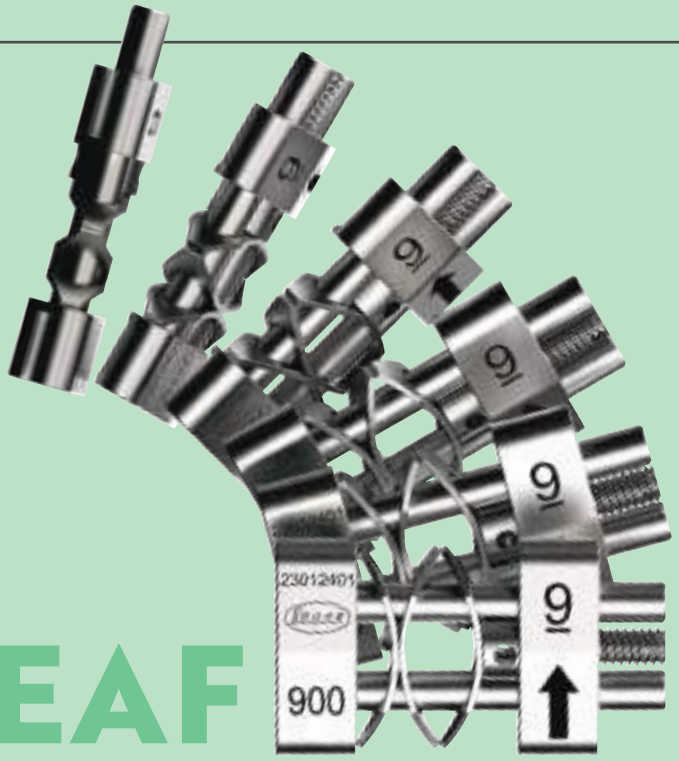
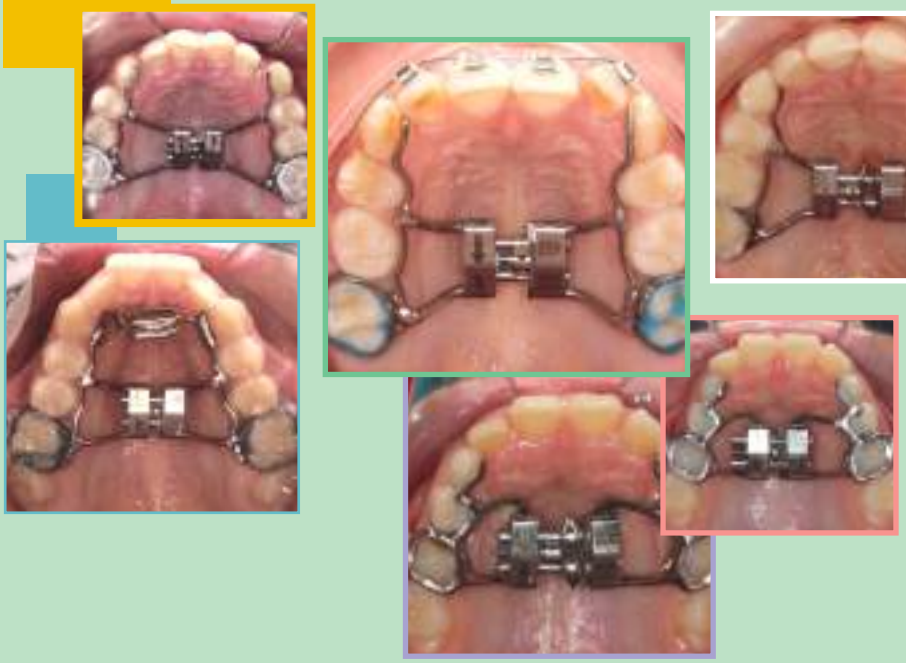
Roberto **FERRO**



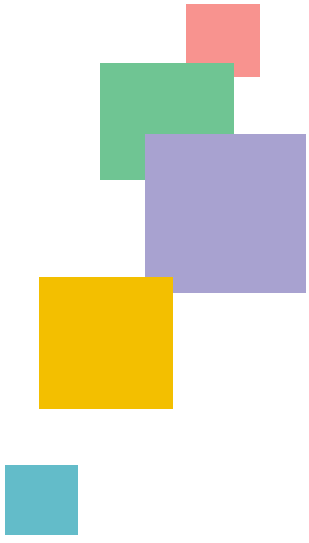
LEAF EXPANDER®

Clinical atlas



English version

Roberto FERRO



LEAF EXPANDER®

Clinical Atlas

ISTITUTO STUDI ODONTOIATRICI

Edited and distributed by
©LEONE S.p.a. 2024
www.leone.it

Graphic design: Leone Graphics Dept. S.p.a.
Print: ABC Tipografia s.r.l.

To Carlo
who was born to fight

To Alberto
always makes me feel good

Atlas
INDEX

HOW THE AUTHOR PRACTICES ORTHODONTICS: **FERROSOFIA**

Will the orthodontic service providers get rid of the orthodontist or will the orthodontist downsize their business plans?

The supposed modern orthodontics that is invading and transforming our profession mirrors the speed with which society is changing.

Artificial intelligence, aligners, mini screws: these would seem to be the basic ingredients for being a 'successful orthodontist'; the impression is that the professional who is practising 'metalbiomechanics and/or functional' is an old-fashioned clinician who has not kept up with the times.

Maybe reading the changes reveals other truths. As a matter of fact, no one cannot notice the creeping and pervasive aggression by the orthodontic providers against our healthcare profession.

It is plain for all to see that consolidated multinationals are transforming the orthodontist into a 'subcontractor' or rather a 'retailer' of the product with the formula *('you dear dentist take care of the documentation, I take care of the diagnosis, I manufacture the product, you pay me for it and then you resell it')*.

And this step is being followed by the next: multinationals are violating the relationship between orthodontist and patient by creating one between them and their 'client who wants the aligner' with the clear aim of totally rid of our figure.

This is why I believe that these changes - strongly induced by rampant commercial marketing - are exploited by professionals who have a simplified, misunderstood if not utilitarian view of orthodontics.

Orthodontics is not just about straight teeth, but harmony of the face, that is easily achieved in a growing patient when jaw dysgnathia can be corrected early on, facilitating the development of a normal occlusion.
Today there are increasingly frequent courses for treating complex cases where you are also taught how to use expensive and invasive appliances, but if you intercept these cases in early mixed dentition, the cases will be perhaps, **yes, surgical, but never complex.**

A simple appliance such as the **Leaf Expander**, for example, is enough to solve a contraction of the upper jaw, i.e., a malocclusion, in a short time and in a non-aggressive way, which should certainly not be treated in adulthood, when the problem has become complicated and expansive to solve.
And it is the Ars Medica that teaches us that illnesses should be treated from the beginning and not when they become apparent.

I think, therefore, that the time has come to review how clinician approaches the profession: if orthodontics is now mostly for the adult patient, it will be and must become even for the child.

And despite this being called 'the century of polymers', with the child, efficient orthodontics remains and will remain orthopaedic, functional and metalbiomechanics.

WHY **AN ATLAS**

An atlas is an iconographic tool whose task is to comprehensively illustrate a topic as in this case the Leaf Expander.
Based on this definition, 30 clinical cases in which the Author used this appliance are reported.
The reader will not be confronted, as is always the case in books or presentations at conferences or social media posts, with selected cases, to be admired, if not envied.
The cases presented may appear sub-optimally documented or may belong to uncooperative subjects, perhaps frightened by the dentist, with oral hygiene that is far from irreproachable, or they maybe cases in which there were errors in the appliance choice, but through which will have the worth of showing how these were solved.
Perhaps the finishing touches to the permanent teeth will be missing because the parents are already satisfied with the result or economic conditions dictate a stop to further treatment.
But...**this is the everyday clinic, these are the cases that, working people, need.**

For this reason, the **keywords** adopted will help the reader to immediately understand the cases in which the Leaf Expander was used.

