protecting the arches from the pathological consequences (night guard orthesis).

- Behavioral etiology associated with malocclusions.

- The occlusal balancing must be done beforehand, by addition, with reserves. In case of failure, the patient must be referred to specialized consultation.

- In dentistry the prescription of anxiolytics and antidepressants is not recommended (to be limited to muscle relaxants).

-The injection of botulinum toxin into the masticatory and peri-cranial muscles is widely practiced in some practices, without any occlusal equilibration.

Figure 5-30: The injection of botulinum toxin must be renewed regularly. It is a symptomatic treatment that can help, but its long-term effects are not well known. Do not use, in first intention in the case of a simple functional equilibration.

BRUXISM.

Treatment depends on the etiology of bruxism

- Occlusal etiology

- Various orthoses, in case of painful contractures, which must often be worn all the life, because the following gnathological occlusal equilibration gives rates of failure of treatment of TMD between 40 and 75%.

- If bruxism is not accompanied by pain: permanent nocturnal wearing of a protective splint.

- Functional equilibration of swallowing and chewing reduced the number of therapeutic plates by 85-90%.

- Remain true bruxisms of central origin where the permanent nocturnal port of a plate of protection remains necessary, to protect the arcades.

Figure 5-31: see figures 5-7, 5-8

MIO or in lateral or anterior position, or a phenomenon of engaging of teeth in MIO associated with lateral and anteroposterior movements of very small amplitude. Repetition, intensity, duration of these contractions may have a periodontal impact or may cause significant

abrasion of the tooth surfaces and / or muscle fatigue that may lead to painful muscle tetany, a change in the resting position and intercuspation position of the patient.

Serious behavioural problems

TEMPOROMANDIBULAR DISORDERS T.M.D.

Initial triggering factor:

- a malocclusion
- a dyskinesia or joint injury
- an imbalance: muscle, posture
- a behavioral disorder, stress
- **a pathology of central origin**

Possible interactions:

Complementary examinations:

To be referred to a specialized neurology consultation:

Occlusion may be involved, in function of the expression of pathology

Essential neuralgia of the Trijumeau

Neuropathic pain…

*Le Gall.,Lauret Cah.Prothèse 98; Le Gall et Lauret 2011

Figure 5-32: Central pathologies such as neuropathies or essential neuralgia of the trigeminal nerve, have a priori nothing to do with occlusion. I have been confronted several times with patients suffering from trigeminal neuralgia. During the crisis the pain was so severe and our inability to relieve her so great that they all thought of suicide. After the introduction of implantology in at least two cases of essential trigeminal neuralgia, it was possible, by extracting the teeth acting as trigger zones and replacing them with implants, to considerably reduce the intensity of the crises.

Stress related phenomena should not be confused with pathologies such as schizophrenia, delusions or serious behavioural disorders related to drugs, which must be addressed from the outset in a specialized consultation if there is a slightest doubt. If dental treatments were to be undertaken secondarily, they would be done with the agreement of the psychiatrist, excluding important work at the beginning.

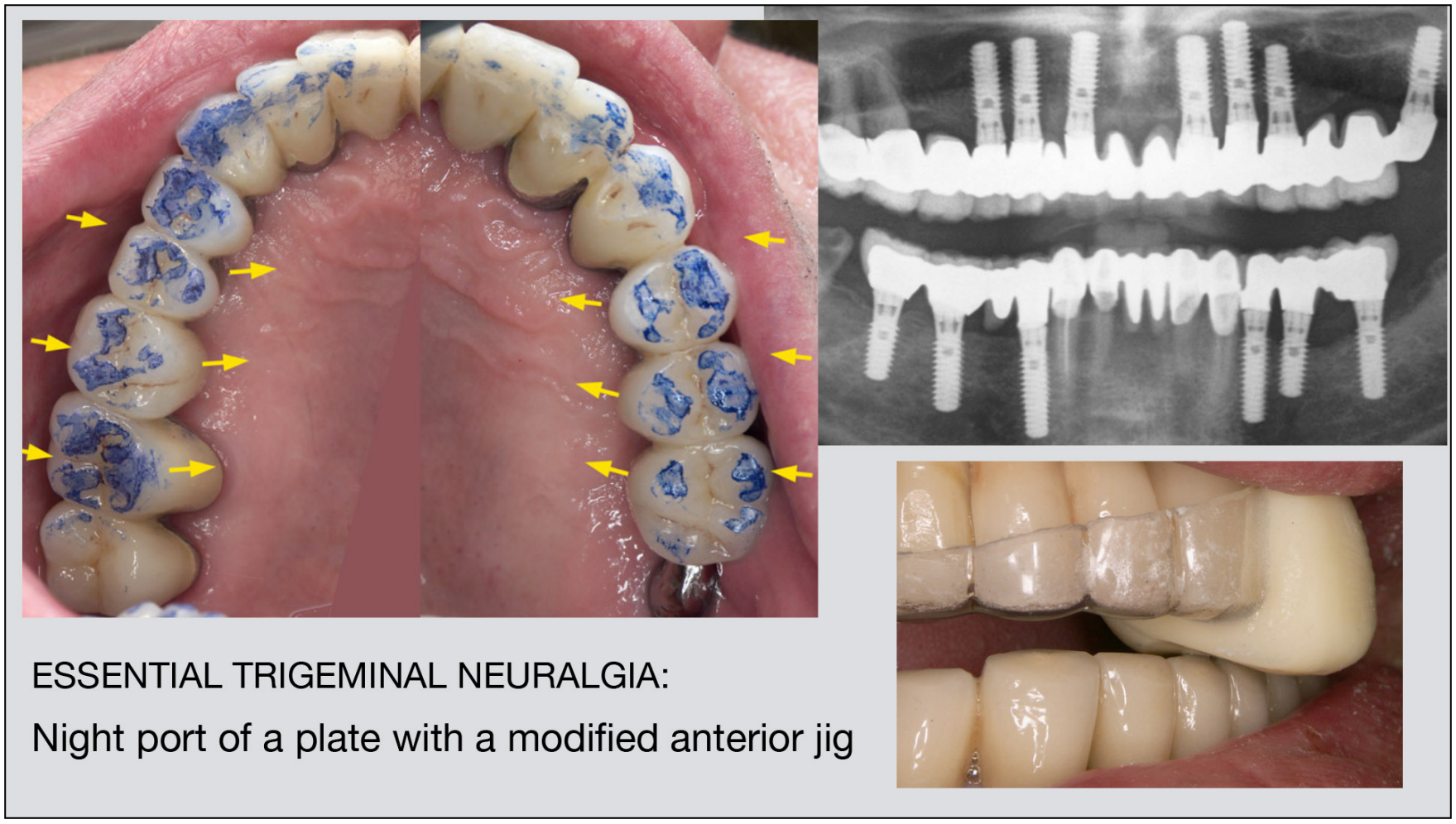


Figure 5-33: See figure 5-6

OCCLUSAL FUNCTION ON IMPLANT PROSTHESES

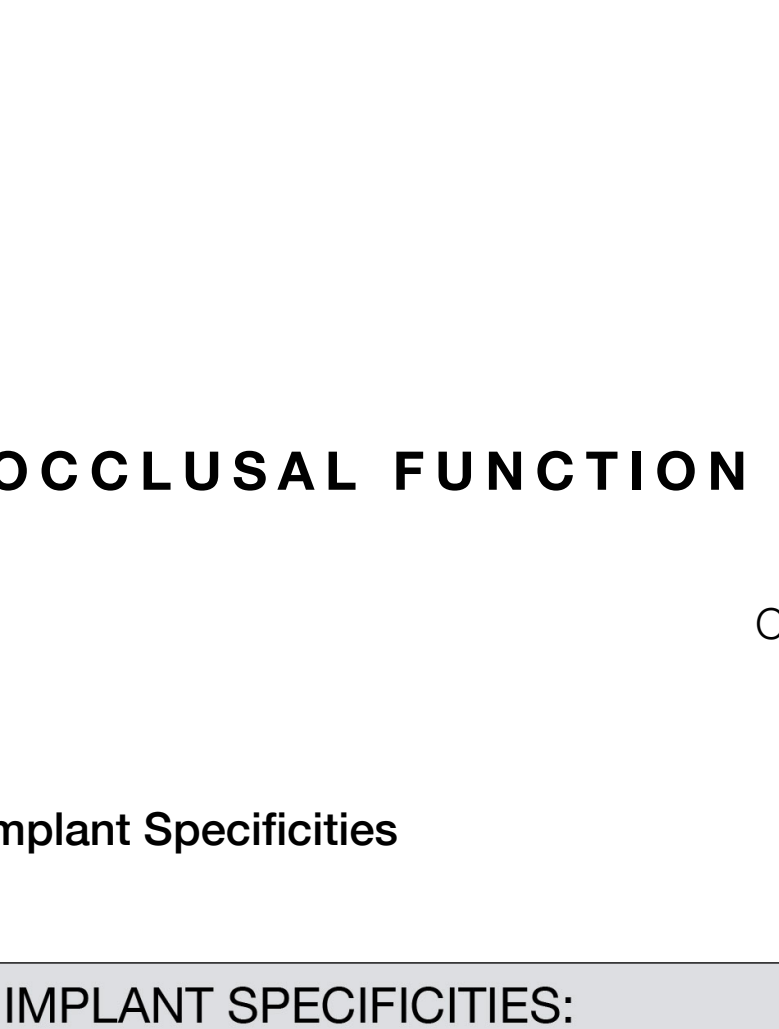
Chapter 6

Implant Specificities

IMPLANT SPECIFICITIES:

Lack of periodontal ligament: reduced mobility

Implants and extended fixed restorations: none or very reduced clinical mobility.



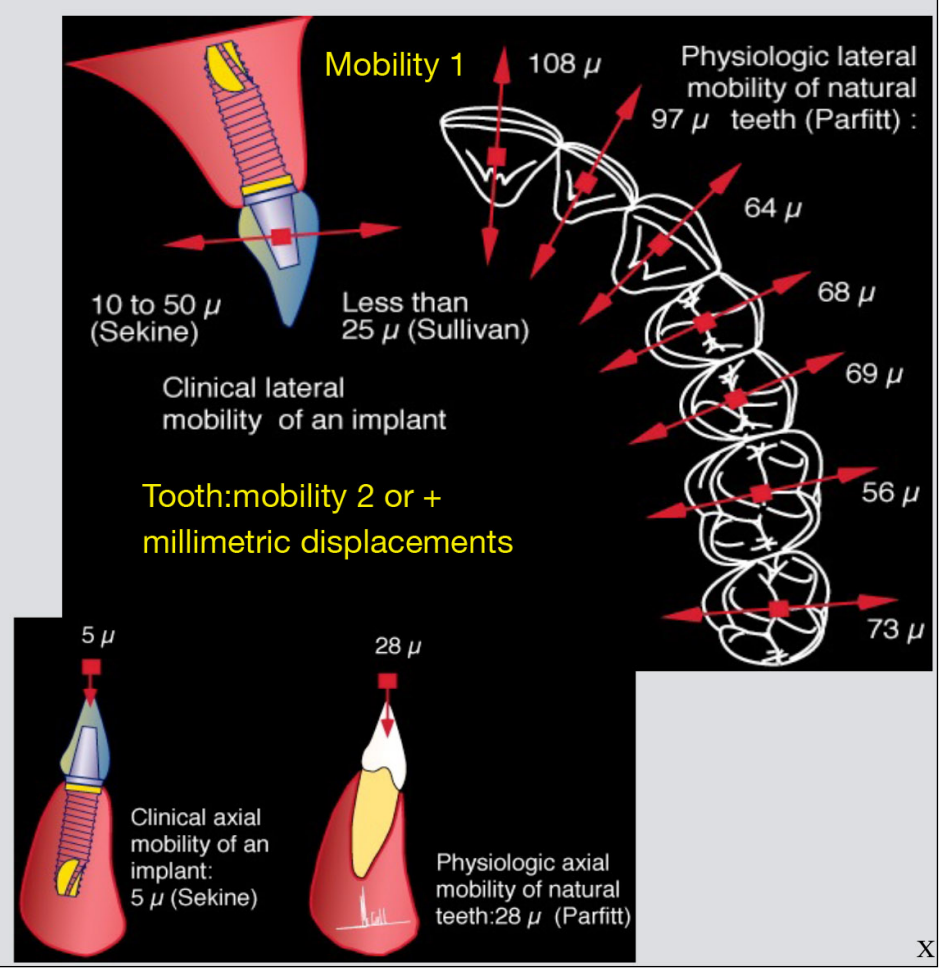


Figure 6-1: The viscoelastic behavior of the ligament of a tooth, allows a two-stage response to the occlusal load. In a first phase weak forces can cause more or less displacement, within the limit of the clinical mobility of the tooth. In a second phase, in direct support on the bone, it takes large forces to cause a small displacement, because it is only the elasticity of the bone that allows movement. It is quite different around an implant where the absence of ligament leads to a direct linear response to the load (Sekine 1986) as in the second dental phase. The elasticity of titanium associated with the application of large forces on small diameter implants can quickly become critical for crestal bone.

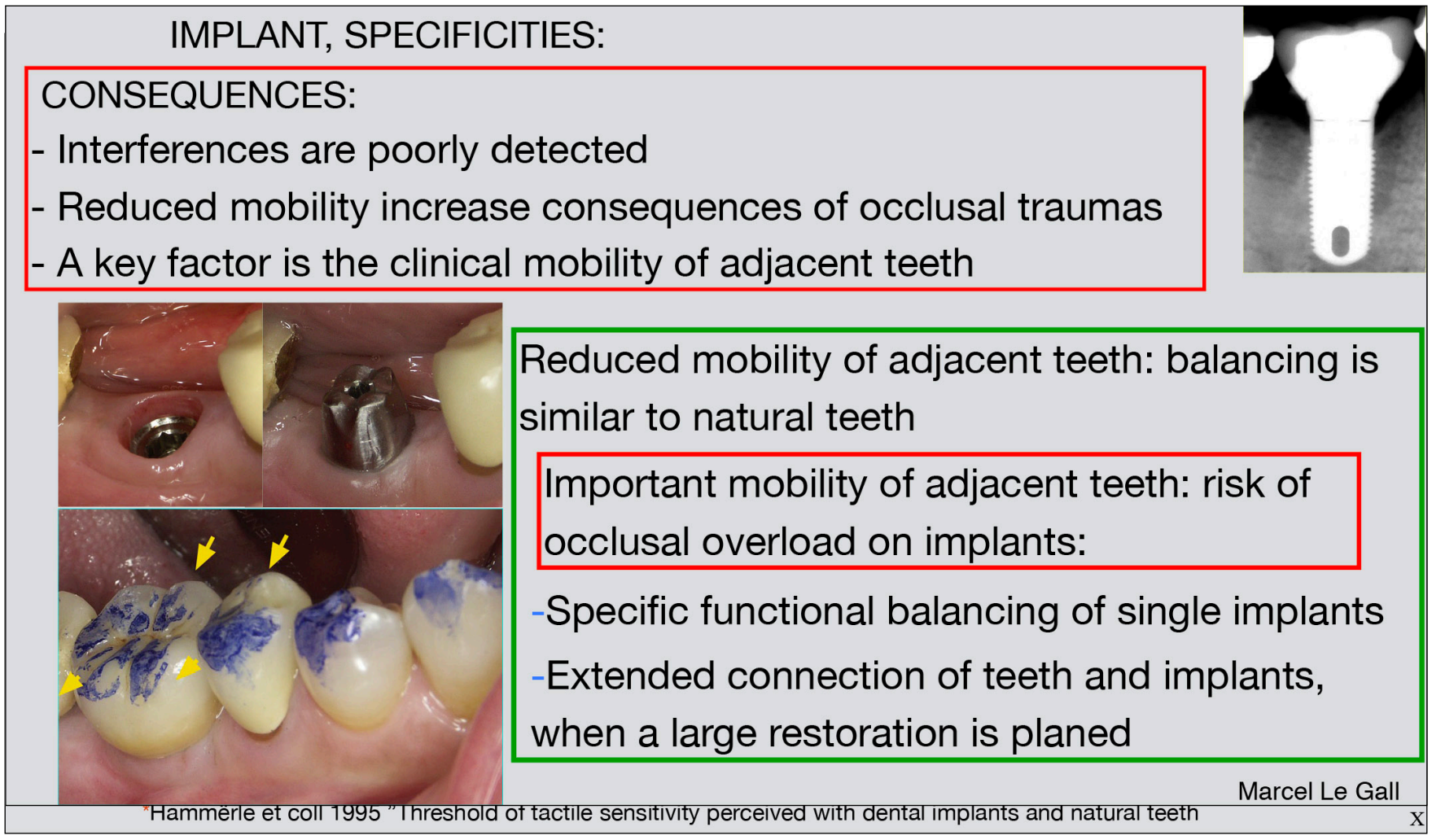


Figure 6-3: The contacts and guides that were initially non-dominant on the implant, are found completely balanced with the neighbors during the following controls (Le Gall and Le Gall 2016) due to the natural wear of neighboring and antagonistic teeth. The functional balance is maintained then. In the presence of significant mobility of neighboring teeth, it is the extensive prosthetic connections, the prosthetic geometry and the functional balance that are the keys to the durability of the whole.

- Compared to natural Spelling of neighbouring teeth, the lack of ligament around implants, reduces their clinical mobility. The implants, like the extended fixed restorations, have a very reduced clinical mobility. And the motionlessness amplifies the consequences of occlusal traumas.
- The clinical mobility of neighbouring teeth is an essential key. If their mobility is reduced, the equilibration is similar to that of natural teeth, provided that osseointegration and bone adaptation have already been achieved. If this is not the case, the contacts and guides should not be dominant at the start. In case of doubt, it is possible to interpose and slide between the implant and its antagonist an occlusion film of 15 to 20µm. The contact will be gradually restored few months later with the natural wear of the opposing teeth and neighbouring (about 40µm per year). On the other hand, if the mobility of the neighbouring teeth is important, there is a high risk of occlusal overload on the implants, with the need to make a specific equilibration of the embedded implants (occlusal film doubled or thicker), or the obligation to make an extensive restraint, to limit the mobility of the whole.

- The tooth and the cortical bone have the same Young's modulus (hardness), while that of titanium is 5 to 10 times greater (Lemons and Philips 1993). Titanium is stiffer, but more elastic than the tooth (like a waking spring). The absence of a ligament causes a direct response to the occlusal load (Sekine et al 1986). On a complete arch, the contention effect allows the distribution of the mechanical load. But on a unitary implant, the response to transverse and oblique mechanical loads is the presence of a large stress zone, concentrated around the peri-implant bone crest (Kilamura et al 2004). Its importance depends on the ratio between the section and the length of the implant which determines its transverse stability and its immobility. It is essential to avoid long implants of small section.
- At the end of the first year of loading, the radiological measurement of bone loss shows that it has a contour similar to that of the zone of maximum tension (Kilamura et al. 2004). The bone loss observed in the studies and considered normal, directly involves the way the loads are applied to the teeth, which depends on the occlusal concept. These results were obtained by applying the concept of canine protection, which proposes to prevent contact between the posterior teeth. If this model were effective, there should be no stress zones around the posterior implants. Out there is stress and bone loss, so there is no canine protection, because during chewing the posterior teeth get closer to the contact. But there are malocclusions between the teeth of the triturating side, on occlusal faces that have never been coordinated and balanced to chew together. This is what we observe regularly by simulating chewing on such occlusal surfaces, and totally invalidating the theoretical concept of canine protection whose alleged demonstration was only made on an articulator with simple hinges (d'Amico 1958).
- But other causes may also be responsible for primary or secondary bone loss, such as: septic exudates from the leak-free micro-gap (abutment, screw-retained crown), the multiplication of surgeries (Misch et al., 2005), bio-corrosion, and infection. However, by applying the functional model, on implants whose connection is tight or supra-gingival, on the contrary, we observe an increase in the level of peri-implant crestal bone (Le Gall 2016).
- Therefore, when choosing an implant system, our goals are first to select an implant eliminating or minimising the risk of infection and able to withstand transverse dynamic forces whose intensity must be controlled by the fine equilibration of chewing. This is not the case for prostheses balanced according to the standard model, which seeks to prevent the posterior contacts to avoid having to balance them, but who does not succeed because the human TM-joints are not simple hinges.