Keywords:
- *primary dentition*
- *mixed dentition*
- *permanent dentition*
- *posterior cross-bite*
- *anterior cross-bite*
- *upper jaw discrepancy*
- *oral habits*
- *Class I*
- *Class II*
- *Class III*
- *Leaf Expander*
- *Leaf Expander with grid for non-nutritive oral habits*
- *Leaf Expander and functional treatment*
- *Leaf Expander and interceptive treatment*
- *composite guides*
- *bracket system with Ni-Ti archwire.*

Some cases are accompanied by bibliographical notes, the author's evaluations, tables, drawings and pictures that can facilitate understanding and further investigation of the cases (from diagnosis to treatment choice).

PS: the cases presented are part of the documentation of the Practical School of Orthodontics, i.e., a facility where, alongside theoretical training, orthodontics is taught by practising it on patients and, as is only natural, since 'by making mistakes one learns', it is more than understandable that one may encounter some 'professional blunders' by the student side.

This experience has been translated into an atlas thanks to Dr Alberto Besostri, to whom my thanks go for having actively assisted me in this work.
I am bound to Alberto by a natural friendship and brotherly affection.

Roberto Ferro

LEAF EXPANDER - CLINICAL ATLAS

- **INTRODUCTION**
- **LEAF EXPANDER**
- **CONSTRUCTION FEATURES** (FROM ANALOGIC TO DIGITAL)
- **PRESENTATION OF 30 CLINICAL CASES IN THE THREE DENTITIONS** (DECIDUOUS, MIXED AND PERMANENT)

INTRODUCTION

The posterior cross-bite, commonly referred to as cross-bite (XB) (Fig. 1) is the most common form of cross-bite and is the consequence of a discrepancy in transverse dimension between the dento-alveolar processes of the two jaws, whether or not supported by a skeletal discrepancy. The upper jaw is narrower than the lower and is unable to correctly 'cover' it, as a lid.[1]

Fig. 1 - unilateral right cross-bite in primary dentition
(Drawing from the book "La dentatura decidua: dove l'ortodonzia inizia" di Roberto Ferro, Ed Martina Bologna 2022)

During the closing movements between the two jaws, pre-contrasts appear that destabilise the occlusion; in order to avoid them, the mandible deviates to one side; this slippage causes a more or less evident facial asymmetry with deviation of the chin on the cross-bite side; at the same time, the musculature is also forced into neuromuscular compensation with an excess of tension on the cross-bite side.

From an occlusal point of view the picture results in a non-coincidence of the inter-incisive lines, with the superior in line with the median of the face and the inferior deviated from the cross-bite side. The sagittal relationships are Class II (with the cusps of the upper which are not in contact with the central fossae of the lower) on the XB side and Class I or III on the normal side.
Typical, finally, is the presence of an inclination of the occlusal plane vertically with the cross-bite side lower than the normal side (Figg. 2 a-d).

Fig. 2 a - early mixed dentition: the two jaws are not congruent in the transverse plane due to a transverse contraction of the upper arch and the subject, during the closing movement, had pre-contracts at the level of the deciduous canines

Fig. 2 b - in order to stabilise the occlusion, the mandible deviates to the left; the result is a posterior left cross-bite, resulting precisely from the transverse contraction of the upper jaw (functional posterior cross-bite)

Fig. 2 c - Class I dental relationships on the non-cross-bite side

Fig. 2 d - Class II tooth ratios on the cross-bite side

This type of cross-bite, due to the features described above, is defined as a *functional posterior unilateral cross-bite*. It represents for more than 90% of cross-bites of the first dentition.[2,3,4,5]

The transverse discrepancy between the two arches may not be evident at a visit in habitual occlusion. This is the case with some Class II forms in which mandibular advancement with repositioning of the occlusion in dental Class I causes a cross-bite to appear; this is called *relative transverse discrepancy* (Figs. 3 a-f).

Figs. 3 a-c - museum models of a dental Class II

Fig. 3 d - museum model of a repositioned Class II dental, right side

Fig. 3 e - museum model of a repositioned Class II dental, left side

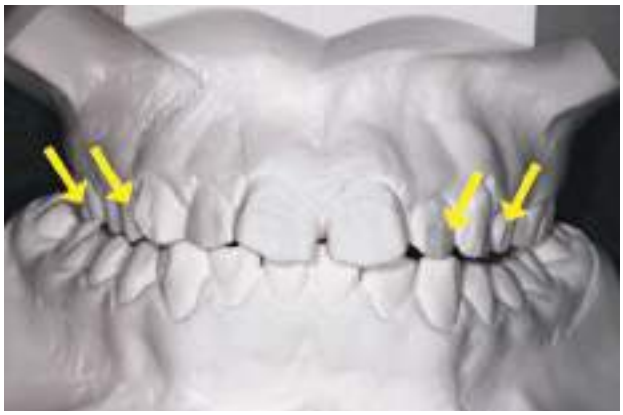


Fig. 3 f - repositioning causes a bilateral cross-bite to appear in frontal view, a sign of a severe transverse discrepancy between the two arches

In Class II forms with transverse discrepancy, the anteroposterior position deficit of the mandible is due to a mandibular retrusion, rather than a reduced mandible size. This is why in mixed dentition the former are referred to as functional forms to differentiate them from anatomical forms.[6] At the same time, the presence of a cross-bite in a dental Class III tends to disappear with the advancement of the upper jaw. Maxillary transverse deficit associated with mono- and bilateral posterior cross-bite is a frequent clinical occurrence (6-30% of the population).[6,7]
Its treatment is most often addressed in mixed dentition and it is due to the possibility of spontaneous resolution in the transition from the first to the second dentition, through expansion of the upper arch.
Either orthopaedic devices are used (capable of opening the median palatine suture) or orthodontic devices, which, by definition, only change the spatial position of the lateral dento- veolar processes; in fact, an expansion even with light orthodontic forces, but conducted within 9/10 years, is capable of opening the median palatine suture.[8,9]
Among the most popular methods is the orthopaedic rapid upper arch expander (ERP). It was introduced in California in 1860 by Emerson Angell, but at that time did not find favour among practitioners as it was not believed to be able to open the median suture of the palate (radiographic confirmation of this mechanism would come with the discovery of X-rays 35 years later by Whilhelm Conrad Röntgen) (Figg. 4 a, b).

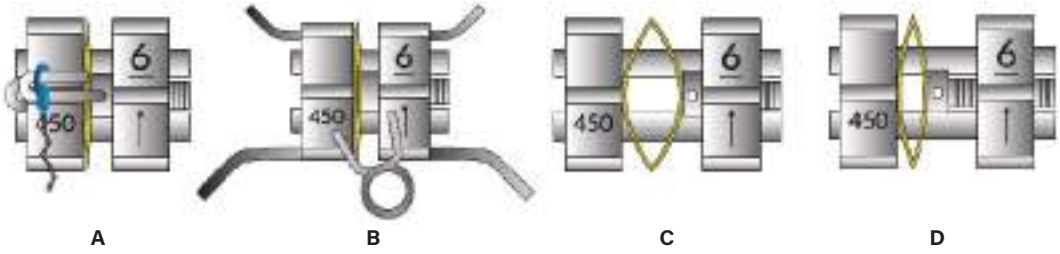
Figs. 4 a, b - portraits of Angell and Röntgen (Emerson Angell: 1822-1903 and Whilhelm Conrad Röntgen: 1845-1923)

It took another century (in 1961 to be precise) for the rapid expander and the involvement of suture to be exploited, and this was thanks to the intuition of Andrew Haas who, after experimenting with it on animals, moved on to its routine use on humans. Seven years later, Biederman proposed a form of expander that became very popular among practitioners: the Hyrax (Hygienic Rapid eXpander) (Fig. 5).[10,11,12]
At the moment, the literature has not yet identified the best way to correct a cross-bite in mixed dentition while also granting effectiveness to orthodontic appliances such as the quad helix.[13]

Fig. 5 - rapid palatal expander, analogue, Hyrax type in mixed dentition anchored on first molars

LEAF EXPANDER

The Leaf Expander is also a palatal expansion device, introduced to the market in 2013. The appearance of this device is in appearance not dissimilar to that of other expanders currently in use, both for rapid and slow expansion; the substantial difference lies in the active component of the device. It is a cobalt chrome metal structure incorporating a central screw that, when activated, compresses 2 or 3 leaf spring-shaped nickel-titanium springs. Once compressed, the leaf springs expand - the deactivation phase - and release a constant, continuous force that expands the artefact itself and discharges onto the dento-alveolar processes of the upper jaw, expanding them (Figs. 6 a-d).



Figs. 6 a-d - how the Leaf Expander works (in this case 450 g and 6 mm)
- at A: as it comes from the workshop; the 2 leaf springs are is reactived and compress the springs and are held by a clip
- at B: the clip when removed after cementation
- at C: the leaf springs open and expand, increasing the overall diameter of the Leaf Expander; fully opening the springs results in an expansion of 3 mm
- at D: the screw is reactived and compress the springs; the activated leaf springs will re-expand, producing an elastic, light and continuous force *(The designs of the various Leaf Expander types are taken courtesy of Lanteri C, Beretta M, Lanteri V, Gianolio A, Cherchi C: Il Leaf Expander, Edizioni Aries 2, 2023)*

Typically, the anchor teeth are the deciduous second molars or the permanent first molars, with the metal sidebars firmly adhered to the lingual collars of the diatoric teeth. Depending on the size of the transverse discrepancy, either a 6 mm or a 9 mm screw can be used; the forces expressed can be 450 or 900 g depending on the age of the patient (Figs. 7-9).

Fig. 7 - the 4 Leaf Expander models on the market.
There are four models of Leaf Expander, subdivided by extent of expansion (6 or 9 mm) and force generated (450 or 900 g). The 6 mm expansion requires two leaf springs, while the 9 mm expansion requires three leaf springs. In the 6mm Leafs, the full opening of the pre-activated leaf springs from the laboratory results in an expansion of 3 mm, in the 9 mm Leafs the expansion is obviously greater, namely 4.5 mm

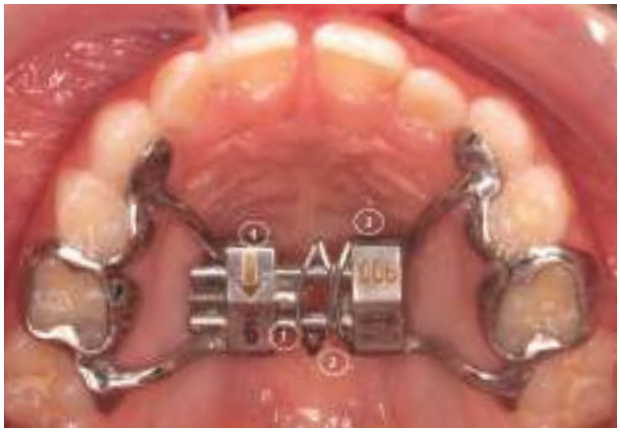


Fig. 8 - Leaf Expander (FDD) Full Digital Designed 9 mm digitally moulded and cemented on second deciduos molars
1: the screw to expand
2: the 3 fully open Ni-Ti leaf springs
3: the amount of force applied is shown (900 g)
4: the arrow indicates the direction to perform every activation

Fig. 9 - Leaf Expander (FDD) Full Digital Designed da 6 mm digitally moulded and cemented on second deciduos molars
1: the screw to expand
2: the 2 fully open Ni-Ti leaf springs
3: the amount of force applied is reported (900 g)
4: the arrow indicates the direction to perform every activation

Therefore, the choice of both the extent of expansion and the force to be applied will be the prerogative of the clinician. The choice of anchorage on deciduous second molars lies in the preservation of the cortical of the permanent molars.[14,15,16]
The leaf springs are pre-activated in the laboratory (by pressing them onto each other and holding them in place by means of a ligature that includes both the screw and the springs themselves). Once the appliance has been inserted into the mouth and the springs have been released, an initial orthodontic expansion of 3 mm or 4.5 mm is guaranteed, depending on the type of Leaf used. Reactivation of the springs can be done according to clinical needs, paying attention to the fact that a quarter turn corresponds to 0.1 mm of re-activation (and 10 quarters therefore to 1 mm of re-activation).

Once the active expansion phase of the arch is completed (the duration of which depends on the age of the subject) the expander is held passively for a further 3/6 months as a retention. Subsequently, the Leaf Self Expander[15] came onto the market, i.e. a self-activating expander that does not need to be reactivated by the clinician as it is screwless. (Figs. 10, 11).

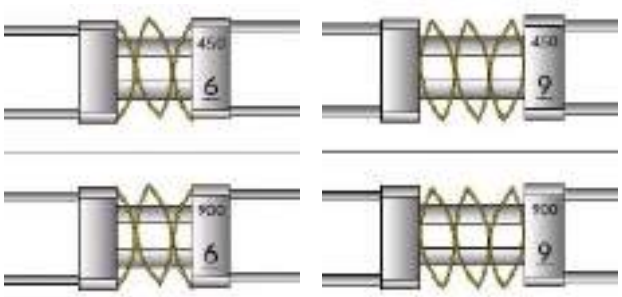


Fig. 10 - Leaf Self Expander. There are four types of Leaf Self Expander on the market, subdivided by the extent of expansion (6 or 9 mm) and force generated (450 or 900 g). The 6 mm expansion requires 4 leaf springs, while the 9 mm expansion requires 6 leaf springs.

Fig. 11 - Leaf Self Expander digitally moulded and cemented onto the first molars. There are 4 leaf springs that allow 6 mm expansion with a force of 450 g

Its effectiveness is totally based on the elasticity of the Ni-Ti leaf springs it is made of, which release continuous and controlled forces. Even for Leaf Self Expander there are two models,, depending on the expansive capacity: 6 mm and 9 mm. In the first case the device has 4 leaf springs, in the second case 6. With both the 6 mm and the 9 mm device, forces of 450 and 900 g can be applied, as with the Leaf (Fig. 10). The force expressed will be chosen by the clinician according to the age of the subject.
The efficacy of this slow expansion device in growing subjects is comparable to that obtained with rapid palatal expansion treatment[8,17,19,20,21] except that for the latter there is a greater anterior expansion effect.[14,22]
In addition to the undoubted advantage of no compliance treatment, the particular strengths of this device are:
- the simplicity of activation and the reduction in the number of appointments required;[8]
- the development of predetermined, light and constant forces according to the manufacturer's specifications;[23]
- comfort with emphasis on the absence of pain even in the first week of treatment;[8,24,25,26,27]
- a capacity, however, to act on the palatine suture even if in a limited manner;[21]
- the increase in intermaxillary diameters between deciduous and permanent teeth;[8,21,28]
- better control of the buccal inclination of the molars;[14,16,18,28,29]
- the increase in diameter of the nasal cavities.[8,14,30,31]

Even in the only study performed in adults, the device achieved increases in transverse diameter with minimal increase in the inclination of the anchoring elements.[32]
Finally, in cases of severe anterior crowding, oral respiration and in borderline subjects in terms of age, its use has been proposed by means of a 'hybrid' protocol in which, first, the diastasis of the palatine suture is induced - as with RPE (3 turns of the screw per day for 10 days) - and then, by releasing the leaf springs, an increase in the inter-arched diameter is achieved.[33]

CONSTRUCTION FEATURES (FROM ANALOGIC TO DIGITAL)

Freely taken from Alvise Caburlotto[34] and Stefano Negrini[35]

The Leaf Expander can be manufactured traditionally (in analogue way) after having developed the upper arch impression on a plaster model, rather with the bands chosen in the studio (Fig. 12) or, as is increasingly the case nowadays, digitally with a CAD-CAM system (Fig. 13).