So peri-implant crestal bone loss, described classically, is it of infectious origin or mechanical origin?

We will provide a more elaborate answer to this question.

Occlusion and Implant Protocols

Depending on the clinical cases and the implant system:

- Some of the prosthetic protocols are identical to those of natural teeth (DVO, inter-maxillary relationship, classical or digital impression …),
- Some must be changed (adjustment of the static and dynamic occlusion …),
- Others are different depending on the system (management of implant components, type of implant / abutment connection, trans-screwing, sealing …).
- The implant systems follow protocols ranging from the simplest to the most complex, within some cases the use of a large number of expensive components, without there, being an obvious relation to the quality level of the results.

Simplicity must be preferred: it is faster, more efficient and less expensive.

From the realization of a fixed provisional complete restoration, immediately after the insertion of the implants, the different clinical stages will be developed.

The initial occlusal equilibration is limited to obtaining immediately after the placement a maximum of simultaneous contacts in MIO, which must be of the same intensity and well distributed on the arcade. It seems difficult to do more, without lengthening the session excessively. Patients are advised a hard diet for three weeks, avoiding the implanted area on small restorations. Later, on the permanent prosthesis, the occlusion will be balanced during chewing and swallowing, with progressive loading.

The stages of occlusal adjustment on the permanent prosthesis start with the choice of the vertical dimension and the recording of the intermaxillary relationship using anterior jig and the optimal position of the tongue, on the frame of the bridge.

The natural position of MIO occlusion is used more than 1000 times a day during swallowing. This position is an occlusal wedge that allows triggering of the peristaltic swallowing wave that transfers the bolus to the stomach.

In addition to facial and morphological aesthetic criteria, the choice of the vertical dimension can be simply determined from phonetic pronunciation tests of the S, associated with the

Spelling of centre - must be centre

realisation of several deglutitions with the tip of the tongue in anterior palatal support. It is a jig made on the frame that will then ensure vertical rigging. It is gradually adapted to the height of the vertical dimension retained in swallowing position. This position must preserve a free space, even minimal, between the rest posture and the contact on the jig during swallowing. The jig is then used to record the mandibulo-maxillary relationship between the posterior teeth.

For a fixed restoration, the recording of the inter-maxillary relationship obeys a very precise protocol. Several types of recording materials can be envisaged, but it is preferable to use two strips of Moco® wax, softened in hot water, to the consistency of soft butter. The patient must close slowly without any resistance of the wax and without any pressure of the elevating muscles to obtain the exact position of the mandible. If the recording material, which is too hard, has a resistance to closing, the prosthesis will be in supra-occlusion posteriorly. If the closure is performed under muscular pressure the prosthesis will be in posterior infra-occlusion.

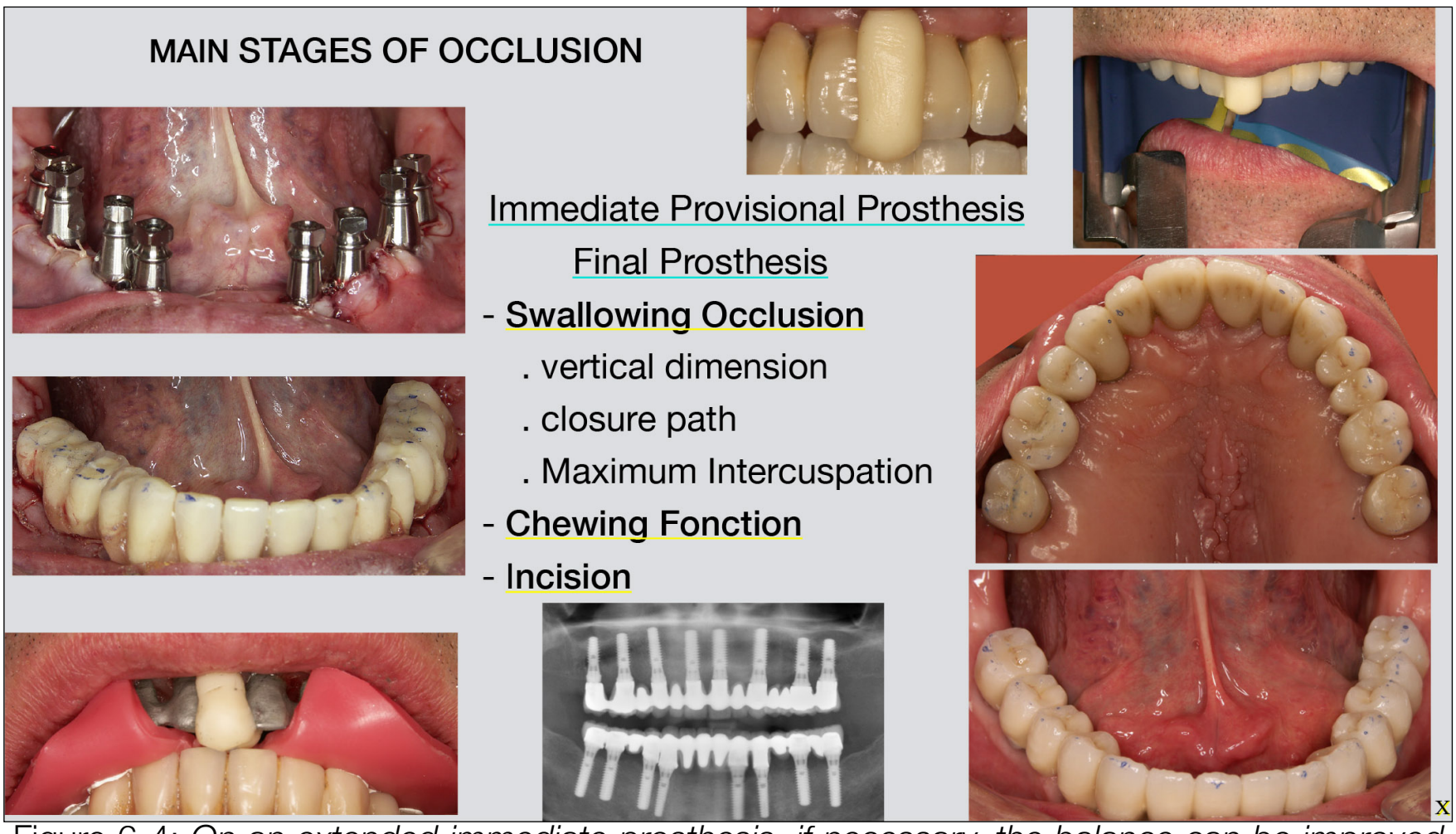


Figure 6-4: *On an extended immediate prosthesis, if necessary, the balance can be improved in the following appointments. The steps of the protocol to be followed for the final equilibration are summarized in the center of the figure. They must be followed in this order. Use two strips of wax simultaneously to record the inter-maxillary relationship, to allow the tongue to move easily to the palate. The use of a wax sheet through the palate does not allow the tongue to take its optimum position against it. And in this case the inter-maxillary relationship is inaccurate*

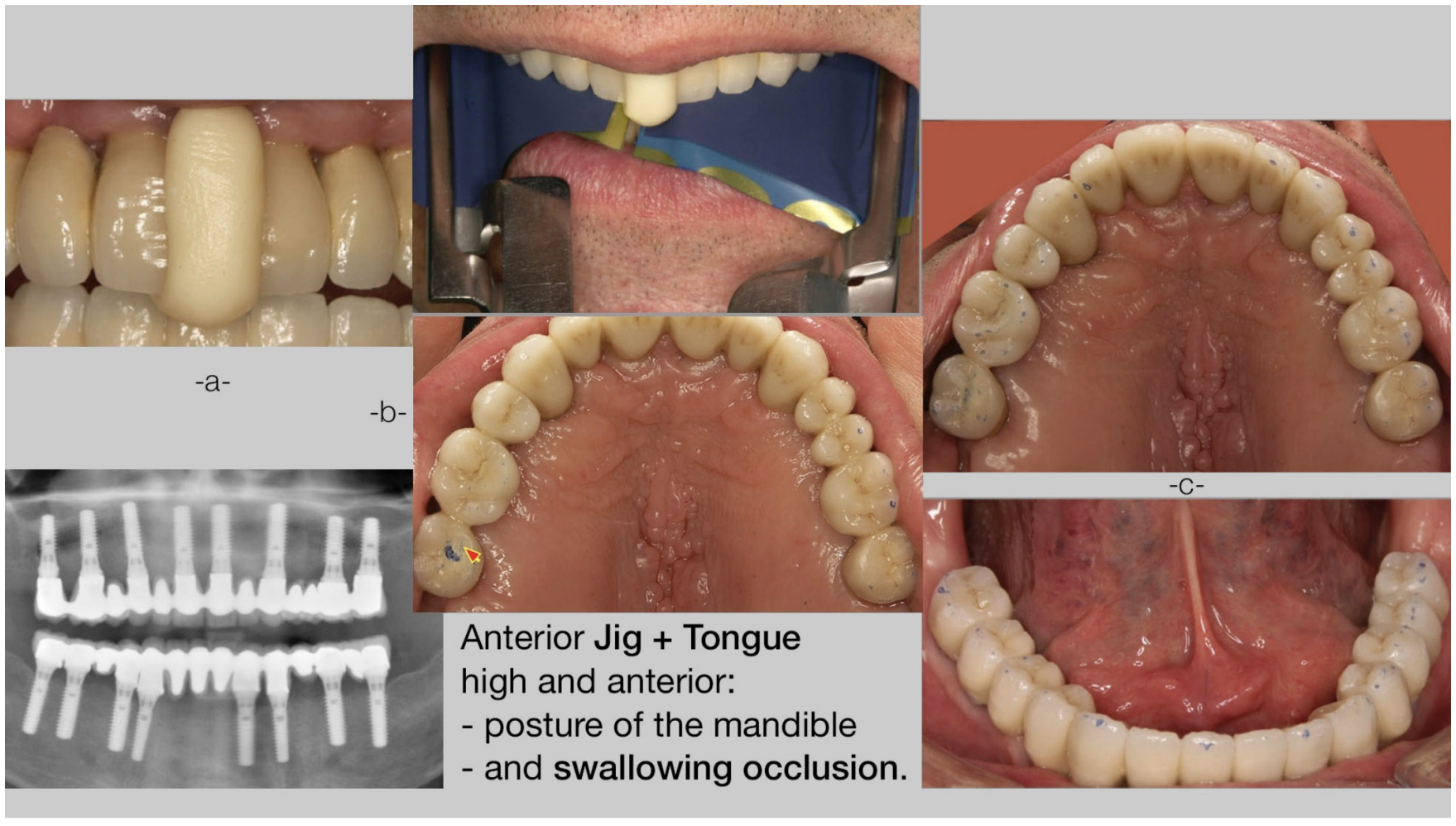


Figure 6-5: *The colored occlusion film should be placed simultaneously on both sides. If it had been placed only on one side it would have resulted in a displacement of the mandible towards the side where it would have been placed.*

Coloured spelling

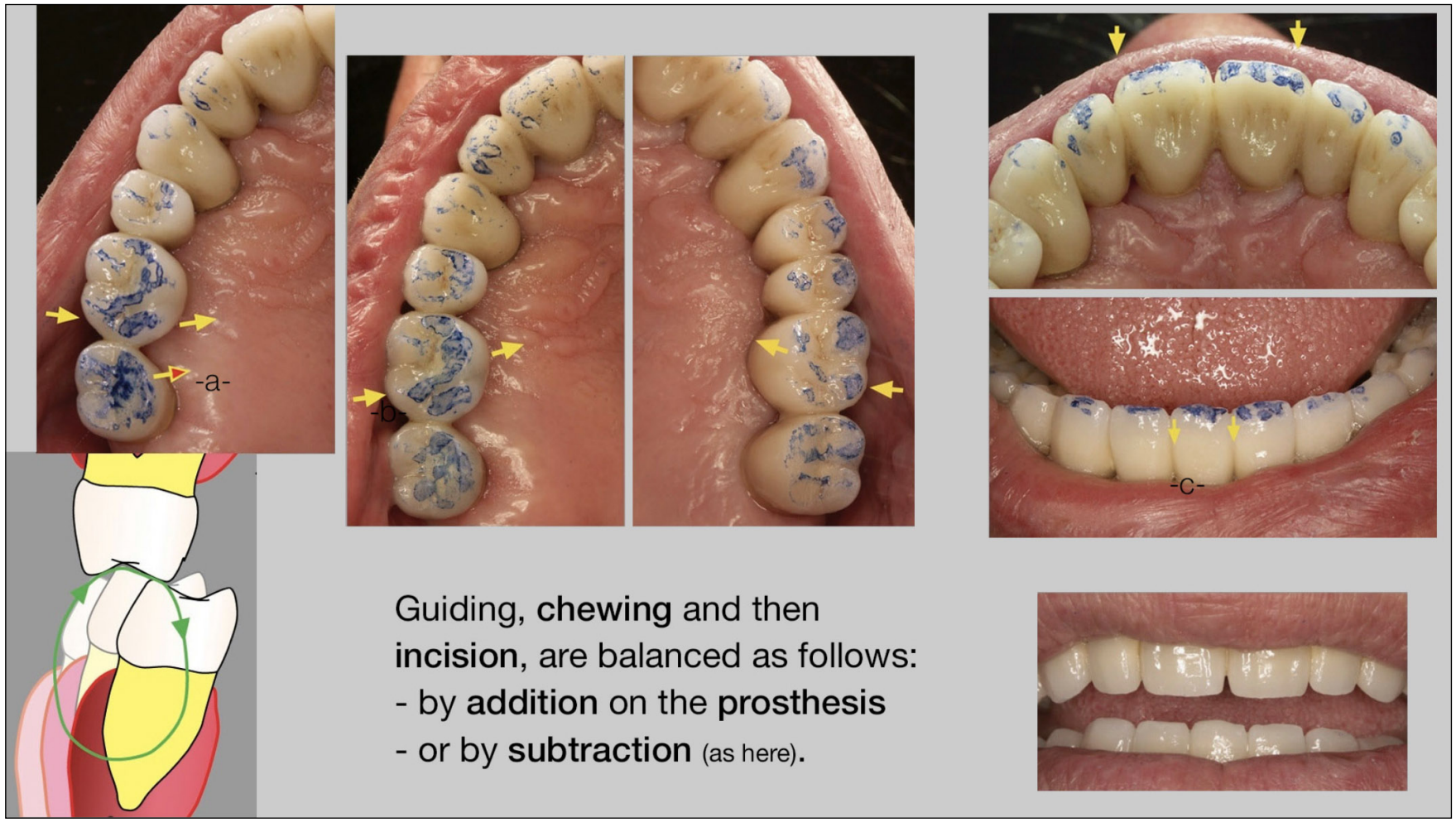


Figure 6-6: -a- small correctlon to do on M_2. *Corrected surfaces must be carefully polished. The treatment of this case is finished.*

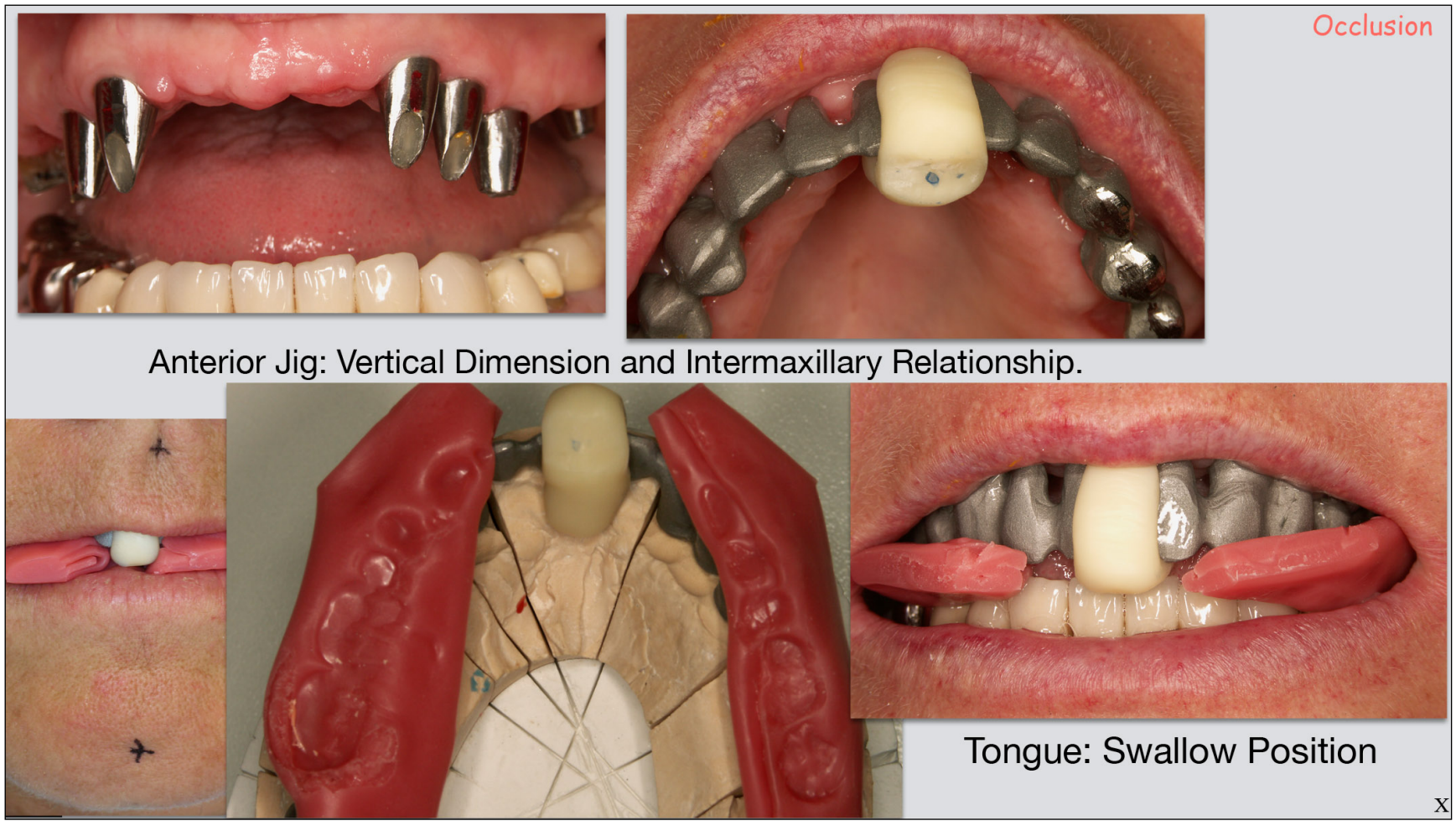


Figure 6-7: *After an approximate approach and tests based on the pronunciation of "S" and swallowing on the proviisonal prosthesis, the final choice of the VDO is made on the frame, performing similar tests.*