Fig. 12 - bands tested in the mouth and inserted into the alginate impression

Fig. 13 - Leaf Expander digitally designed

In this case, using a digital flow, the device is designed directly on the scan, without any need to print a physical model of the dental arch. In this way, the device is very precise and not operator dependent, as in the traditional analogue mode, where the overall appliance quality is based on several factors such as: the choice of bands, the manual bending of the wires, the soldering of the components, the standard thicknesses and the experience of the dental technician himself.[34]

The first advantage of this method is the possibility of using the scan made for the initial documentation, which is sent directly to the laboratory via STL file; no new impressions or other appointments are therefore needed, and overall working time is shortened. The structure of the device is designed, by drawing it, in a matter of minutes using the *3DLeone Designer software*. Thanks to this tool, will be easy developing an expander that adapts intimately to the anatomy of patient's mouth, skimming the mucous structures with extreme precision (Figs. 14, 15).

Fig. 14 - the digitally designed Leaf Expander that adapts intimately to the dental structures while respecting the mucous membranes

Fig. 15 - expander framework designed with *3DLeone Designer software*. In addition to the design of the bands and pads, the specially manufactured connections are designed to have a precise, fast and simple fitting when assembling to the Leaf screw, which will be welded after laser melting printing

3D files of the active components (expansion screws, tubes and others such as mini screws) are imported from a continuously updated library in the software. Components such as the Leaf screw are added in a second step through laser welding. The final design is then exported and printed via a laser melting process, most often using Cr-Co orthodontic alloys. The thickness generally used for the bands is 0.7 mm, while for cementation there is a uniform gap (0.05 mm) for the entire band, which is automatically calculated by the software (Fig. 16).

Fig. 16 - the thickness generally used for bands is 0.7 mm, while for cementing there is a uniform gap (0.05 mm) for the entire band that is automatically calculated by the software

Once 3D printed out, the structure of the device is polished. The screw chosen at the design stage is then positioned thanks to the dedicated slots (specially designed for precise, fast and simple assembly) and subsequently welded with a laser procedure.[35] The appliance can be sent to the clinician either on a resin 3D printed model or on its own (Figs. 17, 18).

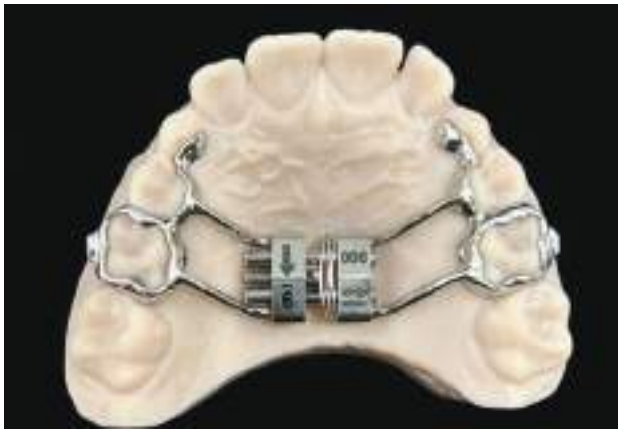


Fig. 17 - Leaf Expander sent to the clinic on a resin model (delivery can take place without a model). Manufactured by: ORTODONZIA ESTENSE, Specialised Orthodontic Laboratory

Fig. 18 - Leaf Expander, without resin model, as sent to the clinic. Manufactured by: ORTODONZIA ESTENSE, Specialised Orthodontic Laboratory

Advantages and disadvantages of digital versus analogue methods
The advantages of digital manufacturing are many and concern the clinician, the patient and the laboratory.

For the **clinician**, the advantages of adopting this process lie primarily in:
- eliminating all impression materials, the storage of impression spoons, the storage of impression trays, as well as the time to ship impressions by courier;
- decreasing appointments for both the possible use of separating elastic bands (seldom in the first years of life) and for band testing;
- deleting the patient's pain resulting from the invasion of the band's interdental space (and this is a considerable advantage that not only makes the orthodontic experience more empathetic, but also heralds positive marketing for the practice in recent years);
- having an extremely precise appliance, not operator dependent, but designed and harmonised to the anatomy of the tooth with adherent bands, which is the reason cement is used as an adhesive material and not, also, as a filler;
- lastly, the opportunity to establish a more participative relationship with the laboratory for the opportunity to check the design of the device thanks to a free software, the *3DLeone Viewer*, which not only allows the future appliance to be analysed in all perspectives, but also allows any changes to be communicated to the technician.

There are two main advantages for **patients**:
On the one hand, their number of appointments is reduced; on the other hand, they are quickly and comfortably fitted with an appliance that, except for the bulkiness, does not cause discomfort. In fact, customised bands do not cause gingival inflammation.

For the **laboratory**:
digital innovation has revolutionised the profession by enabling the manufacture of precise, high quality, standardised appliances that are non-operator dependent and material saving (from plaster to the resin itself).

For the **clinician**:
There is, however, a disadvantage to be added, namely the difficulty in detaching the custom-made bands, which are smooth and very tight. This negative combination for the removal can be overcome by designing small detachment notches both palatal and vestibular (Fig. 19), so as to provide a foothold for the band remover, otherwise it is necessary to use a crown cutter.

Fig. 19 - disconnection notch on the vestibular side. Manufactured by: ORTODONZIA ESTENSE, Specialised Orthodontic Laboratory

PRESENTATION OF 30 CLINICAL CASES IN THE THREE DENTITIONS
(DECIDUOUS, MIXED AND PERMANENT)

The article presents 30 clinical cases divided both by dentition (from deciduous to mixed and permanent) and by complexity and type of treatment.

Cases of posterior cross-bite of mixed dentition are presented (from the early to the late dentition, *resolved only with Leaf*, some of which were followed until the development of the dentition was completed).

There are documented cases (of mixed and permanent dentition) in which the *Leaf has been combined with a grid* to stop an oral habit - in this connection I remember objecting to one of my co-workers for having prescribed a rapid expander with a grid rather than a Leaf, since of the inconvenience the grid could give the parents in the daily activation of the expander.

Four cases of anterior cross-bite in deciduous and mixed dentition are proposed: two were solved with the combined use of *Leaf and face mask,* one solved spontaneously with *Leaf alone and one after setting up a nickel-titanium arch sling*.

In other cases, Leaf has been used as an expander in combination with other treatments such as the use of functional, fixed or distalising systems.

Bibliography

1. Ferro R. La dentatura decidua: dove inizia l'ortodonzia. *Edizioni Martina* Bologna 2022.
2. Bell RA, Kiekach TJ. Posterior crossbites in children : developmental-based diagnosis and complications to normative growth patterns. *Semin orthod* 2014; 20: 77-113.
3. Thilander B, Wahlund S. Lennartsson B. The effect of early interceptive treatment in children with posterior cross bite. *Eur J Orthod* 1984; 6: 25-34.
4. Kurol J, Bergland L. Longitudinal study and cost-benefit analysis of the effect of early treatment of posterior cross-bites in the primary dentition. *Eur J Orthod* 1992;14:173-179.
5. Kennedy DB, Osepchook M. Unilateral posterior crossbite with mandibular shift: a review. *J Can Dent Assoc* 2005; 71: 569-73.
6. Tollaro I, Baccetti T, Franchi I, Tanasescu CD. Role of posterior transverse interarch discrepancy in Class II, Division 1 malocclusion during the mixed dentition phase. *Am J Orthod Dentofac Orthop* 1996;110:417-22.
7. Ferro R, Besostri A, Olivieri A, et al. Prevalence of cross bites in a sample of Italian preschoolers. *Eur J Paediatr Dent* 2016; 4: 307-309.
8. Vella M, Cressoni P,Tripicchio C, Mainardi E, Esposito L. Early Treatment with a Slow Maxillary Ni-Ti Leaf Springs Expander. *Appl. Sci.* 2021,11.
9. De Clerck HJ, Proffit WR. Growth modification of the face: A current perspective with emphasis on Class III treatment. *Am J Orthod Dentofac Orthop* 2015; 148 (1): 37-46.
10. Haas AJ. Rapid expansion of the maxillary dental arch and nasal cavity by opening the midpalatal suture. *Angle Orthod* 1961; 31: 73-90.
11. Haas AJ. The treatment of maxillary deficiency by opening the midpalatal suture. *Angle Orthod* 1965; 35: 200-217.
12. Biederman W: A hygienic appliance for rapid expansion. *Journal Pract Orthod* 1968 Feb;2:67-70.