Provisional spelling

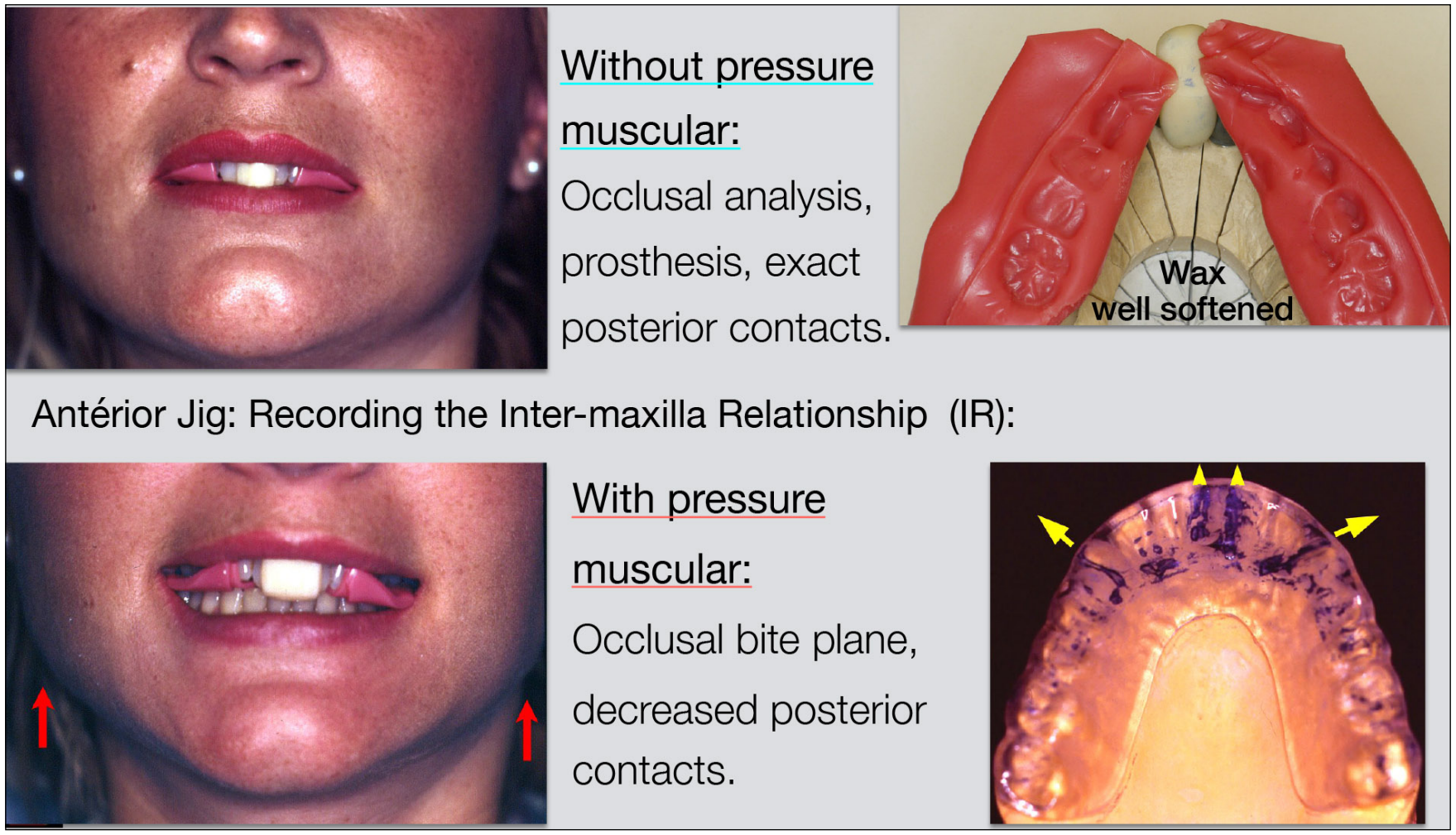


Figure 6-8: *Specific Silicone occlusion materials can be used for recording. But be careful, because these materials are very accurate and if residual bubbles persist on the opposite model, the recording material will not position correctly on this model.*

The use of wax is preferable because it adapts better to the micro bubbles or slight defects of the impression. The hard and brittle wax should be placed in water at about 30°, to avoid fracture, before being repositioned on the model.

On a complete fixed restoration, tongue protocol and jig is relevant to determine the vertical dimension and the registration of the mandibulo-maxillary relationship. When the vertical dimension is determined, its simultaneous recording with the inter-maxillary relationship is achieved using the jig and two side bands of Moico® wax. When setting up the restoration the tongue-jig protocol is again used to balance the swallowing occlusion. A deflecting supra contact is detected on the second maxillary right molar. It is carefully removed by light subtraction, respecting MIO. The swallowing MIO is now well balanced (right figure).Chewing] will now be tested using occlusion film. An over-guidance of cycle exit is visible on the second maxillary right molar (left photo a). it is carefully eliminated. In the central photos, the guides are now well balanced for chewing on the right (b) and left (c) sides. The last step is to check the incision which is well balanced, with a reduced overlap. The technician who did this work was well aware of functional occlusion. There were very few corrections during the placement, which is very rare ...

Implants: Guidelines for Occlusal Equilbration

In the presence of a complete fixed restoration, on implants connected, the rules for occlusal balancing are identical to those of natural teeth. Because of extensive restoration, the rigid connection allows sharing the occlusal load on the entire prosthesis, while reducing or eliminating the consequences of overhangs and cantilever, on the bone of the underlying implants.

But when natural teeth and implants coexist on the same arcade, there are two main problems:

Firstly: the implant has no resilient ligament like teeth, in these condition, the usual balancing protocol, when the implant, is osseointegrated in a well adapted bone, is as follows:

– with light occlusal pressure : the contacts on implants must be lighter than on natural neighbouring teeth

– with stronger occlusal pressure : swallowing and chewing contacts and guidances must be well balanced with natural teeth.

When an implant is osseointegrated in a good quality, or cortical bone, it is reliable to support and share all of the functional forces without any restrictions.

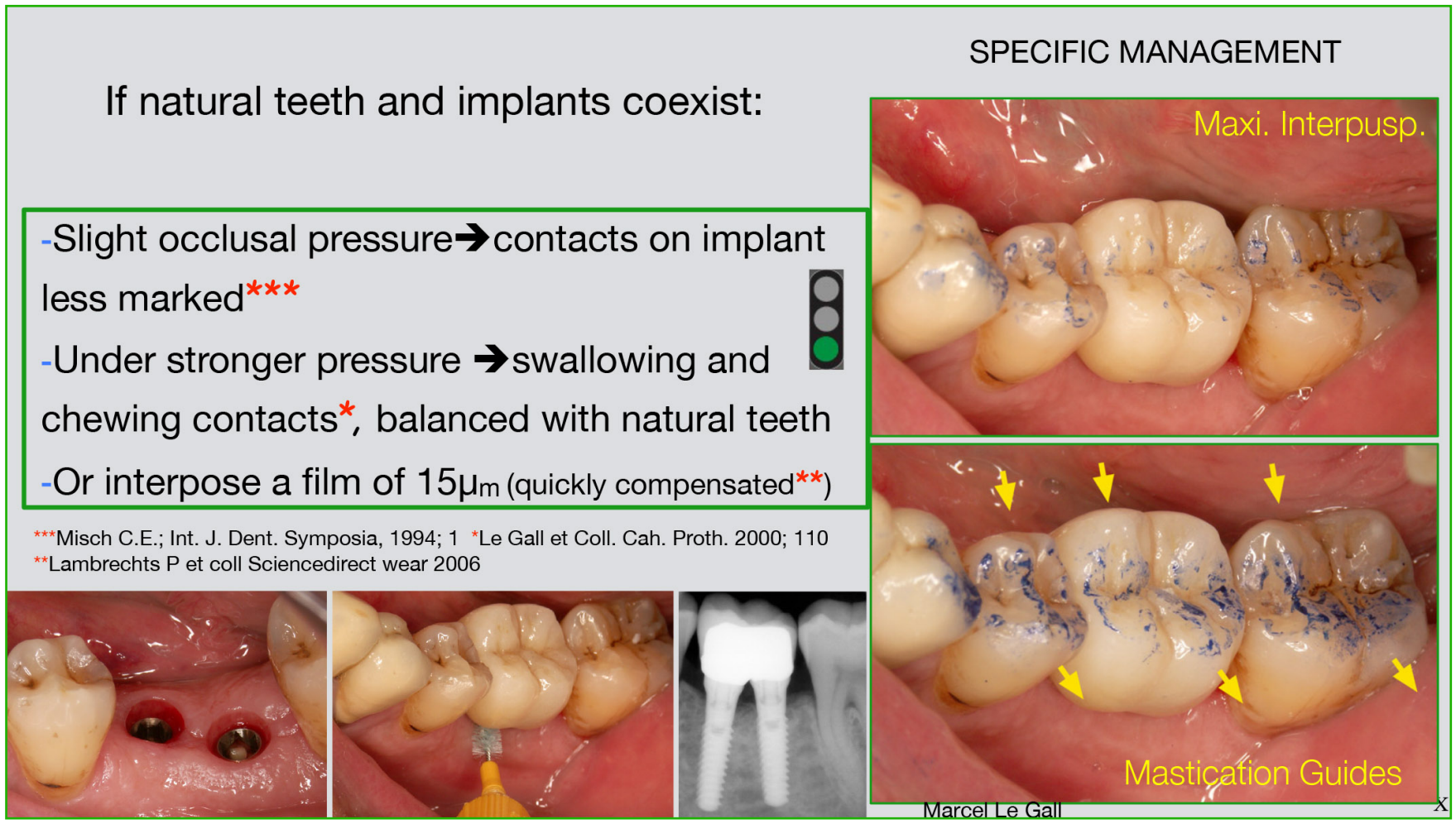


Figure 6-9: *When an implant is osteo-integrated into a cortical bone or of good quality it is able to support and share all the functional occlusal forces with the neighboring teeth. This is not the case at the time of first loading and equilibration in a bone of mediocre and unsuitable quality. The protocol to follow is different.*

This procedure should take account of the existing natural adjacent teeth mobility for each patient. If natural teeth have a great clinical mobility, it may be necessary to make extensive connections and/or to connect rigidly teeth and implants, or to treat as below:

Secondly: at the first balancing of an implant, in a non-adapted or poor bone quality, the aim is to have only light stimulation forces to favour rapid bone adaptation, without any uncontrolled overloading, possibly contributing to bone loss.

Taking into account the natural wearing of teeth, this result can be obtained when at the end of balancing, 1 or 2 layers of thin coloured film, so 20 to 40µm, can slide between the implant and its opposing tooth. The thickness of the film depends on the clinical mobility of the adjacent and opposite teeth and It may need to be more than 2 layers in some cases.

Excluding pathological (toothwear) habits (like bruxism), and from biocorrosion, enamel “physiological” wear rate has been measured at an average loss on molars of 122µm after 3 years (Lambretch et al), which represent 0,4mm on 10 years, and a 2mm loss of vertical dimension on a life period of 50 years. It’s not negligible, but it’s more important, in parafunctional habits like bruxism or when biocorrosion is present. When these loss concern all the arcades they are not compensated by an extrusion of the teeth (continuous growth is not

Spelling neighbouring

PLURAL RESTORATION ON IMPLANTS:

The usual techniques use the protrusion and laterality movements to balance occlusion:

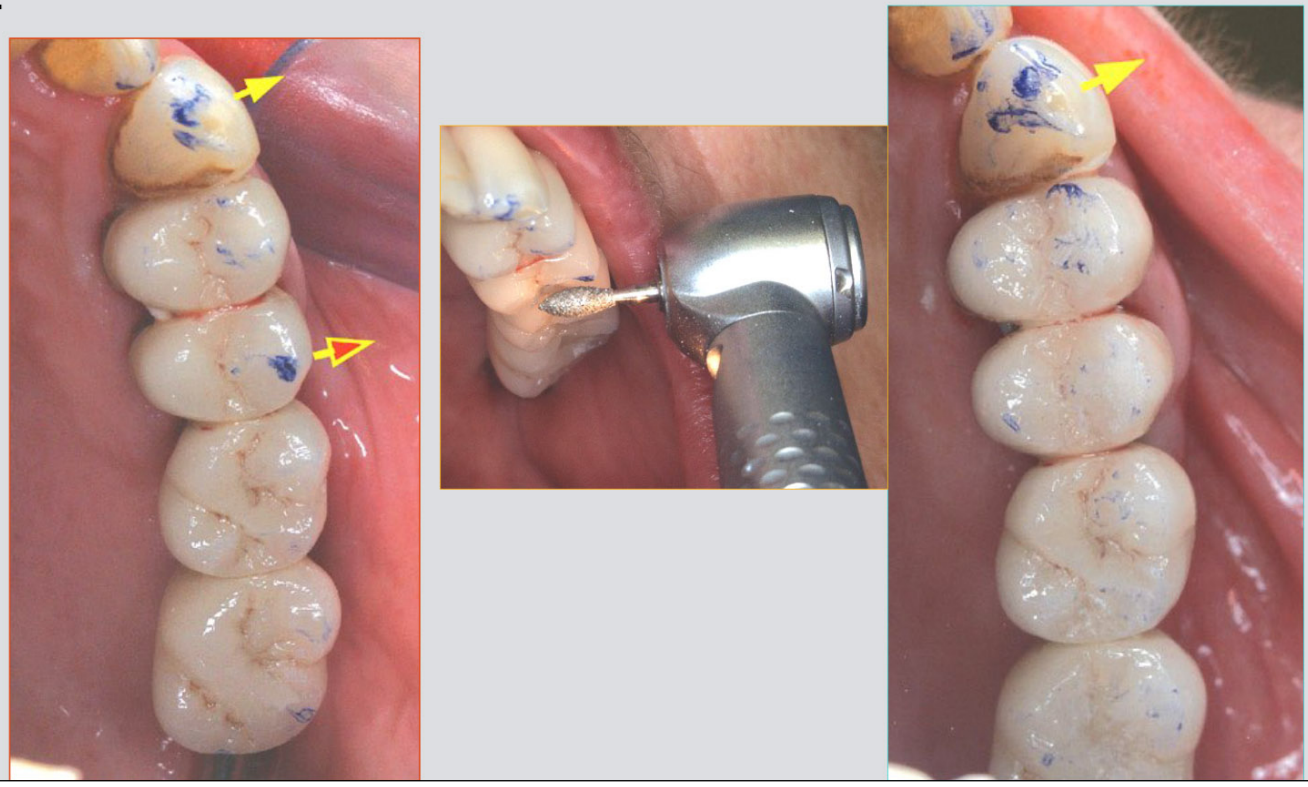


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Figure 6-10: *During laterality movement, only a limited part of the functional envelope is checked. A only big interference is detected and corrected A theoretical rule has been respected ….*

PLURAL RESTORATION ON IMPLANTS:

It is therefore very common to forget malocclusions chewing guidance and incision..
Cuspid protection is ineffective during real fonction. (Le Gall 2018).

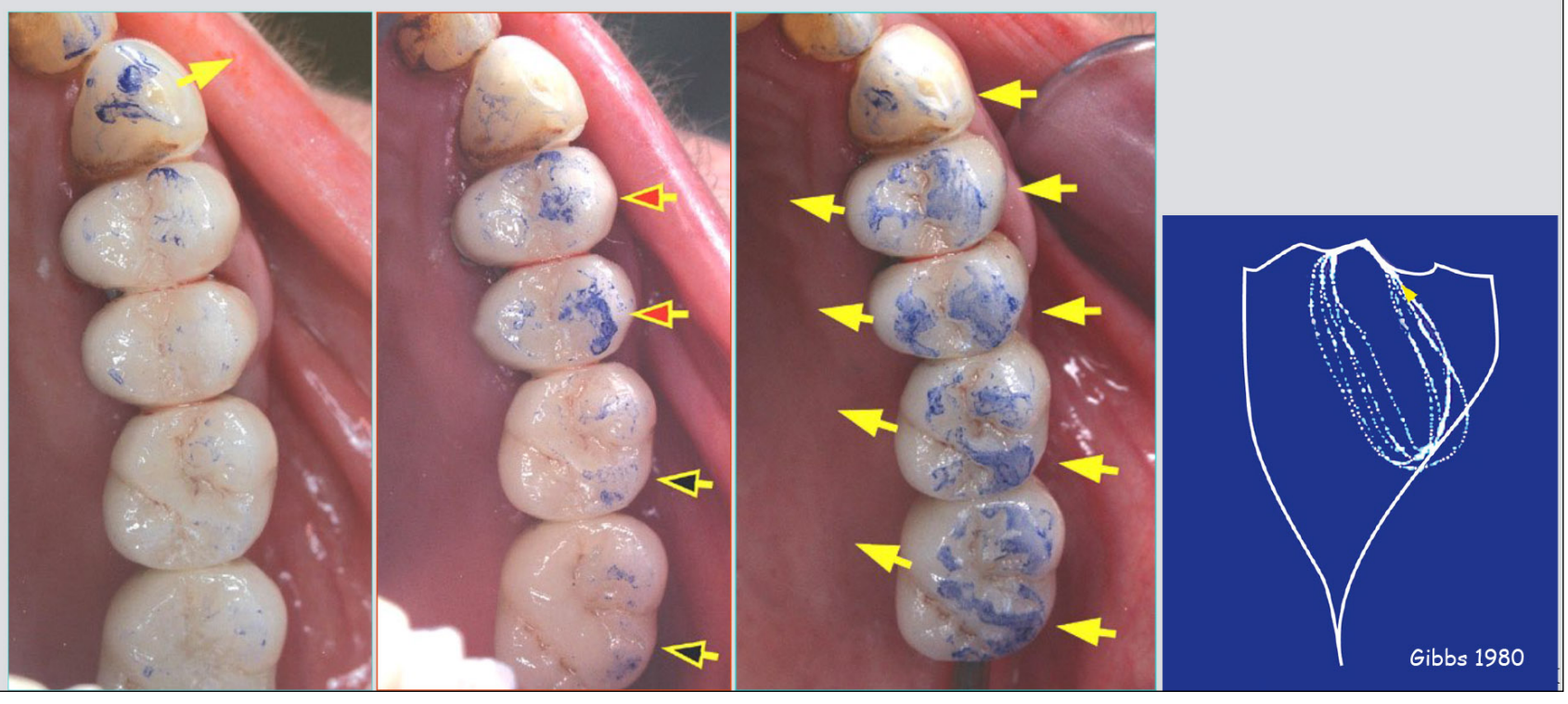


Figure 6-11:*…but in fact, the functional guidances are not balanced. Only the chewing simulation, allows to reveal and balance functional envelope, revealing overguidances that can be corrected by subtraction (like in this case) or infraguidances that must be corrected by addition and need a come back to laboratory. Unfortunately the classical articulators have not the ability to reproduce chewing cycles kinetics, and the final adjustment must be done in the mouth of the patient. When balanced, the cycle found again its optimal pattern and not any overloads are transferred to the peri-implant bone, but only positive stimulations.*

existing in human teeth). When a natural tooth has lost its antagonist, it will over erupt progressively, with all of its periodontal and alveolar tissues. An arcade in occlusion with permanent occlusal stimuli don't react in the same way. We know that augmentations of the vertical dimension, even moderately (lower than 5mm), are followed by an intrusion of the teeth, but will not return to its original situation. It is then highly probable that, during slow and progressive wear, there are neither teeth extrusion, nor intrusion.

Referring to natural wear, the fact to balance an implant restoration with very light occlusal contacts and guidances, allows generally to observe during the following year, a progressive return of balanced occlusion, by the natural wear of the opposing teeth, and may be a light displacement of the opposite (ligament adaptability). This procedure allows a progressive loading and an adaptation of the peripheral bone implant , without any risk of overload.