13. Ugolini A, Agostino P, Silvestrini-Biavati A, Harrison JE ,Batista KBSL Orthodontic treatment for posterior crossbites. *Cochrane Database of Systematic Reviews* 2021.
14. Serafin M, Fastuca R, Caprioglio A. CBCT Analysis of Dento-Skeletal Changes after Rapid versus Slow Maxillary Expansion on Deciduous Teeth: A Randomized Clinical Trial. *J Clin Med* 2022 Aug 20;11-16.
15. Beretta M, Mangano A, Lanteri C, Gianolio A, Cherchi C, Lanteri VII Leaf Self Expander: espansione mascellare collaborazione zero. *Bollettino di informazione Leone* 2020 105;38-44.
16. Lanteri V, Cavagnetto D, Abate A, Mainardi E, Gaffuri F, Ugolini A, Maspero C. Buccal bone changes around first permanent molars and second primary molars after maxillary expansion with a low compliance Ni-Ti Leaf spring expander. *Int J Environ Res Public Health* 2020,17, 9104.
17. Lione, R, Franchi L, Cozza P. Does rapid maxillary expansion induce adverse effects in growing subjects? *Angle Orthod* 2013; 83: 172–182.
18. Abate A, Ugolini A, Maspero C, Silvestrini-Biavati F, Caprioglio A, Lanteri V. Comparison of the skeletal, dentoalveolar, and periodontal changes after Ni-Ti Leaf Spring Expander and rapid maxillary expansion: a three-dimensional CBCT based evaluation. *Clin Oral Investig*. 2023 Sep;27(9):5249-5262.
19. Benhamour S, Brezulier D. Hyrax versus Leaf Expander in growing patients, what about adverse dental effects? A retrospective study. *Int Orthod* 2022; 20: 100684.
20. Gianolio A, Cherchi C, Lanteri V. Rapid and slow maxillary expansion: a posteroanterior cephalometric study. *Eur J Paediatr Dent* 2014; 15(4): 415-418.
21. Lanteri V, Abate A, Cavagnetto D, Ugolini A, Gaffuri F, Gianolio A, Maspero C. Cephalometric changes following maxillary expansion with Ni-Ti Leaf Springs Palatal Expander and rapid maxillary expander: a retrospective study. *Appl Sci* 2021,11,5748.
22. Paoloni V, Giuntini V, Lione R, Nieri M, Barone V, Marino Merlo M, Mazza F, Paasaleva S, Cozza P, Franchi L. Comparison of the dento-skeletal effects produced by Leaf expander in prepubertal patients: a two-center randomized controlled trial. *Eur J Orthod* 2022; 163-169.
23. Lowe R, Makowka S, Manzella K, Warunek S, Al-Jewair T. Mechanical properties of the Ni-Ti Memoria Leaf Spring Activated Expander (Ni-Ti MLSAE) for maxillary transverse discrepancy correction: an in-vitro study. *J Clin Exp Dent* 2020;12(2):154-160.
24. Ugolini A, Cossellu G, Farronato M, Silvestrini-Biavati A, Lanteri V. A multicenter, prospective, randomized trial of pain and discomfort during maxillary expansion: Leaf Expander versus Hyrax Expander. *Int J Paediatr Dent* 2020;30: 421-428.
25. Nieri M, Paoloni V, Lione R, Barone V, Marino Merlo Mjr, Giuntini V, Cozza P, Franchi L. Comparison between two screws for maxillary expansion: a multicenter randomized controlled trial on patient's reported outcome measures. *Eur J Orthod* 2021: 293-300.
26. Rutili V, Nikeri M, Franceschi D, Pierleoni F, Giuntini V,Franchi L. Comparison of rapid versus slow maxillary expansion on patient-reported outcome measures in growing patients: a systematic review and meta-analysis. *Progress Orthod.* 2022 12;23(1):47.
27. Altuhafy M, Jabr L, Michelogiannakis D, Khan J. Self-perceived pain in Hyrax versus other maxillary expansion orthodontic appliances: a systematic review of clinical studies. *Eur Arch Paediatr Dent.* 2023 24(3):279-292.
28. Manzella KS, Warunek S, Scott Conley R, Al-Jewair T. A controlled clinical study of the effects of the Ni-Ti memoria Leaf spring activated expander. *Australasian Orthod J* 2018; 34(2):196-204.
29. Ulug B, Ozcirpici AA. Early maxillary expansion with the Ni-Ti memory Leaf Expander - A compliance-free fixed slow maxillary expansion screw: a report of 2 cases. *Turk J Orthod* 2021.
30. Lanteri V, Farronato M, Ugolini A, Cossellu G, Gaffuri F, Parisi FMR, Cavagnetto D, Abate A, Maspero C. Volumetric changes in the upper airways after rapid and slow maxillary expansion in growing patients: a case-control study. *Materials* 2020, 13, 2239.
31. Mobrici P, Lanteri C, Beretta M, Caprioglio A. Dental and skeletal modifications in adult patients treated with slow maxillary expander. *Mondo Ortodontico* 2012;37(5)(S1):S41-S46.
32. Gianolio A, Donelli M, Angelino E, Lanteri C, Beretta M. Espansore a balestre in Ni-Ti "hybrid": RME e SME con lo stesso dispositivo. Studio pilota. *Dental Cadmos* 2023; 91(4):288-299.
33. Caburlotto A: RPE from analogic to digital: vantaggi e svantaggi della metodica digitale. *Bollettino di Informazione Leone* 110/10-2022.
34. Negrini S: Full digital Leaf Expander in Il Leaf Expander di Lanteri C , Beretta M, Lanteri V, Gianolio A, Cherchi C. *Edizioni Aries 2* Milano 2023.

30 CLINICAL CASES

chapter 1 CASES TREATED **ONLY WITH LEAF EXPANDER**

chapter 2 CASES TREATED WITH **LEAF EXPANDER AND 2x4**

chapter 3 **ANTERIOR CROSS-BITE** CASES

chapter 4 CASES TREATED WITH **LEAF EXPANDER AND ANTERIOR GRID**

chapter 5 **COMPLEX CASES** WHERE EXPANSION PHASE WAS ACHIEVED WITH LEAF EXPANDER

POSTERIOR CROSS-BITE IN MIXED DENTITION

Case treated only with Leaf Expander

CLINICAL CASE no. 1

Nathalie
age 8

8-years-old subject who, within a normal facial and dento-skeletal profile, presents an upper jaw transverse discrepancy that results in a monolateral functional posterior right cross-bite.

Treated in 6 months with a 9 mm and 900 g Leaf Expander (Full Digital Designed), she is currently undergoing a six-monthly check-up.

She presents a correct occlusion and does not wear any retention; we are waiting for patient growth and dentition changing, forecasting an almost normal occlusion.