The follow-up of occlusion has allowed to observe routinely this progressive return of occlusion, in parallel to the bone reinforcing (next chapter), so supporting the validity of the procedure.

On this fixed implant restoration, classical lateral movement allows to see an interference on left second bicuspid (Fig. 6-10). After correction, classical occlusal balancing is finished, because during laterality movement only the cuspid guidance is visible (Fig. 6-11).

However, a chewing function test (center) shows totally uncoordinated and traumatic occlusal guidance. The cuspid protection (left) is not efficient during chewing function. Right picture shows coordinated guidances after balancing. Occlusal forces on implants are now well shared and not traumatic.

Functional Occlusion and Peri-Implant Bone Level Evolution

The aim of this article (Le Gall and Le Gall JPIO 2016) is to try to assess the impact of the load or the occlusal overload on the level of the peri-implant bone. It was first necessary to remove at best all the risks of infection around the implant and to compare the capacity of key concepts occlusal to balance and get atraumatic occlusal surfaces on implants.

Then from two lines of implants, of same concept, to make a comparison of the evolution of the peri-implant bone between a group balanced canine protection and a second group balanced by simulating the actual chewing function. In order to know if there is really a correlation between the occlusal concept applied to an implant prosthesis and evolution of

peri-implant bone level. (link to download the article: https://univoak.eu/islandora/object/islandora%3A77291)

Occlusion and Bone Loss on Natural Teeth

For occlusal schools bone loss can only be infectious, but can also be caused by a single traumatic occlusion. This statement is presumed but not actually proven.
For the Swedish School of Periodontology bone loss is still infectious. Occlusion is reduced to the role of cofactor.
In periodontology, the role of occlusion in bone loss on natural teeth was discussed and challenged and ultimately brought to an infectious aetiology, by the fact that polymorphic microflora is always present in the mouth and around the periodontal tissues and has a key role in bone loss. It was concluded that the natural teeth in the presence of a premature contact, there was always a microbial flora that was the primary aetiology of bone loss. In fact this flora can be physiological or pathogenic and the host response is of paramount importance in the

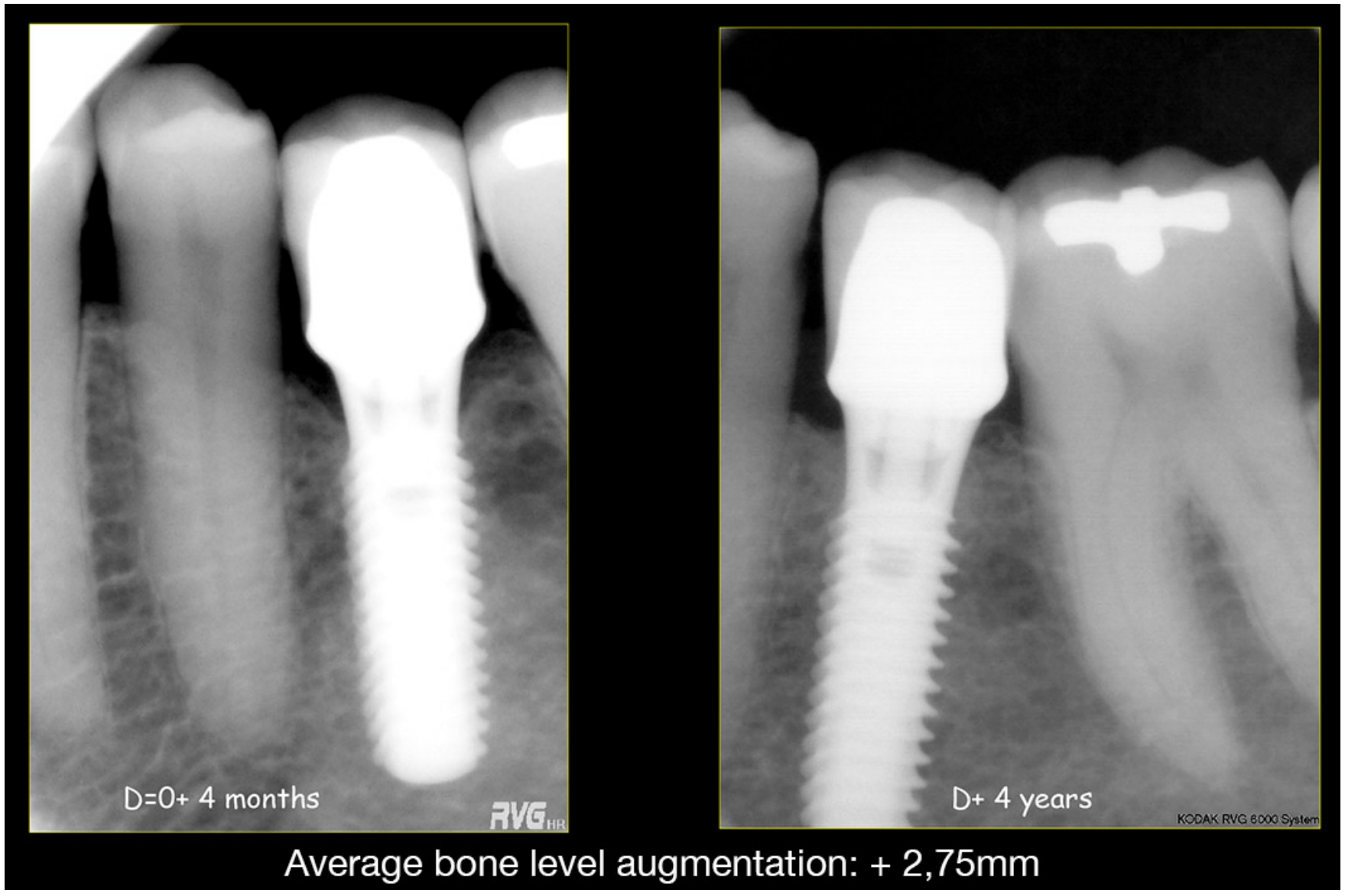


Figure 6-12: *A single implant on a lower second left bicuspid, showing an increasing bone level of 2,75mm, 44 months later. That is exceptional*

installation of an infectious process or not. Practically, until now, it has not been possible to prove that around a tooth, the presence of a suspected bone loss of occlusal origin, could exist in the absence of germs.

Occlusion and Bone Loss on Implants

According to implantologists, there are two possible local aetiologies to explain the peri-implant bone loss:

The first is infectious, as peri-implantitis reported or not the surface condition, the presence of permanent micro-gap responsible for infectious exudates, peripheral sockets … may be

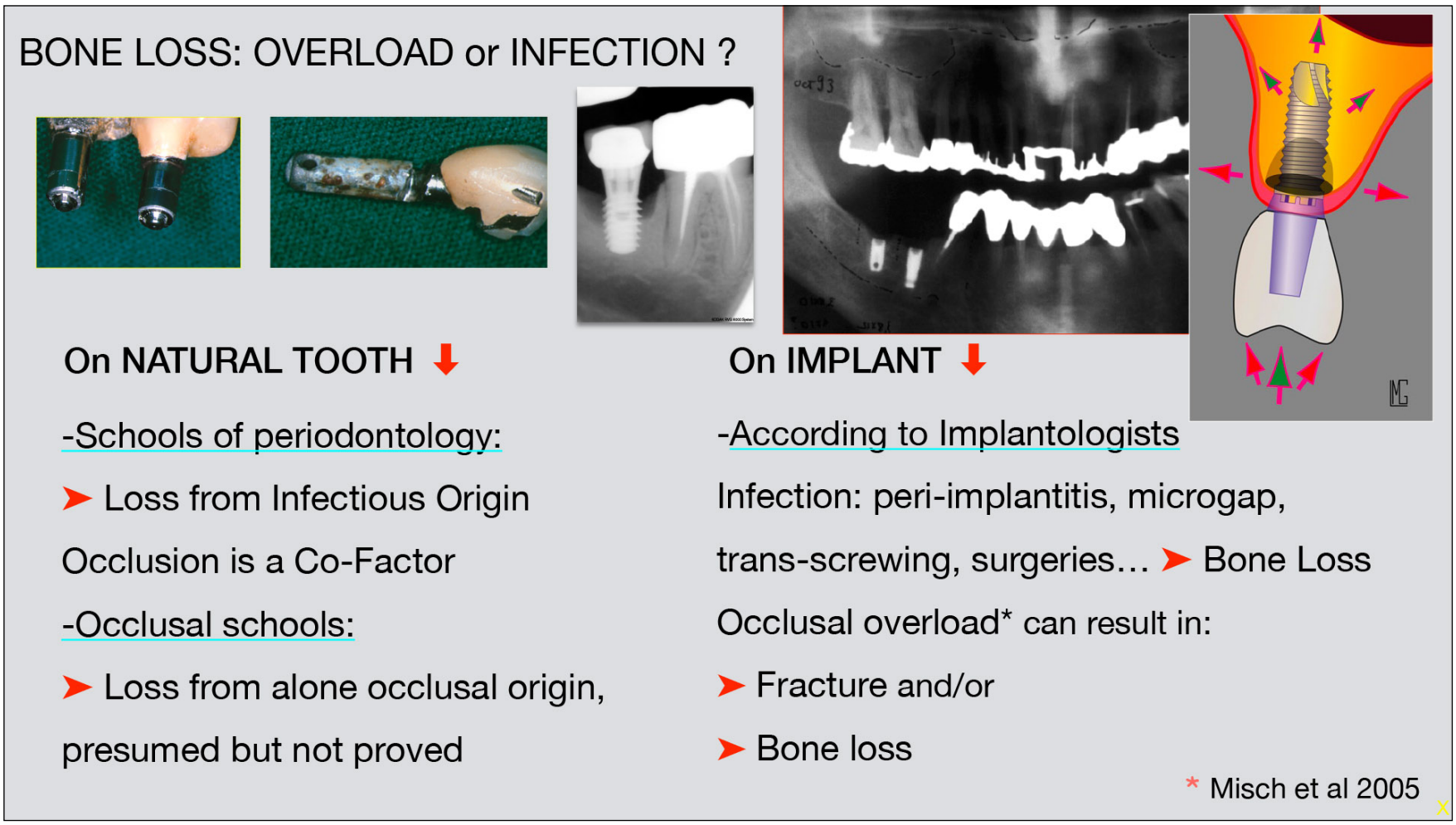


Figure 6-13: *In implantology, generally, a bone loss lesion in basket shape, is related to infectious origin (central X-ray), when a bone loss in V form is related to occlusal overload (Fig 8-86, left lower X-ray)*

responsible for bone loss.

The second is the presence of occlusal interferences and overloads that may be solely responsible for the fracture of implant components and / or bone loss (Misch et al 2005, Chiba and all 1993 Frost 2004), because the absence of mobility and avoidance mechanisms, amplifies the consequences of malocclusions that could be associated with bone loss resulting from occlusal overloads on poorly balanced occlusal surfaces.

Studies show that loads of moderate intensity applied to the bone (total hip arthroplasty, orthodontics treatment, implantology) can cause bone loss, even in the absence of infectious

germs (Chiba et al 1993, Frost 2003). Other publications show that low forces can stimulate and induce bone remodeling (Cowin et al 1991, Frost 2004). Misch (2005) found a direct relationship between occlusal trauma and bone loss around dental implants.

In, implantology, basket-shaped bone loss is generally related to an infectious origin, whereas V-shaped bone loss is often related to occlusal overload.

Prerequisites for a Study on Bone Loss or Gain Around Implants

The prerequisites for such a study is first to compare the levels of bone around implants of similar emergence profile and concept. The selected implants must have specific features and

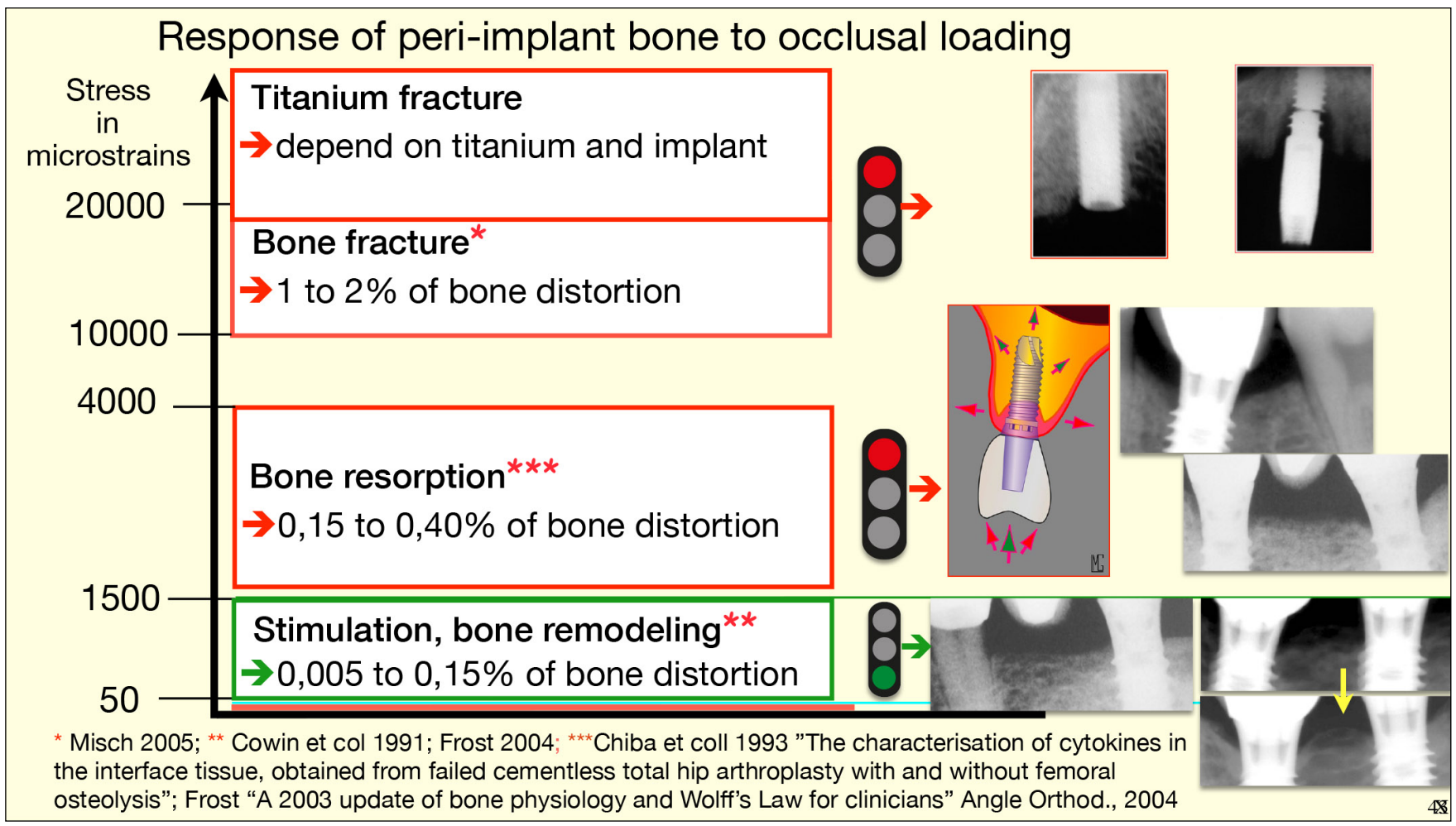


Figure 6-14: *In implantology forces exceeding 1500 microstrains (mst) can be responsible only for bone loss and those exceeding 10,000 to 20,000 mst may be responsible for bone fractures and implant components. Between 50/100 mst and 1500 mst there is stimulation and bone remodeling and below 50/100 mst, there is no longer any stimulation, therefore bone atrophy.*

protocols of use that allow them to withstand and dissipate harmoniously chewing forces (Le Gall et al 2005), while eliminating the risk of infection to the best that can cause bone loss whose origin is not mechanical. In particular, all contributing factors mucositis and peri-implantitis, which can be related to:

➤ The surface condition of the body and the emergence of the implant neck and shape:

- In prescribing surface-processing too rough and porous, in the bone area of the implant neck. The surface condition of an implant depends on the scale at which it is observed, it is a fractal (Mandelbrot 1973): the more it is magnified, most irregularities occur. The balance of the microstructure must allow good bone attachment while controlling the risk of bacterial colonisation.
- By favouring on the neck of the implant at the transmucosal level or bone level, a machined surface but not polished as a mirror, , excluding rough and porous surfaces.
- By choosing an emergence of simple form which is easy to ensure hygiene by the patient and allowing optimal aesthetic results (watch mode effects of prosthetic components of complex shape whose effectiveness is questionable).

➤ The lack of stability and seal of the abutment-implant interface, by using:

- An internal connection, strong, waterproof, by morse taper or related, so without any micro-gap at bone or biologic space level, responsible for bacterial contamination, away from any means of hygiene, and subject to bio-corrosion (Ektessabi, Mouhyi et al 1997).
- A remote connection of the bone by a transmucous neck (it could be suppressed now, by using a monobloc implant).

➤ The leaking of the prosthetic connection:

- Avoiding screw-retained prosthesis, with a non-functional unsightly screws on the occlusal face and whose prosthetic limit is subgingival and not waterproof, like for abutment. Bio-corrosion is present in the micro-gap (Ektessabi, Mouhyi et al 1997) and toxins leakage is also responsible for a permanent contamination of the peripheral mucosa with an increased risk of mucositis, peri-implantitis and bone loss.
- By preferring the permanent sealing of the prosthesis, without occlusal screw, which enables optimum adjustment of the occlusion, with meticulous removal of excess subgingival cement. If the emergence neck is well designed without overhang, or rough surface, the cement is easy to eliminate and later, the prosthetic dismantling for cleaning-up is no longer necessary. Therefore, the requirement of a close and scheduled maintenance is deleted for the patient.

Implants selected for this study, are one-stage implants. Their emergence flared head and neck, share the same patent, with a body almost similar:

- Straumann Sin Octa® is cylindrical. These implants have been used for a study, developed below, on bone level evolution (Akça et Çerheli, 2008).

- Zimmer SwissPlus® is slightly tapered. These implants are used in clinical practice in our office for almost 20 years(Le Gall and Le Gall 2005, 2006).

The implants of these two brands are directly comparable. The only real difference is the occlusal concepts applied to balance occlusion, CPO and CR /-VS-/ Functional Occlusion

Clinical study: Straumann® Implants

A clinical study of 2 years (Akça and Çerheli, 2008) compare the evolution of the bone level on 15 fixed restorations of 3 units on 2 implants with 34 fixed restorations of 3 units supported by one tooth and one implant, rigidly connected. Against all expectations they measured a significant bone level augmentation around the implants connected to natural teeth, and a decreasing bone level around the implants connected together.

An other study (Lindh and al 2001) found similar results and not knowing how to interpret their results, the authors considered that any attempt of interpretation was speculative.

An attempt at interpretation can currently be offered. The occlusal concept applied in these studies is the canine protection, with a high probability of the presence of incoordination chewing guidances or interference on the occlusal surfaces of posterior teeth.

In the case of bridges, connecting one tooth and one implant, two mechanisms can be retained without being able to specify their level of involvement: on the one hand the differential damping between tooth and implant which generates low forces on the implant neck, so stimulating bone, resulting in bone gain. On the other hand, avoidance mechanisms generated by the mechanoreceptors of the natural teeth, that moderate the impacts on malocclusions.

Regarding implant supported restorations, mechanoreceptors are absent, the forces are poorly regulated and patients chew on malocclusions without control. The developed forces are stronger and responsible for bone loss (Chiba et al. 1994 Frost, 2003).

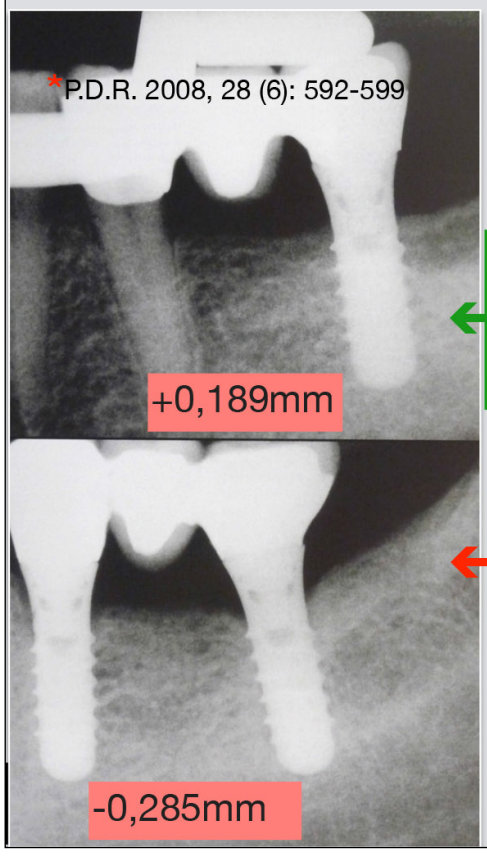
Clinical Study: SwissPlus® Implants

This comparative study has been published in the 2016 January / February JPIO. You will find below several clinical cases within this study:

This is a retrospective study of a randomized group of 30 patients and 40 single or two connected implants. Only one implant was connected to a natural tooth. The prostheses were all sealed with permanent cement, cleaned thoroughly. These implants were all placed and the prostheses balanced by both authors. The follow-up period ranges from 1 to 8 years. All the

WITNESS GROUP:

Implant-tooth-supported restorations and implants-supported restorations. Two years follow-up Kicanç Akça, Murat C. Çehreli*



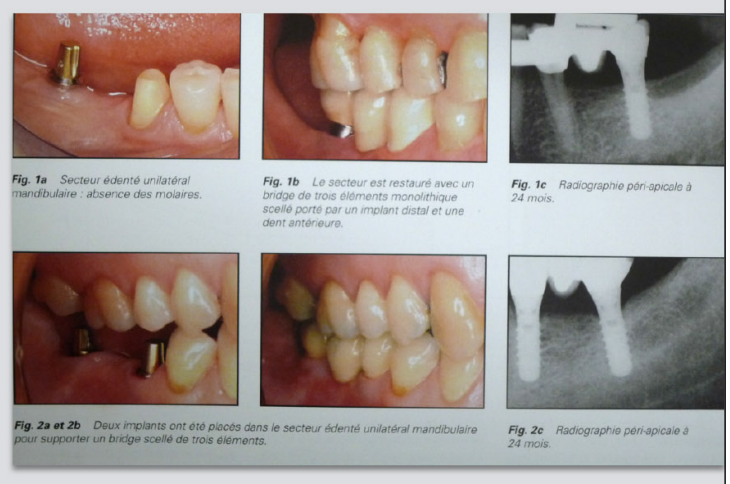
49 bridges of 3 units (15 IS, 34 TIS)

Occlusion, Cuspid protection: Occlusal traumas or bad guidances (very probably)

Tooth-implant connection➤
Increasing bone level around implant

Restoration on implants➤
Decreasing bone level

Significant difference opposite to T analysis



Lindh et coll obtained same results in 2001, but considered any interprétation as speculative.

x

Figure 6-15: *Note the positive remolding of bone around the implant connected to a tooth, it is the opposite of what says the theoretical analysis. Conversely bone loss is observed around the implants connected 3 units bridges. For conventional concepts, it's inexplicable.*

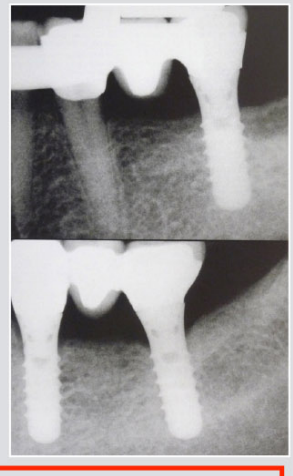
Interpretation attempt:

Bone stimulation**
Strains➔0,005 à 0,15% of bone distortion

➔

Teeth-implant restorations: bone gain
-absorption difference➤releases light forces on bone➤bone stimulation
-dental receptors➤regulation of occlusal forces, malocclusions avoiding reflexes

*Misch et col A positive correlation between occlusal trauma and peri-impl bone loss, 2005
**Cowin et col 1991, Frost 2004
***Chiba et coll 1994, Frost 2004



Protection canine: malocclusions postérieures
Mobilité clinique des dents: non précisé

Bone resorption* ***
strains ➤ 0,15 à 0,4% bone distortion

➔

Restorations on implants: loss of bone
-receptors and avoiding reflexes are missing, regulation of forces are reduced or missing
-The patient chews on the interferences without any perception➤occlusal forces are stronger

x

Figure 6-16: *These logical functional interpretations begin to prove that an approximate balancing of implant supported restorations can be dangerous to the long lasting of implants.*

clinical cases illustrated above show an increase in the bone level and an improvement in its density, unexpected at the time of implant placement. The average bone gain is 1.33 mm with an average follow-up of 43.7 months. The general standard deviation is σ 1.51, indicating homogeneous, non-dispersed data. The average bone gain is high and significant.

The implications are interesting. They show that the remodelling is not limited to one year, for it continued for a long time, it's similar for the bone density. They also point-out that if hyper loading, or occlusal traumas, can result in bone loss, a well balanced loading is stimulating and can result in bone augmentation. The occlusal faces must be finely balanced to maintain the occlusal forces in the stimulation range. The classical occlusal concept allows to balance, a reduced share of the functional envelope only, and is not capable of such results.

The classical recommendations arguing for "occlusion in canine protection" do not plan to balance the occlusal surfaces of the posterior sectors and lead to opposite results, because the canine protection does not exist during chewing.

Moreover, these results were obtained on implants whose machined titanium necks are simply flared, without microspires, nor switching platform, without complex shape or rough surface treatment at the level of the microgap. It is legitimate to question the real usefulness of these characteristics, which were introduced with the aim of reducing bone loss around the neck of implants and which most often lead to inverse results.

The promoters of these devices are mistaken for the solution, because in fact it is the remaining malocclusions on unbalanced occlusal surfaces that are responsible for this bone loss because the canine protection does not exist during chewing. We have shown in the first part that the so-called canine protection is a myth. The figures from this article indicate that it is the occlusal equilibration during chewing that is the true mechanical key to peri-implant crestal bone durability.

By balancing and sharing the largest axial and transverse forces, we stay in the bone stimulation range. Only the restoration of the natural model of chewing and swallowing achieves a sufficient degree of equilibrium, which is the decisive condition for the maintenance and increase of peri-implant bone level and density.

Conversely, classical concepts, based on the myth of canine protection, must be abandoned, because in implantology, even more than in other disciplines, make them responsible for bone loss and make them dangerous for the durability of the implants. In these conditions, continuing to use them, could be considered unfortunate for the patient.

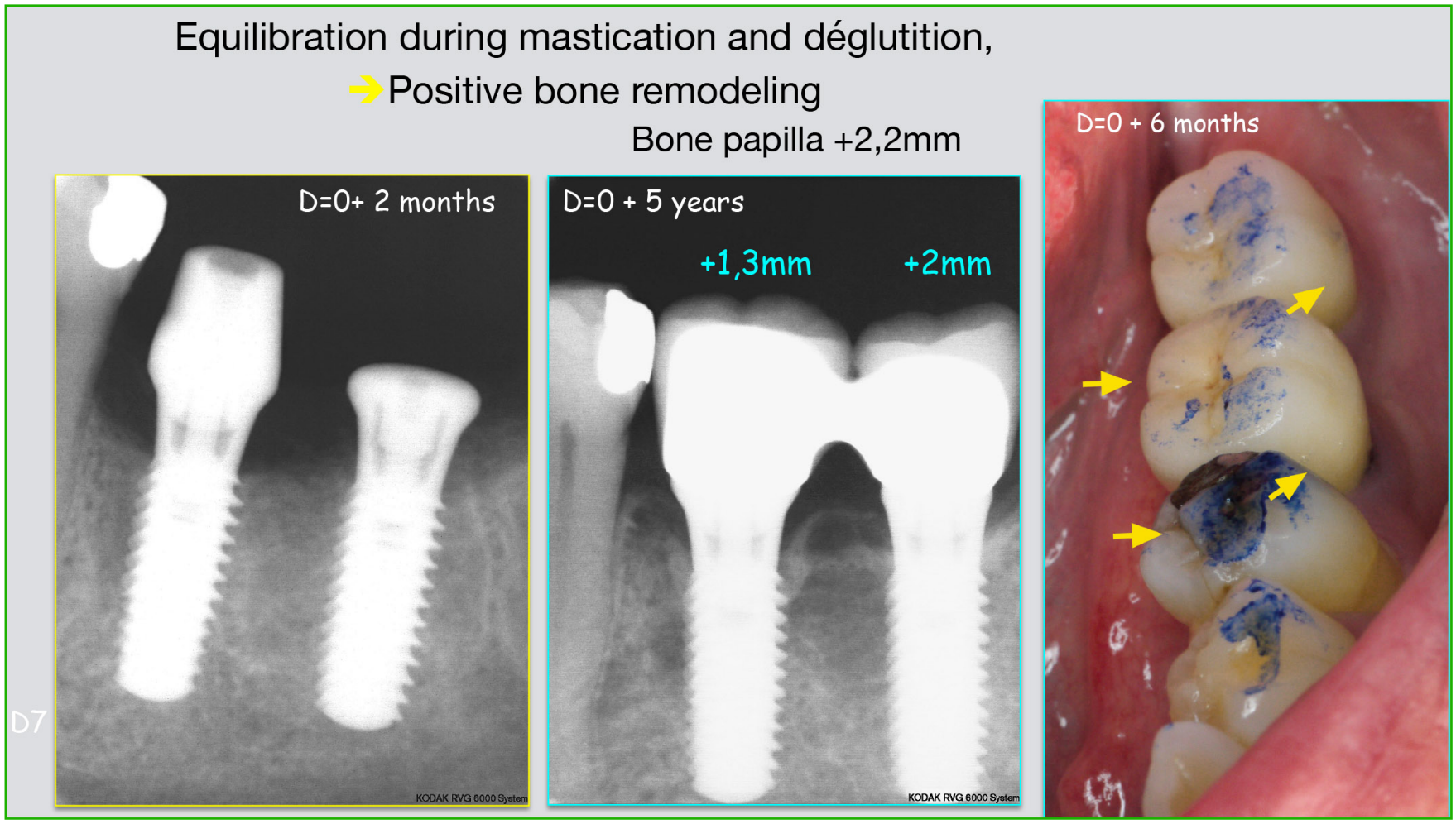


Figure 6-17: *The chewing guides are lightweight at the time of installation, no retouching was done afterwards. Stimulation ➤ bone gain.*

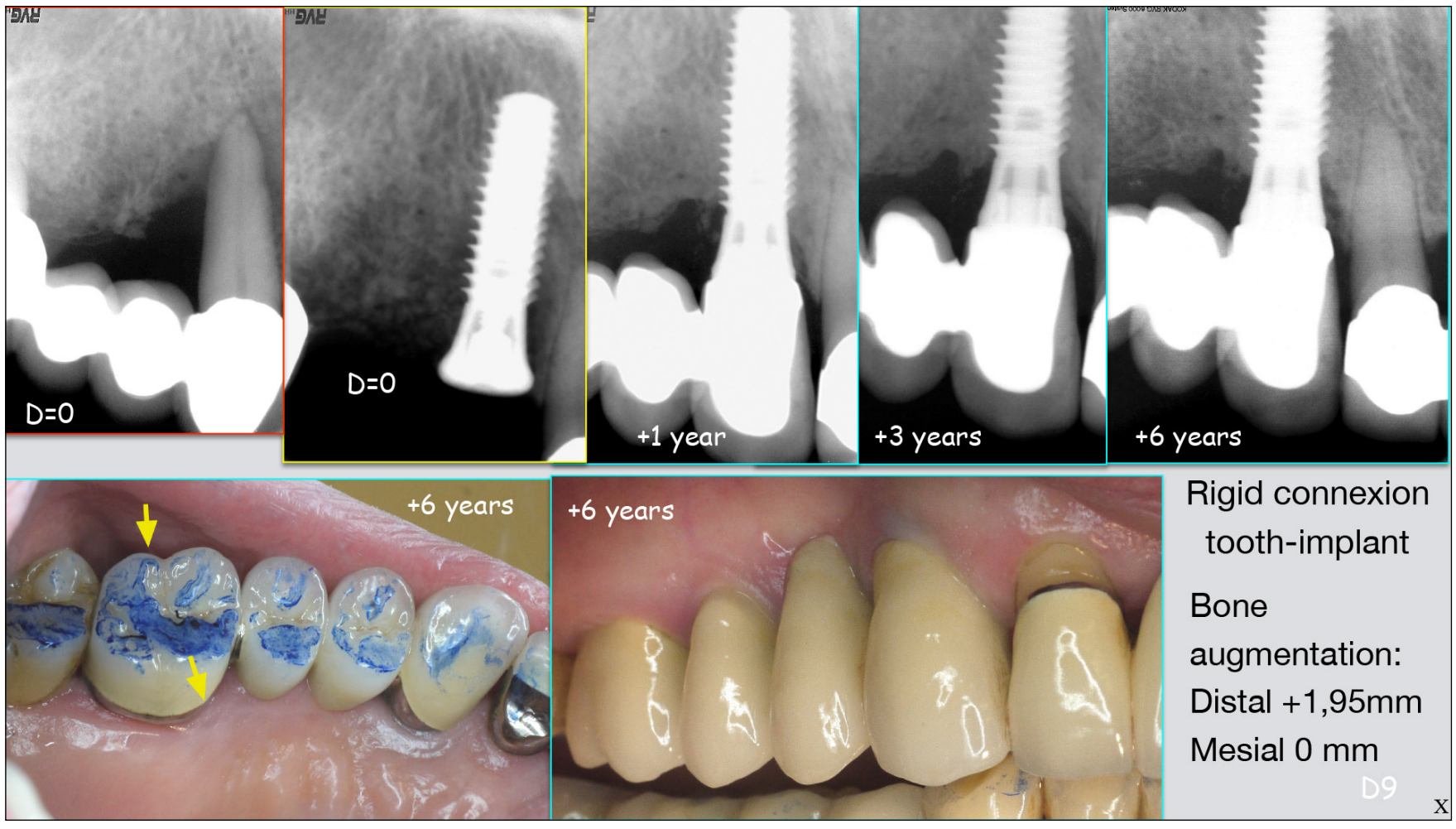


Figure 6-18 *Clinical case connecting a tooth and an implant. Before extraction bone was very resorbed around cuspid. Appeared missing buccal plate. At the implant insertion, none membrane has been used, only a bone substitute (tricalcium-phosphate) has been placed around. Six years later, look at the bone level improvement and the well balanced chewing guidances, the same day. None occlusal alteration has been done from the initial balancing. Light balanced occlusal forces are responsible for bone stimulation and the gain on distal face of the connected implant, similar to Akça result, but opposite to theoretical analysis expectations. Measurement: 13 Mesial 0s (0mm) Distal +2,15 threads (1,95mm) Average +0,97mm.*

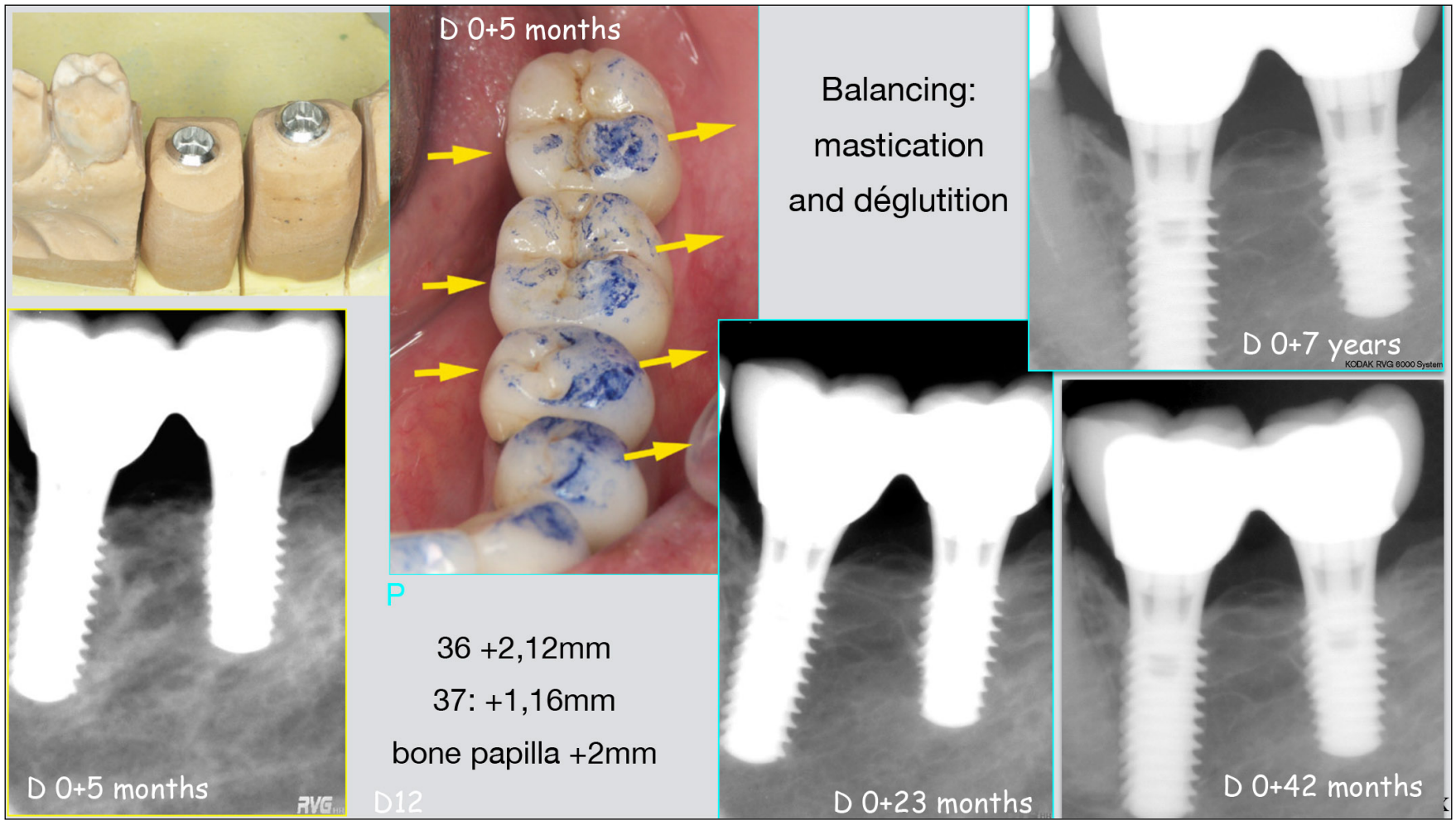
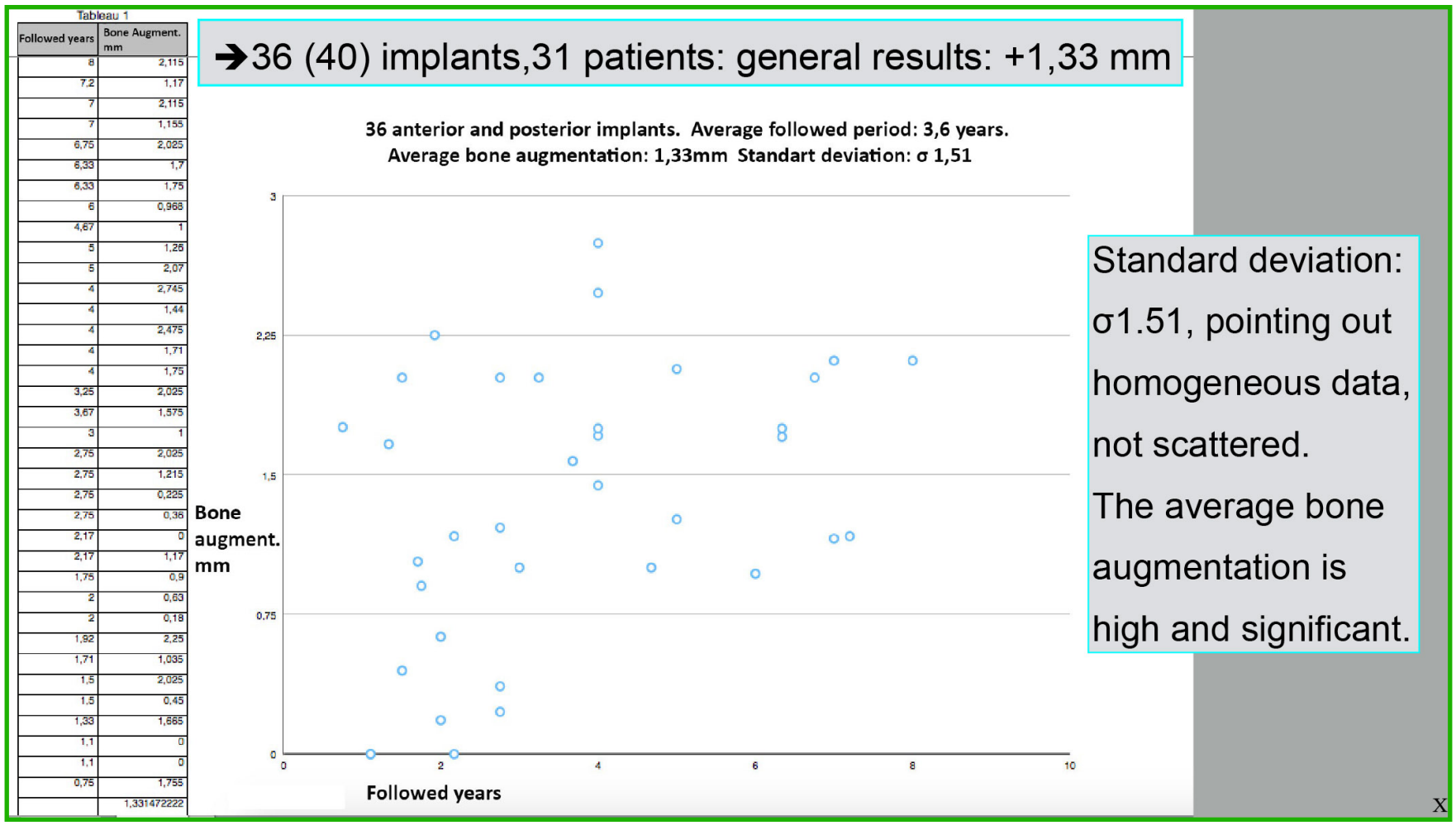