Figs. 1 a-e - initial documentation: frontal and profile facial pictures

Figs. 2 a-e - initial documentation: intraoral clinical pictures

Fig. 3 - panoramic radiography is the only X-ray examination required

Fig. 4 - **June 2022**: delivery of the 9 mm and 900 g *(FDD) full digital designed* Leaf Expander, cemented on E

Figs. 5 a, b - the month following, **July 2022,** the leaf springs are already open and reactivated with 15 turns

Figs. 6 a, b - **September 2022:** check, cross-bite solved in 3 months; the leaf springs are opened and we decided to leave it in situ for another 3 months

Figs. 7 a-e - **December 2022:** after a total of 6 months of treatment the appliance is removed

Figs. 8 a-c - **December 2023:** check at 12 months after appliance removal; we are in the intertransitional mixed dentition, which is proceeding normally

References on a glance and images

Proffit WR
1936-2018

Proffit WR, Fields Jr HR, Larson BE, Sarver DM
Ortodonzia moderna 6ª edizione italiana 2021 *Edra edizioni*

The correction of posterior cross-bites in mixed dentition

"Posterior cross-bite correction in mixed dentition increases the circumference of the arch and provides more space for permanent teeth. On average, a 1-mm increase in interpremolar width increases arch perimeter values by 0.7 mm..."

"Expansion in mixed dentition reduces the incidence of posterior cross-bite in permanent dentition."

"Although it is important to determine whether the XB is skeletal or dental in the years of early mixed dentition the treatment is the same since relatively light forces can move teeth and bone...The heavy force given by a device with a central screw is only necessary when the medial palatine suture has begun to digitise significantly during adolescence..."

(Page 361)

POSTERIOR CROSS-BITE IN MIXED DENTITION

Case treated with Leaf Expander and 2x4 in 4 months

CLINICAL CASE no. 9

Joanna
age 8,9

Almost 9-years old girl is finishing early mixed dentition in Class I molar on the left; there is a misalignment of the interincisive lines with a functional unilateral posterior cross-bite on the right extended from the lateral incisor to the molar (obviously on the right it is Class II - consequently it is a functional subdivision on the right).

She was treated with 6 mm and 450 g Leaf Expander cemented on the first molars with the addition from the second month of a 2x4.
The treatment lasted a total of four months and the patient is checked quite regularly every six months. The dentition changing is now complete and the patient, as well as her parents, is satisfied with the result.

She does not wear any retention.

Figs. 1 a, b - initial documentation: frontal facial pictures

Figs. 2 a-d - initial documentation: intraoral clinical pictures

Fig. 3 - **February 2019:** cementing a Leaf Expander (6 mm and 450 g)

Figs. 4 a-c - the following month in **March 2019** when an upper 2x4 with a .016" Ni-Ti arc is placed

Fig. 5 - **April 2019:** fully Leaf Expander re-activation (2 months for pre-programmed expansion)

Figs. 6 a-c - **May 2019,** check: the cross-bite has been completely solved

Figs. 7 a-e - **June 2019,** when we remove it after four months: no retentions is delivered.
Let *'growth does its path'* by performing just a little slicing at the lower arch

Figs. 8 a-e - **September 2021:** we wait the exfoliation of 75; there is generalised gingivitis due to poor oral hygiene

Figs. 9 a-e - **November 2022,** end of dentition changing: the treatment lasted 4 months

Fig. 10 - **February 2019:** before starting

Fig. 11 - **November 2022:** end of dentition changing

Figs. 12 a-c - **July 2023,** check; the patient does not wear any retentions

ANTERIOR CROSS-BITE IN PRIMARY DENTITION

Case treated with Leaf Expander and face mask

CLINICAL CASE no. 12

Rachel
age 5,9

A 5 years 9 month old girl with primary dentition shows with an anterior cross-bite and Class III dental notes, especially on the left side.
The skeletal pattern, acquired as part of a poor and repeated teleradiographic documentation, is a Class I, despite of a Wits value of -7 mm.
Also the ratio and the length of the mandibular body and the anterior skull base was found to be within the normal range. This parameter, which is based on the concept of architectural equivalence of Enlow et al. (1969), is used by the author when he has diagnostic difficulties in cases of dento-skeletal Class III in the first years of life.[1,2]

Initially, it was subjected to palatal expansion with 6 mm, 450 g Leaf Expander and sagittal traction with Petit's mask using, only at night, elastic bands of 300 grams.[2,3]

In 10 months, the cross-bite was solved and correct occlusal relationships were achieved on both sides.
Except for a 3-month interlude to align and level the upper frontal group - using pre-informed brackets and .012" Ni-Ti archwires - the patient has only undergone follow-ups over the years.

When the dentition changing is complete, the child, who has become a teenager, and the family are more than satisfied with the treatment they received.

Figs. 1 a-e - initial documentation: frontal and profile facial pictures

Figs. 2 a-f - initial documentation: intraoral clinical pictures

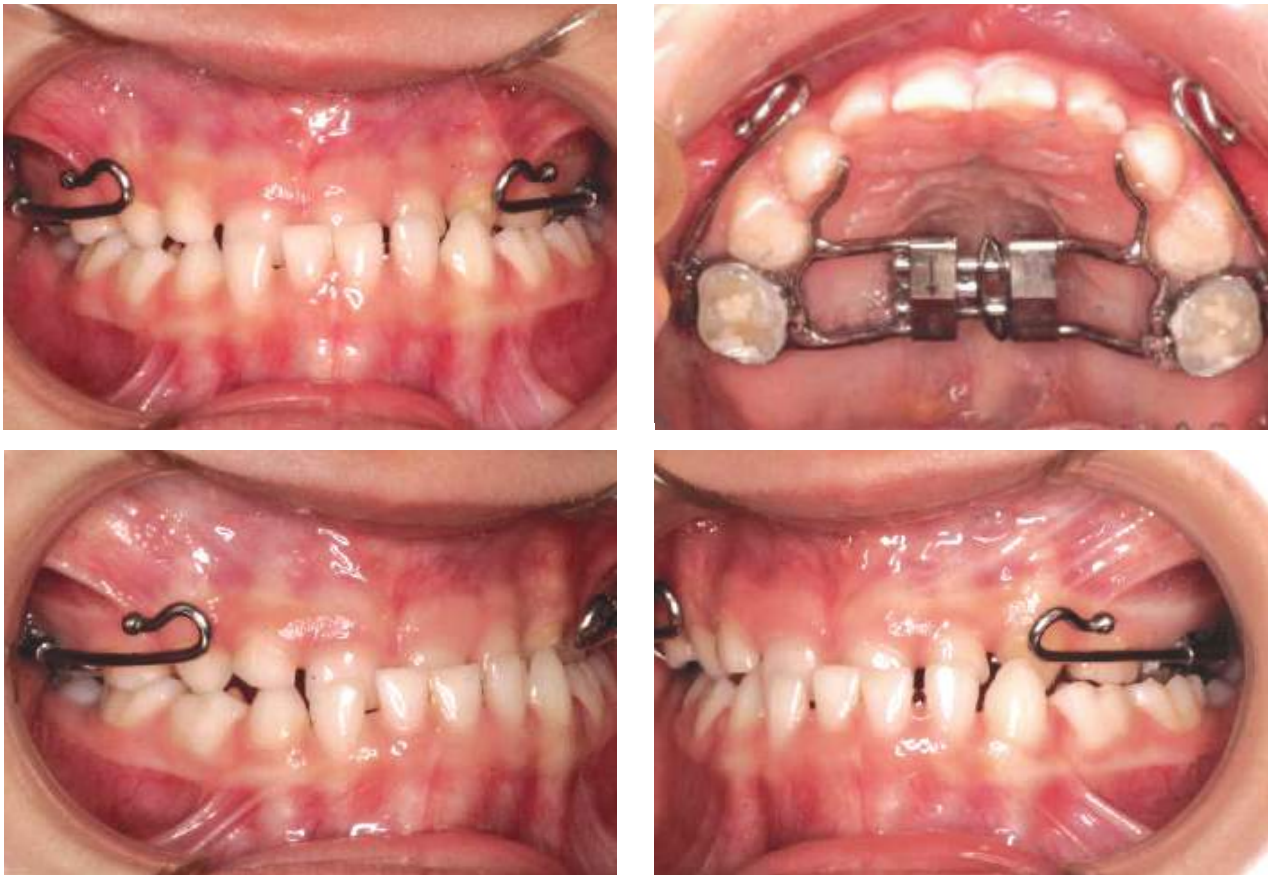
Figs. 3 a, b - initial documentation: plaster models