Figure 6-19: *Peri-implant bone graft and inter-implant ridge go beyond the "laws" of Tarnow and the concept of so-called "canine protection" where bone loss is observed and considered normal.*



Fiigure 6-20:Thirty-six anterior and posterior implants: average bone augmenation 1,33 mm; standard deviation σ 1,51. Average followed period in year.: 3,6 years.

The pdf of this article is downloadable with the following link:

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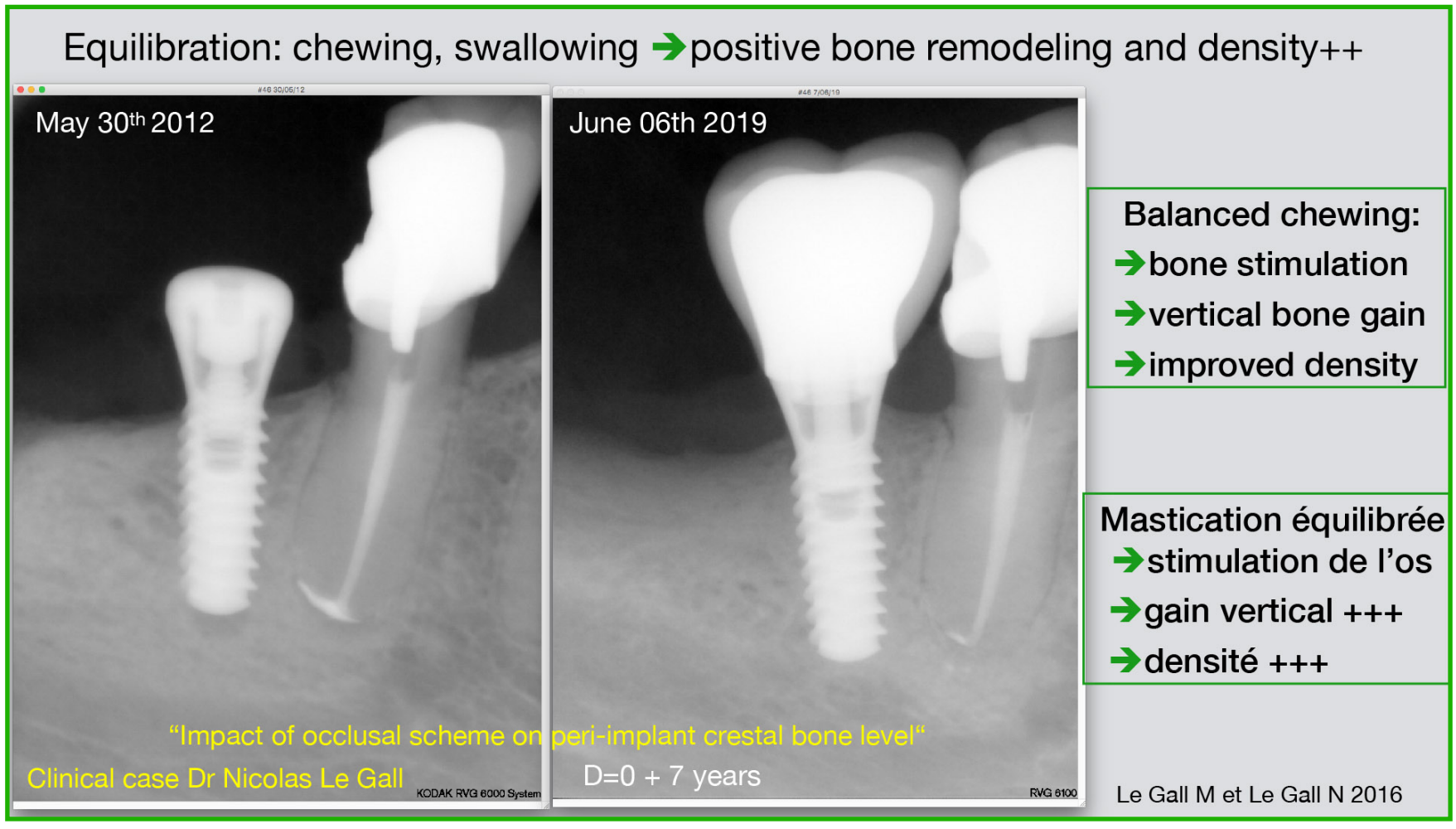

Figure 6-21: This recently controlled clinical case could not be included in the study, as was the vast majority of other cases with similar results. The vertical bone gain and the improvement in bone density confirm that during balanced chewing, the bone is kept in stimulation. This is the opposite of pseudo-canine protection, which does not work in chewing and where bone loss is usually observed and considered normal.

COMPLETE DENTURES: OCCLUSAL MANAGEMENT

Chapter 7

The avulsion or absence of the teeth is a disability that causes the patient to lose his masticatory capacity, and certain functional mechanisms that are linked to it, such as periodontal proprioception. The periodontal mechanoreceptors with their very fine afferences and efferences, whose threshold of perception is micrometric, are absent. They are partially replaced to control function by the receptor of the mucosa on which the replacement prostheses aresupported. Their somatotopy is much less fine (millimetric sensitivity) than that of periodontal afferents. The functional mechanisms of a dentate patient are not directly applicable to the complete prostheses of edentulous subjects, placed on soft mucosa.

When the natural dental swallowing wedge is lost, the only remaining mandibulo-cranial references are the resting posture related to swallowing, facial balance, and condyles position in the glenoid cavities. The introduction of dental radiology immediately led to the proposal of a centric relation position of the condyles in the articular cavities, as RMM reference for the

realization of complete removable prostheses (Mc Collum 1939). If this position, obtained by forced +/- manipulation, obeys a cartesian logic, it does not take into account the functional relation of articular surfaces during swallowing and chewing and the neuromuscular balances that control it.

In the edentulous patient, the play of prosthetic bases on flexible mucosa easily compensates for this error, by a more or less significant displacement of the prostheses, which makes it possible to replace the condyles in functional relation.

VDO-IR: Summarised protocol.

In these conditions:

- how to deprogram the adaptive clinical postures, in mandibular protrusion or others, with a collapsed Vertical Dimension,
- and how to find then, the functional Maxillo-Mandibular Relationship, compatible with swallowing of an edentulous patient?

The following protocol is one way to achieve this (Le Gall ROS 2013). When the VDO is collapsed, it is possible to raise the posterior areas of the old prostheses in a symmetrical and balanced way (Fig. 7-1). If the old prostheses are not available, individual impression trays

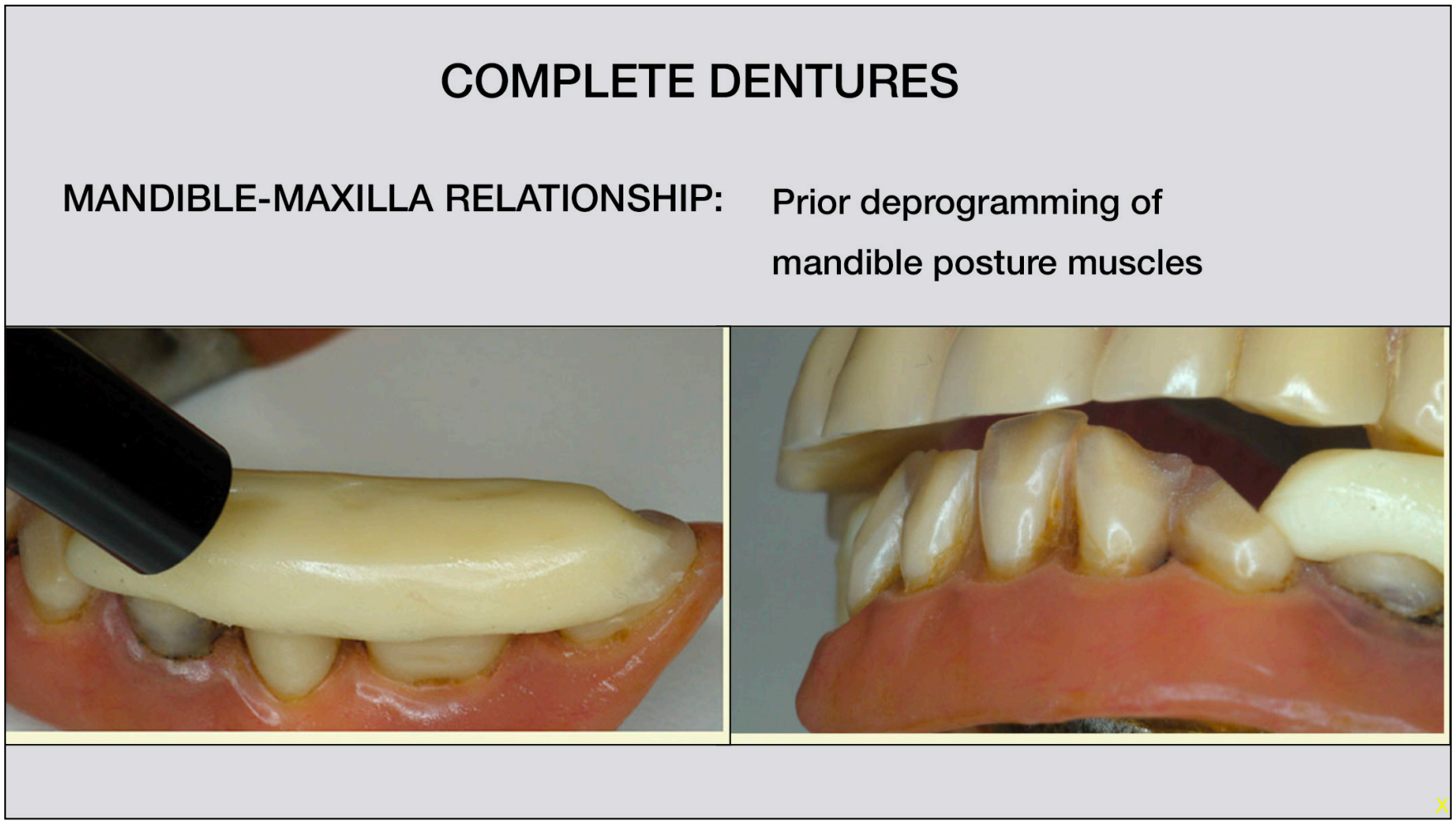

Figure 7-1: Transformation of a former prosthesis with rolls of Revotek ® from GC. These rolls must be flattened and glued to prosthetic teeth, with a very fluid self-polymerized resin. View of the elevation allowing to put the anterior teeth in under contacts.

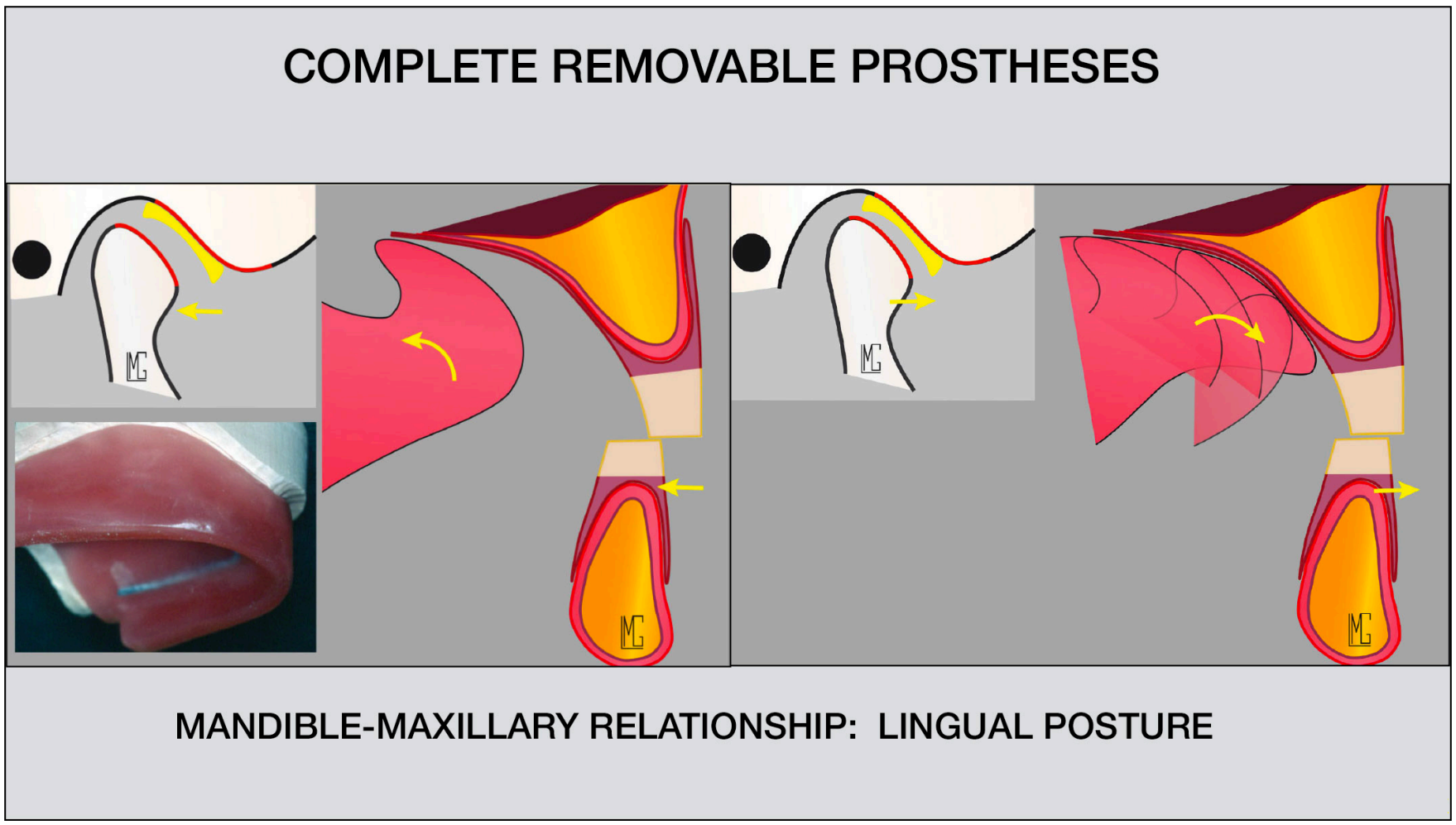

Figure 7-2: maxillary ridge in hard wax, to get the occlusion. It is wiser to make the ridge in a resin base with a hole in the palate to allow a proper lingual positioning. A- Diagram showing the initial lingual posture and the backward movement of the mandible. B-Diagram showing the gradual movement of the tip of the tongue towards the swallowing position while the patient makes small, quick and repeated clicks against the ridges.

supporting flattened rigid rolls, following the same principles, can be made in the laboratory. On an old prosthesis, the anterior teeth must be kept out of occlusion to allow the repositioning of the mandible in the 3 planes of space, because it is not possible to use the anterior jig in edentulous. Deprogramming is often immediate, but as a precaution orthotics should be worn for a few days, because they can also be used to validate the VDO.

Then, as the case may be, one or two Individual Impression Tray, in resin, supporting rigid flattened rolls can be made on a double of the working impressions (Fig 7-2). They must be set in dominant, simultaneous and balanced sliding contacts on the two lateral sectors. The anterior sector can be left in accompanying contact. These modified impression trays will be used to finalise the choice of VDO, the anterior prosthetic volume, and then to determine the MMR of swallowing. When the rolls are well adjusted in height and can slide between one another, the tip of the tongue is returned toward the soft palate, the mandible proceeds to be in a CR (Fig.3-2, 7-2). The patient then makes quick and repeated small snaps, while progressively advancing the tip of the tongue towards its swallowing position which can then be fixed by blocking the rolls (Fig. 8-93B). It is often necessary to stabilise the modified

Impression Tray with a fixator for removable denture. Lingual manoeuvring should be repeated several times before recording the MMR in swallowing posture. From this functional MMR, the swallowing contacts, simultaneous and multiple in balanced MIO, can then be obtained on the articulator.

This protocol is optimal if prosthetic stabilisation with implants is considered.,because in this prosthetic context, if the Inter-maxillary Relationship has been fixed in a manipulated CR, then the prosthesis will be stabilised by the implants, so without possibility of displacement, the occlusal faces will show many malocclusions, with perhaps the need to redo the prosthesis.

Attempts to apply edentulous CR to dentate subjects is most likely a mistake. Indeed, it is not the very minor functional characteristics of an edentulous mouth, which allow to define those of a dentate and healthy mouth. (for example, a subject having lost both his legs, can not serve as a model to understand the physiology of walking, on the contrary, it is the natural model of walking that serves as a reference for designing replacement prostheses.

This attempt to use CR as a reference for dentate patients has been responsible for many clinical setbacks and was the subject of controversy that led to many different definitions of CR (**which is incoherent for a reference position that is unique and stable**), because the MIO closure position of natural teeth, during swallowing, is not confused with the different CRs proposed, in 98% of patients (Posselt 1968, Joerger, 1991, 2005).

Moreover, in dentate mouths, it is possible to observe on the axiographies of mastication cycles, (Figure 5-59b-c in part 1), that all the Rcs ??? are located in the limit envelope guiding the inputs of mastication cycles. On the M_1 couples, they come from a lateral and posterior position of the mandible and slide diagonally forward on the cycle input rail of the upper disto-buccal cusp, before passing the MIO on the enamel bridge.

One conclusion is obvious: the different manipulated CR are invented positions that do not respect the physiology of swallowing and chewing because:

- the more posterior the position, the more the patient tries to advance the mandible to regain its natural closing position,
- the closer it is to its position of swallowing, a bit more anterior, the better it is accepted by the patient.

The mobility of the mucous membranes of edentulous patients can both facilitate and complicate the prosthetic realisation.

It makes it difficult to accurately record some condylar parameters. The positioning of the maxilla model on an articulator using a face bow is possible and useful. On the other hand, the registration of condylar slopes using laterality waxes, as well as the recording of the functional parameters (F-ISS, F-PSS), remains imprecise on mechanical articulators, which in any case do not know how to reproduce chewing.

The occlusal equilibration on the closing path is difficult or impossible in the mouth and often requires a new MMR recording followed by a new mounting of the models on the articulator.

Moreover, the patient's collaboration is illusory because his overall perception of his prostheses is incredibly reduced due to the lack of proprioception.

The realisation on the complete prostheses of dominant guides identical to those of dentate mouths (protrusion, cuspid guidance in laterality ...), as well as the presence of malocclusions or overguiding, generally results in a displacement of the prosthetic bases on the mucous membrane (causing ulceration), in the search for additional balancing contacts, which often permanently compromises the stability and adhesion of the prosthesis. This phenomenon can be objectified after the placement of implants to stabilise unretentive removable prostheses. Previously undetected malocclusions are revealed instantly as soon as the prosthesis becomes fixed.

From balanced occlusion in laterality to balanced functional occlusion

Achieving aesthetic and functional complete dentures, involves ensuring their stability and efficiency during their use:

- During breathing, the phonation, the communicative mimics ... The design of the bases, must respect the functional muscular insertions and the teguments which cover them. The recording in the impression of their functional envelope by piezography (Klein 1970, 1997) is a key determinant in positioning of the prosthetic teeth on the crests, and the stability and adhesion of the prosthetic bases.
- The recording of the intermaxillary relationship, in a position compatible with swallowing, requires a deprogrammed patient, in neuromuscular equilibrium, with the tongue in swallowing posture, to replace the usual manipulation in CR. If these conditions are fullfilled, it makes it possible to reduce and even avoid the displacement of the prosthetic bases on

the mucous membranes. The protocol described at the beginning of this chapter allows for this (Le Gall 2013).

- During chewing movements, a functional occlusal scheme allowing the stability of the prostheses is decisive. Unlike teeth, whose root architecture stabilises the occlusal surfaces, in the edentulous, it is the prosthesis which must ensure this self-stabilisation. Which implies, during unilateral chewing, the presence of accompanying stabilising guides on the non-chewing side. And during incision movement, the presence of symmetrical accompanying guidance between the posterior teeth.

It is a real problem, because the articulator can only perform laterality movements in the reverse orientation to those of mastication.

What impact on the actual function will these inverted guidances have on edentulous subjects?

The result is clear: If on an articulator, the slippery group-function, and contro-lateral side

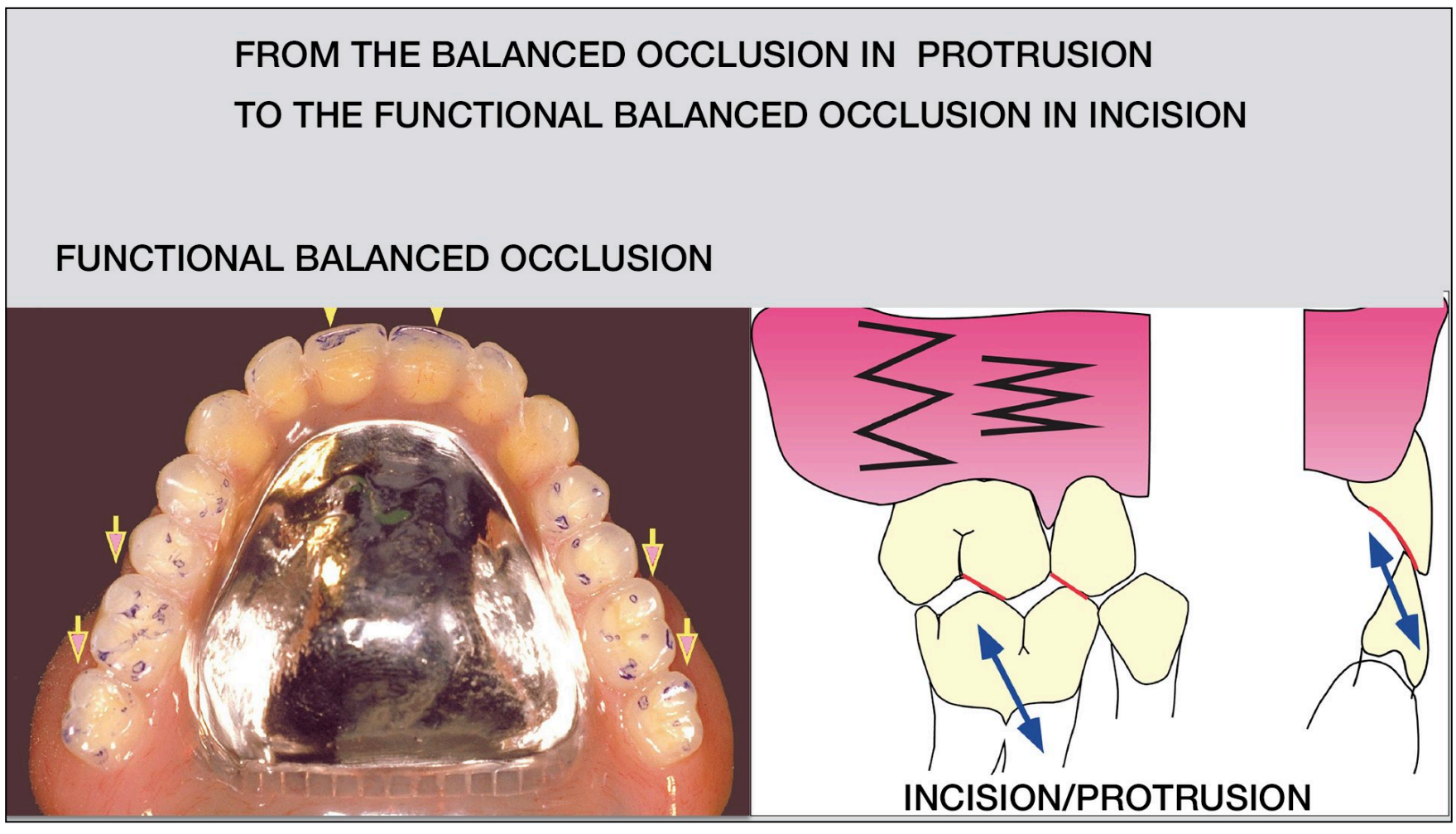

Figure 7-3: The balanced incision movement was set on the articulator by simulating the protrusion. The flexibility of the mucosa partially compensates for the differences, but the equilibration of the incision movement must nevertheless always be checked in the mouth.

accompanying guidance, are present on all the teeth and well balanced on cuspidian slopes, the simulation of chewing in the mouth is good and the guiding appears balanced on all the teeth. The kinematic differences are compensated by the permanent displacement of the

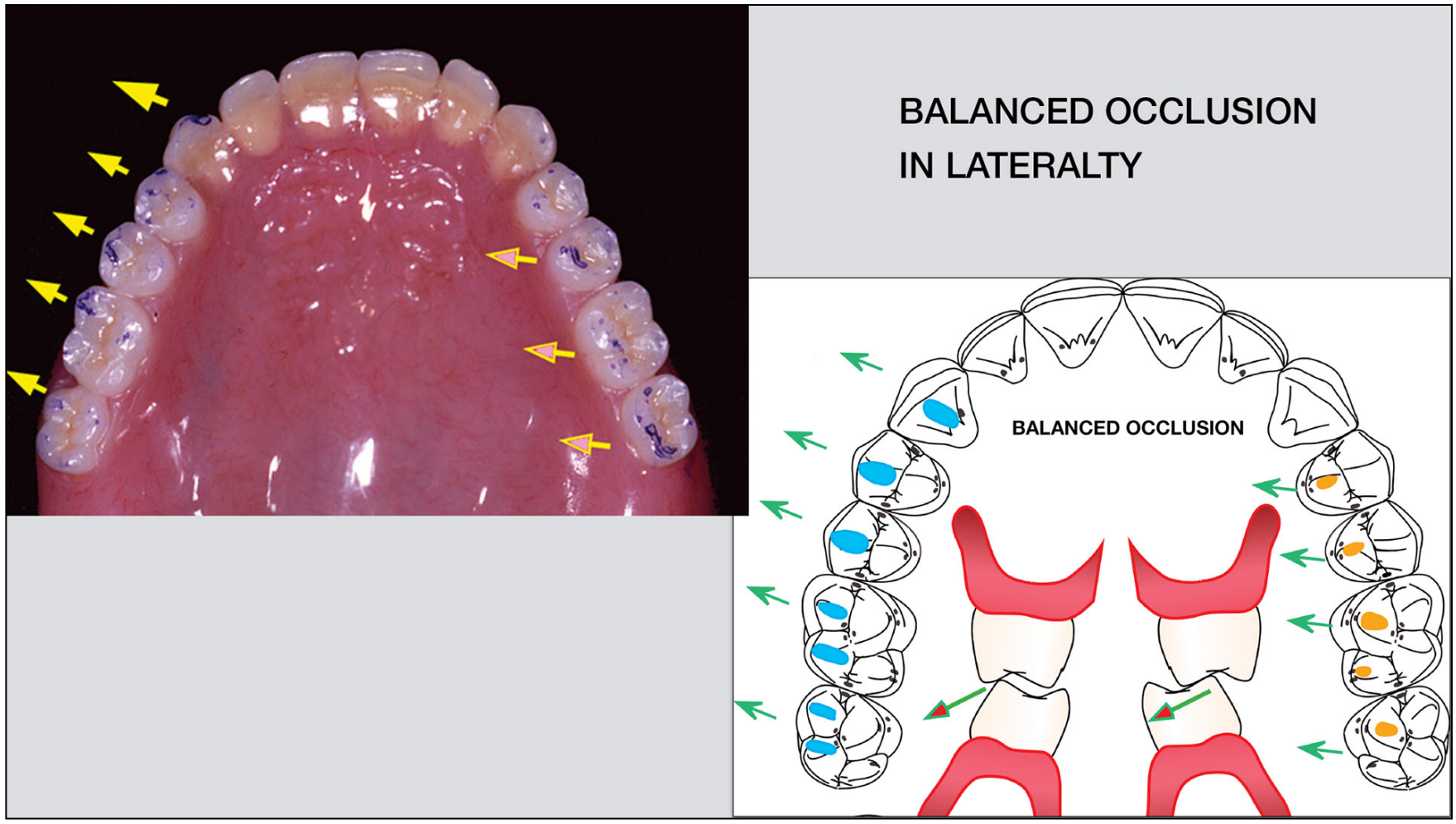

Figure 7-4: *the group function of the right lateral movement is well shared. On the other hand there are 2 strong posterior swinging guides (P2, M2) and 2 weak (P1, M1), requiring a small adjustment.*

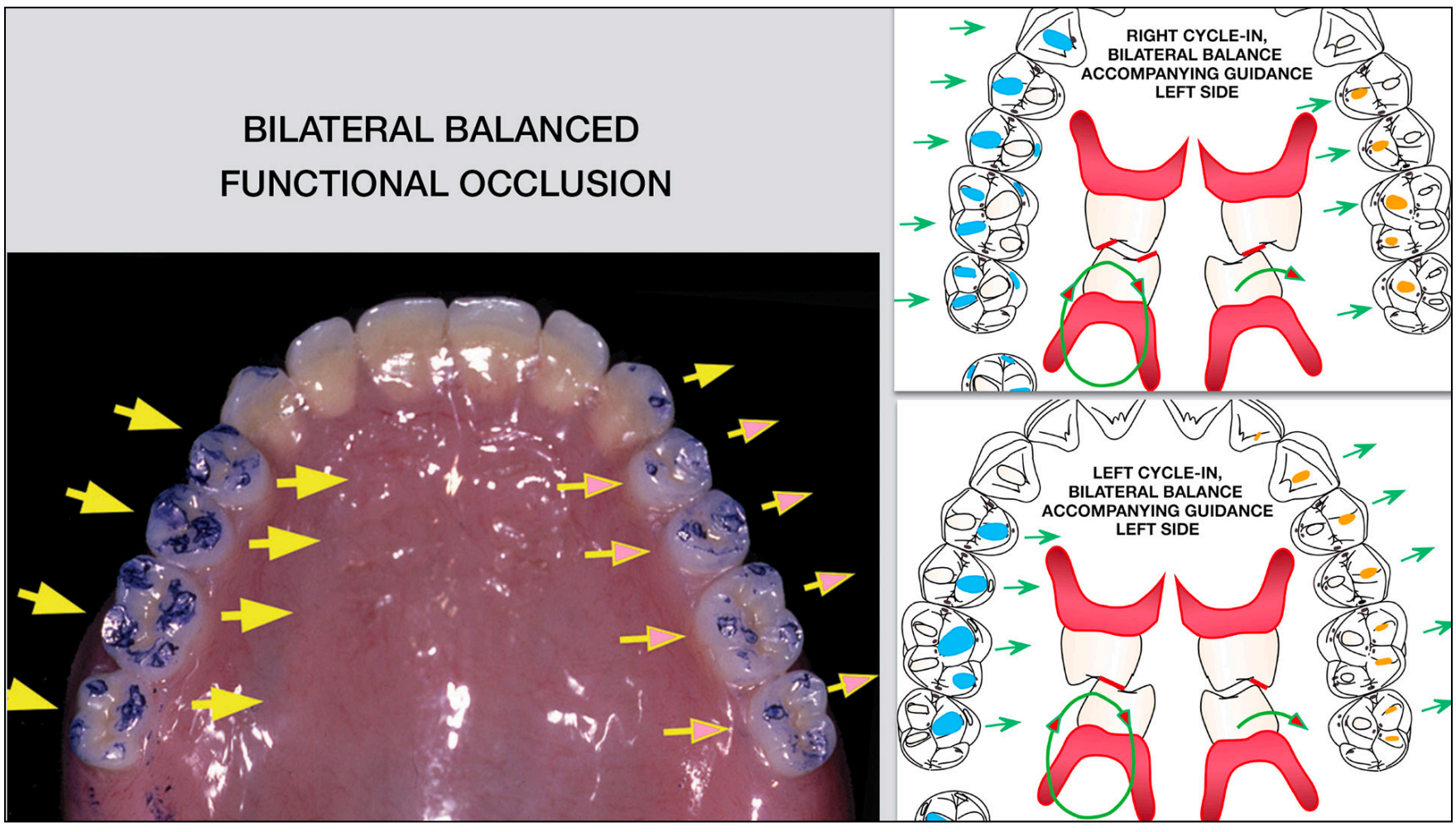

Figure 7-5: *when chewing on the right side, the cycle input and output guides are optimal, the guides on the left balanced side also.*

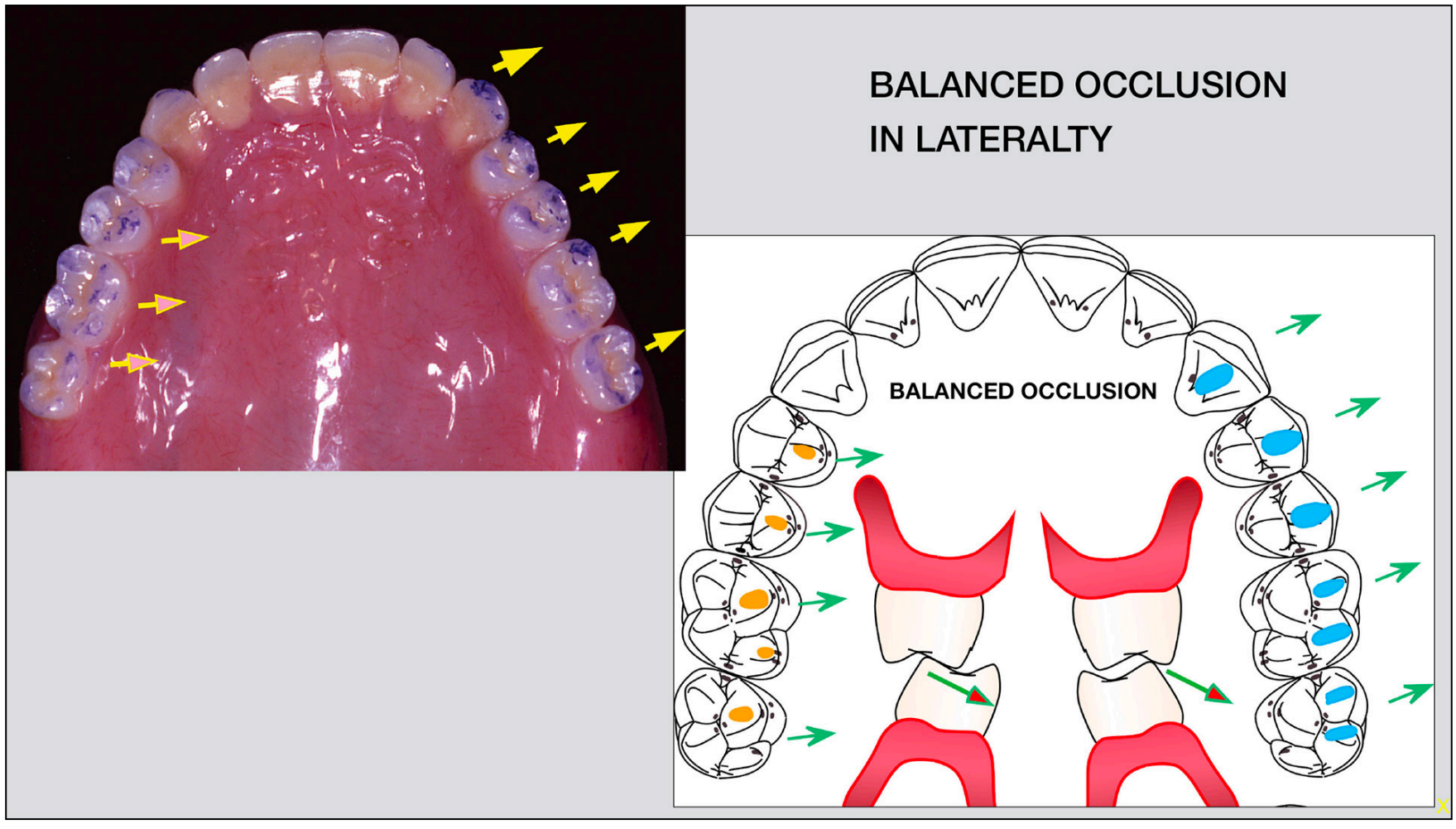

Figure 7-6: *the group function of the left lateral movement is well shared. It is the same for the simultaneous balanced right side, except P1 under-guiding (a small addition is necessary).*