Fig. 3 c - right important mesial step, canine Class III ratio, reverse bite, spacing

Fig. 3 d - left mesial step, mild Class III canine, reverse bite, spacing

SNA	90°
SNB	89°
ANB	1°
Wits	-7 mm
Sn-GoGn	25°
Gogn-ANS PNS	20°
1sup- ANS PNS	105°
1inf-GoGn	95°
1inf- APog	4 mm
OJ	-2 mm
OB	-2 mm
>interincisive	130°

Figs. 4 a-c: initial documentation: radiographic examinations (in yellow the most significant cephalometric deviations)

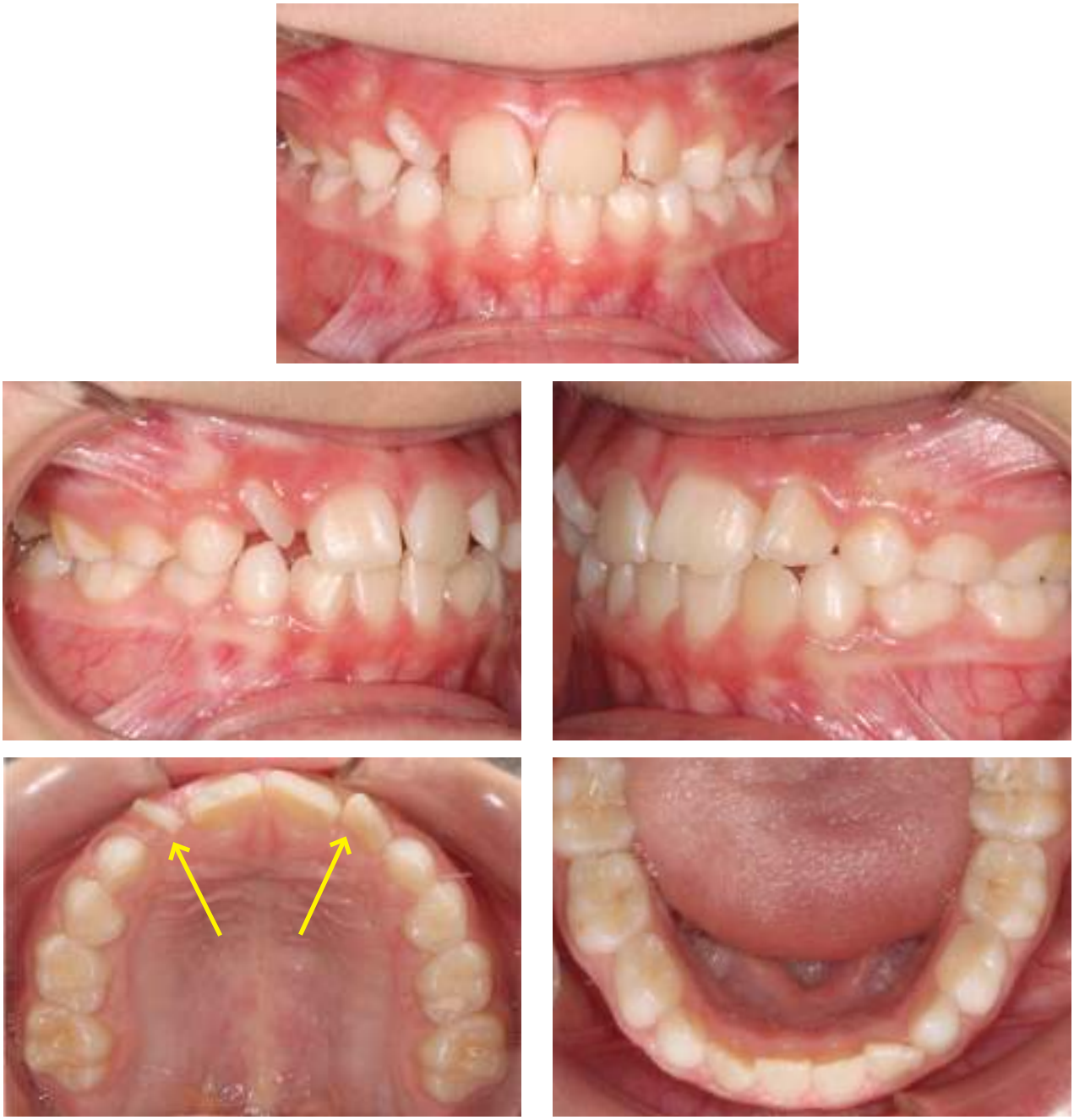


Figs. 5 a-d - use of the Leaf Expander with face mask arms to solve transverse and sagittal discrepancies (Leaf spring is open)

Figs. 6 a, b - use of the face mask

Figs. 7 a-e - after 10 months, both the Leaf Expander and the face mask are removed

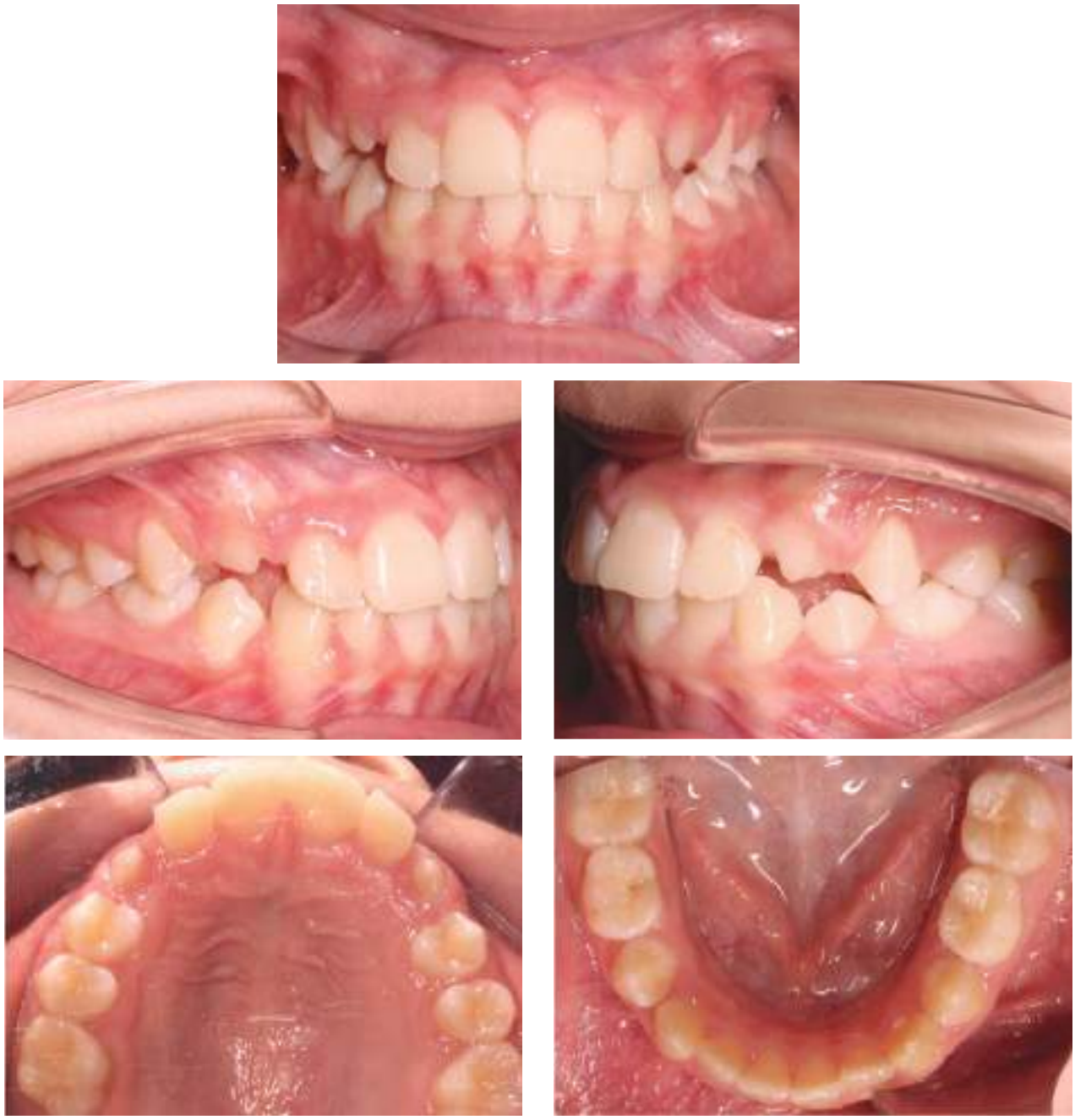
Figs. 8 a-c - once the appliance is removed, the face is photographed, showing no skeletal Class III features as in the pre-treatment pictures