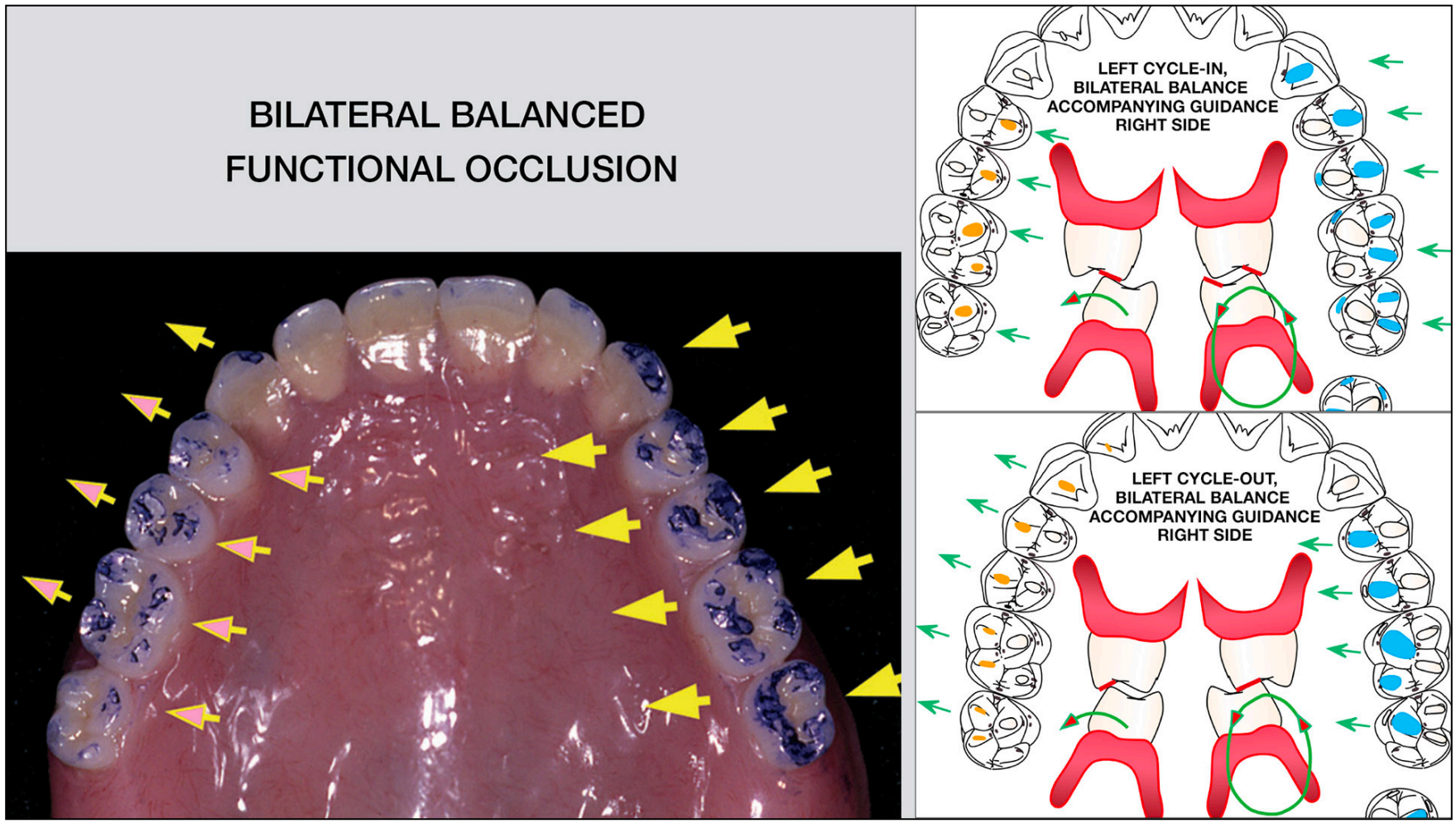

Figure 7-7: *The left chewing cycles input and output guides are optimal. The right balanced guides also , except on the M2 where they are a little weak.*

Figure 7-8: *View of chewing guides of the complete restoration fixed on natural teeth, antagonist with previous complete denture, in bilateral balanced occlusion.*

prosthetic bases on the support mucosa.

If the adjustment of the bilateral balanced occlusion on the articulator is not optimal, chewing in the mouth will not be optimal either. It is therefore necessary that the assembly of the teeth made on articulator is perfectly balanced. However, in balanced occlusion, it's not possible to recreate chewing guide rails of intact natural teeth because they do not have the same orientation on the chewing side and the non-chewing.

The slopes of cycles inputs and outputs, must be softened and without rails, to support the chewing guides, that work in opposite direction and in another orientation, on the non-chewing side. This makes it necessary to modify the occlusal anatomy of many prefabricated teeth whose cuspidian slopes are often too globular, especially the cycle output slopes qualified as non-working in the erroneous gnathological model, and which were not designed to chew.

Occlusal retouching of complete dentures is extremely difficult to do in the mouth, the majority of retouching must be done on the laboratory articulator or manipulating the prostheses, which is not easy.

When the patient begins to be able to chew on his dentures, the observation of the functional surfaces recorded in clinic, on marker film, allows however to make some small final touch-ups or modifications.

The bilaterally balanced occlusion, or globally balanced occlusion model, was used as a reference to balance dentate patients, by some occlusal schools, from the first half of the 20th century. This has resulted clinically, by the need to make extremely mutilating and irreversible

grinding, to obtain simultaneous static and dynamic contacts between all the teeth of the arches, during all movements of laterality and protrusion. The results were catastrophic with complete destruction of the functional anatomy of the teeth and thus the natural functioning model of man. It’s against these concepts that d'Amico was fighting when he introduced canine protection, but alas with an incomplete knowledge of the physiology of mastication.

SYNTHESE-CONCLUSION

Chapter 8

At the end of 1984, we watched for the first time a video of Lundeen and Gibbs (1982) showing a patient who simulated chewing on a Replicator®, the first device capable of reproducing and recording chewing movements. Beside the patient, a specially adapted articulator, reproduced her masticatory cycles, at the same time as she, on her own models.. With Jean François Lauret, my neighbour during this screening, we wondered why she chewed in reverse orientation... She obviously did not chew upside down, but it was us who reasoned backwards, distorted by the way the mandibular movements had been taught to us.

The sirognatograph® from Siemens had just been presented. With our enthusiastic assent the department head, J.Abjean, commissioned a copy for the Occlusion Physiology Research Laboratory (Brest France 1985), which he led and of which we were the only two other members.

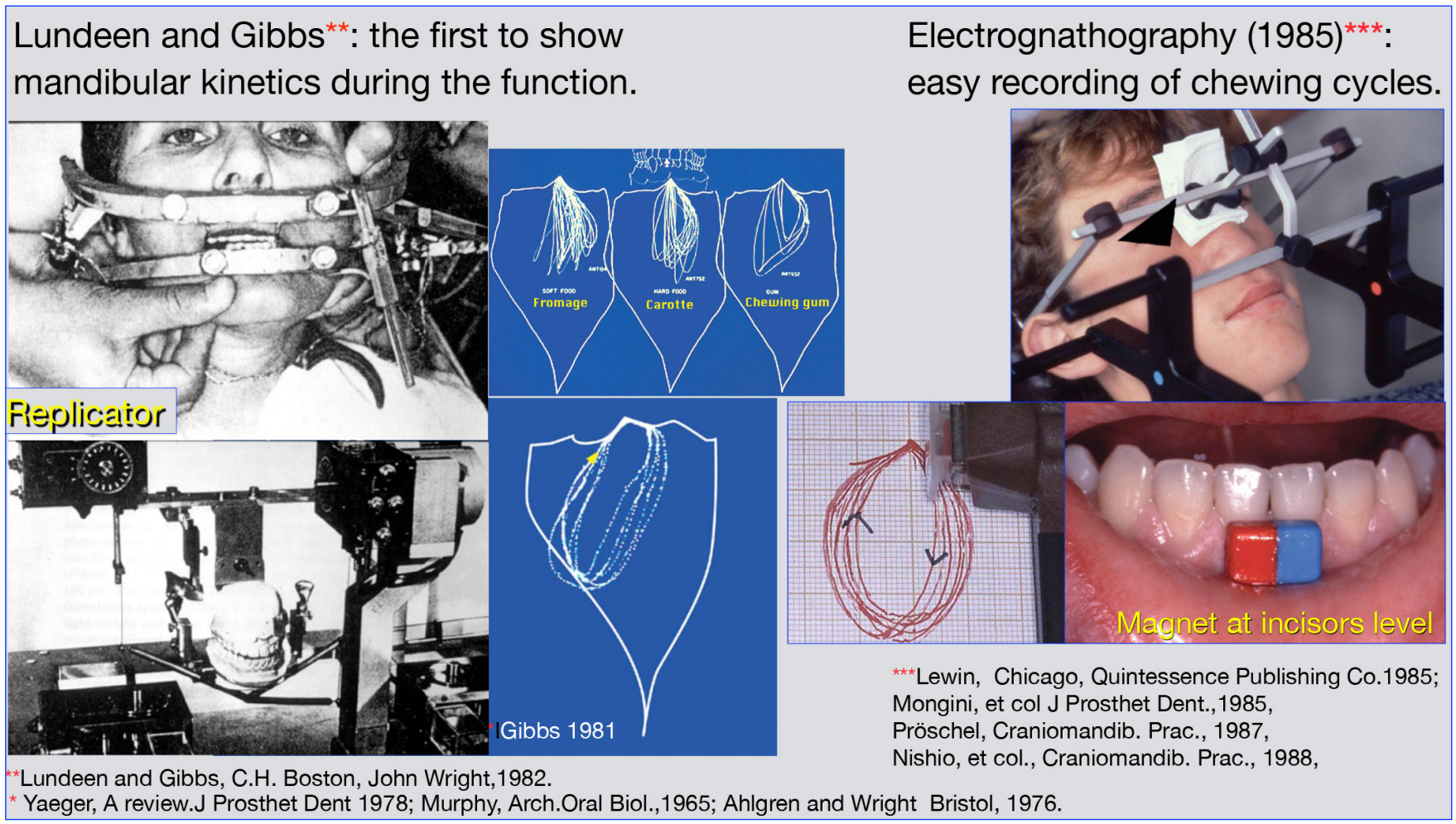

Figure 7-9: *On the left is the Replicator®, which has been a breakthrough in the analysis and recording of masticatory cycles. On the right is the Sirognathographe® used in 1985 in the laboratory of occlusion physiology of the Brest faculty of dentistry. This device was very easy to handle. He used a magnet glued to the neck of the central mandibular incisors that moved in a magnetic field. It was connected to a plotter that printed the cycles either in the frontal plane or in the sagittal plane.*

When we did the first tests on a patient, it appeared to us that during the vacuum simulation of chewing, the teeth on the chewing side touched each other by sliding over each other in a coordinated way. It was a real revolution for us who had already been trained in the dogma of canine protection. We did not dare to speak about it immediately for fear of misinterpretation on our part.

We were very far from imagining the consequences that this would entail and the difficulties that we would have, to make him admit to the dental profession.

Today the facts are indisputable:

- **There is no canine protection during chewing.**
- **The natural closing position in Maximum Intercuspation is that of the swallowing posture** and the cloud of all the different proposed CR positions, is located in the boundary envelope of the input guides of mastication cycles which is located behind and until the MIO passes.

- **The two dogmas defining the operating model of the gnathological school and especially the canine protection** "which is an equivocal concept not validated by evidence-based works" (Rinchuse 2007) **do not account for chewing and swallowing and must be abandoned.**

What are the fundamental contributions of functional occlusion:

- **The natural setting of swallowing is in Maximum Intercuspidation Occlusion.** The more the different CRs and their associated MIO are located in a position posterior to the natural position of swallowing, the more they reduce the cycle input envelope of the chewing cycle (Le Gall et Coll 2010)
- Chewing is organised around the natural MIO.
- Different forms of cycles were recorded first by Lundeen and Gibbs then by Pröschel, without being able to give their real meaning. The muscles involved in chewing have been described by several authors in a more or less complementary way (Carlsöö 1956, Mahan et al. 1982, Steiner et al. 1974, Wood 1978, 1986, 1987).
- **The functional occlusal anatomy of the M1 couples and the various other teeth has been fully described,** as well as the functional role of the different cusps slopes, on the occlusal surfaces. **It was necessary to introduce a new terminology to name them and describe the different phases of the cycles, because it did not exist.** The role of the muscles has been correlated with that of the dental and non-dental kinematics of the cycles (Lauret and Le Gall 1994, 1996, Le Gall and Lauret 1994, 1997, 2002, 2007, 2011etc).
- **The shape of the cycles has been correlated with the balance of dental molar guidance.** The optimal pattern described by Pröschel (1986) corresponds to well coordinated and balanced chewing guides. The various other forms generally correspond to inadequacies or poor coordination of dental and joint guidance. **It has been found, in usual practice, that the restoration and good coordination of posterior dental guidance, generally by addition of test composite, makes it possible to change the shape of the cycles and regain their optimal amplitude while restoring the comfort and effectiveness of chewing** (Le Gall and Lauret 1997).
- The comparative anatomy data confirm the validity of **this current model, which has existed in anthropoids for more than 32 million years.**
- **In cases of TMD with various joint sounds, it has been found that the restoration of balanced function in young patients often results in spontaneous reintegration of the**

discs. While the recapture of discs, deformed or fractured in the elderly is much more difficult, even if the comfort of these patients was still improved…

- In implantology, the comparison of bone evolution between 2 groups of implants with the same concept of emergence, but of different brands, made it possible to observe and measure important crestal bone gains around implant-supported single restorations. , balanced in real function (+ 1.3mm on average). Whereas the balanced control group in CR / CPO showed a loss of bone level, which is also found, in the other publications of implant prostheses, balanced in CR / CPO.
- Observation and follow-up of large fixed restorations, balanced in Functional Occlusion (Figures 5-5, 5-6) point out that there is no secondary TMD or TTD, which is not the case at all for standard balanced dental treatments(CR, CPO). If these data were to be confirmed, the application of only non-functional occlusal concepts to balance the arches could even be held responsible for the increase in TMD secondary to dental treatments.

In conclusion, the description and the functional characteristics of the model proposed by **the Organo-Functional Theory of Occlusion** (Le Gall 2013), represent a considerable advance in the understanding of the functioning of the human masticatory apparatus and techniques that allow to restore this physiology. **The new occlusal model that is needed at the beginning of the 21st century is based on the physiology of swallowing and chewing,** replacing that of the 20th century based on CPO and CR, which proved to be too distant from the functional reality.

Note

For more information on this topic, please refer to:

- *Either at the first part of this ebook published online: "The canine 60 years after Amico: myth or reality" Link:* https://univoak.eu/islandora/object/islandora:76395
- *Either at work in French: "La Fonction occlusale: implications cliniques" (Occlusal function: clinical implications). Le Gall Marcel G. and Lauret Jean-François (†): 3rd edition augmented Editions CDP 2011 Paris* www.editionscdp.fr/ First French edition (CDP 2002), Italian (Masson 2005), Portuguese (Artmed 2008)

- *Either the website in French and English:* www.mastication-ppp.net www.mastication-ppp.fr
- *Either the many articles in French and English, whose pdf are available for free from the website above, in the "publications" section from a Dropbox link.*
- *Either to clinical videos, in French and English, available on the site or directly online:* https://youtu.be/3UdTX2Pzxiw https://youtu.be/5i9cUZRwNns

• *Some links work by clicking directly on it. Others must be copied on the internet browser*

• *The PDFs, of the majority of author's articles, are directly accessible by clicking the following dropbox link:*

https://www.dropbox.com/sh/s5djul5pa4y38np/AAB_Pid6iRrarg2lWXkOsN2qa?dl=0

ABREVIATIONS LIST

AD: Anterior Digastric

AT: Anterior Temporal

Big Data: massive volumes of data. New ways to analyze big data, which conventional ways do not know how to handle

C: Canine, Cuspid

CADCAM: Computer Aided Design Computer Aided Machining

CGP: Chewing Generated Path

CGS: Chewing Generated Surface

CPO: Canine Protected Occlusion

CR: Centric Relation

DM: Deep Masseter

EMG: Electromyography

FD: Full Denture

FGP: Functional Generated Path ; Old term improper. In fact it is the recording of the voluntary movement of laterality, which is not a functional movement.

I: Incisive I_1, I_2

IR: Intermaxilla Relationship - see MMR

Ky: thousands of years

LLP: Lower Lateral Pterygoid muscle

LP: Lateral Pterygoid muscle

MMR: Maxillo-Mandibular Relationship

M: Masseter

MI: Maximum Intercuspation

MIO: Maximum Intercuspation Occlusion

MRI: Magnetic Resonance Imaging

My: millions of years

P: Premolar, Bicuspid

PD: Posterior Digastric

PT: Posterior Temporal

PM: Ptérygoïdien Médial Pterygoid (MP)

SLP: Superior Lateral Pterygoid muscle

SM: Superficial Masseter

T: Temporal

MT: Middle Temporal

TMD: Temporo-Mandibular Disorder

TMJ: Temporo-Mandibular Joint

TTD: Tooth TMJ Dyskinesia.

VD: Vertical Dimension

VDO: Vertical Dimension of Occlusion

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FOURTH COVER

Summary

An essential goal of all odonto-stomatological techniques is the maintenance and / or restoration of the functional capabilities of the masticatory apparatus.

A common obligation of all these therapeutics is to pass by the final equilibration of occlusion. Additive restoration techniques, of lost functional dental volumes, have been the subject of a thorough reflection on how to implement them with current composite materials. They obey a precise protocol. This is why the dental restoration and equilibration techniques of the occlusal function of chewing and swallowing will be treated first, independently of the pathologies with which they could have links or interactions, which will be addressed next, in the rubric of the TMD and whose treatments will often follow the same protocols.

Résumé

Un objectif essentiel de toutes les techniques odonto-stomatologiques est le maintien et/ou la restauration des capacités fonctionnelles de l'appareil manducateur.

Le point commun de toutes ces thérapeutiques est le passage obligatoire par la réhabilitation et/ou le réglage final de l'occlusion. Ces techniques de restauration ont fait l'objet d'une réflexion approfondie, sur la façon de les mettre en œuvre avec les matériaux actuels. Elles obéissent à un protocole précis. C'est pourquoi les techniques dentaires de restauration et d'équilibration des fonctions occlusales de mastication et déglutition seront traitées d'abord, indépendamment des pathologies avec lesquelles elles pourraient avoir des liens ou des interactions, qui seront abordées ensuite, dans la rubrique des Dysfonctionnements de l'Appareil Manducateur (DAM) et dont les traitements suivront souvent les mêmes protocoles.

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