Figs. 9 a-e - during the early mixed dentition: the lateral incisors come out misaligned

Figs. 10 a-c - therefore a 2x4 is placed to align the anterior group

Fig. 11 - radiographic check



Figs. 12 a-e - late mixed dentition

Figs. 13 a-e - dentition changing completed, after reconstruction of 11 following enamel-dentin fracture of same

SNA	94°
SNB	92°
ANB	2°
Wits	-2,4 mm
Sn-GoGn	24°
Gogn-ANS PNS	20°
1sup- ANS PNS	126°
1inf-GoGn	90°
1inf- APog	2,5 mm
OJ	2 mm
OB	2 mm
>interincisive	120°

Figg. 14 a, b - teleradiography at the completed dentition development and at the end of the treatment with the corresponding cephalometric data; the Wits index has clearly improved

Figs. 15 a-d - when the patient is 15 years old: frontal and profile facial pictures

Figs. 16 a-f - when the patient is 15 years old: intraoral clinical pictures

References on a glance and images

Donald Enlow
1927 - 2014

1. Enlow DH, Moyers RE, Hunter WS, McNamara JA Jr.
A procedure for the analysis of intrinsic facial form and growth. An equivalent-balance concept. *Am J Orthod.* 1969 Jul;56(1):6-23.

The authors claim that in any functional assembly of bones of the craniofacial complex there are certain key dimensions that must correspond to each other in order for growth to occur normally; specifically, the mandibular body must have precise proportions in relation to the skull base over the years, otherwise there will be disruption in the sagittal plane.

Barry Leighton
University
of London
1920 - 2002

2. Bhatia AN, Leighton BC. A Manual of facial growth. A computer analysis of longitudinal data.*Oxford University Press* 1993.

The tables for boys and girls show the ratios considered normal between jaw body and anterior skull base depending on the age of the subject. For example, in a 6-years-old boy, the body of the jaw (Go-Me) should have a length equal to 91% of the anterior skull base (SN). The closer the ratio is to 1, the more the mandible has a Class III growth tendency.

♂

Age Years	Male Mean	SD
4	0.86	0.53
5	0.89	0.55
6	0.91	0.51
7	0.92	0.50
8	0.94	0.56
9	0.96	0.59
10	0.97	0.58
11	0.98	0.59

♀

Age Years	Female Mean	SD
4	0.84	0.47
5	0.90	0.43
6	0.92	0.45
7	0.94	0.50
8	0.95	0.48
9	0.97	0.48
10	0.98	0.50
11	0.98	0.53

GoMe/SN report sec the Bathia - Leighton

Jean Delaire
1923-2022

3. Delaire J. Maxillary development revisited: relevance to the orthopaedic treatment of Class III malocclusions. *Eur J Orthod.* 1997 Jun;19(3):289-311.

The author emphasises the importance of an overall approach to Class III skeletal dysmorphia in which the use of the facial mask, although crucial, must be supported by a myofunctional treatment aimed at correcting both the muscular dysfunction that accompanies the malocclusion and the muscular changes caused by the post-treatment dento-skeletal spatial variations.

4. Ferro R. Dove l'ortodonzia inizia : la dentatura decidua; Capitolo 12: il morso crociato anteriore. *Edizioni Martina* Bologna 2022

The author recommends the use of the face mask, not only in skeletal Class IIIs - the true ones according to Moyers' classification - but also in pseudo-Class IIIs, where its use is characterised by lighter sagittal tensile elastic forces (2/300 g).

AUTHOR'S NOTE
ON SUCKING ORAL HABITS

Taken from his text Dove l'ortodonzia inizia: la dentatura decidua *Ed. Martina* Bologna 2022

The persistence of the non-nutritive sucking habit causes a malocclusion in the three spatial planes featured by the presence or tendency of an open bite at the site of finger or dummy pressure, a narrowed upper arch, a posterior cross-bite, a decreased upper intercanine diameter, vestibularised and sometimes diastematous upper incisors with increased arch perimeter and lingualised lower incisors.

These alterations are caused both by direct pressure of the finger on the teeth, by altered pressure of the cheek, lips and tongue and finally by the hyper-eruption of the posterior teeth as a result of the position of the finger interfering with the anterior teeth standard eruption.

Drawing from the book: **L'Ortodonzia pediatrica o delle prime due dentature. Con poco... tanto** Ferro R et al. *Ed Ariesdue* 2018

The open bite is the consequence of the direct pressure of the finger which, while on one hand blocks the eruption of the front teeth, on the other hand, by keeping the jaw detached, promotes the hypereruption of the posterior teeth, thus contributing to the post-rotation of the jaw. Finger pressure also favours a different inclination of the front teeth, proinclining the upper ones and retroinclining the lower ones.

During sucking, the tongue finds itself stuck under the finger and is thus prevented from performing its morphogenetic action on the palate. At the same time, the buccinator muscle increases its activity, which is particularly noticeable at the corners of the mouth, promoting the appearance of a narrowed V-shaped upper arch. Anterior open bite results in a resting lingual interposition and swallowing that takes off from the abnormal lingual position.

There is no automatic correlation between non-nutritive oral habits and malocclusion.
The occurrence of the latter in relation to the harmful habit depends on factors such as:
- the age of debut,
- the type of habit,
- its frequency (hours per day),
- duration of the habit (months or years).

These factors find support in the theory of equilibrium whereby, for a force applied in the stomatognathic system to be able to produce a change, it must be applied continuously for at least 6 hours.

Therefore, it is crucial for the appearance of morphological alterations of the teeth that the child sucks continuously for several hours a day, and not occasionally, as maybe the case when the child only uses the soother to fall asleep.

Five cases (16, 17, 18, 19, 20) in mixed and permanent dentition of subjects with sucking habit treated with various modalities are presented below, with the use of a Leaf Expander with grid in common at an early stage.

CLASS II DENTO-SKELETAL IN MIXED DENTITION WITH UPPER JAW TRANSVERSE DISCREPANCY DUE TO SUCKING ORAL HABIT

Case treated with Leaf Expander, 2x4 and Herbst Hanks type

CLINICAL CASE n. 16

Paolo
age 9,6

A 9.6-years-old subject in the late mixed dentition in Class II dento-skeletal with an open bite and upper arch discrepancy due to oral habit (finger sucking). The initial use of a 6 mm, 450 g Leaf Expander combined with a 2x4 (for a total of 6 months) achieved both correction of the malocclusion in the transverse plane and quit of the harmful habit.

He did not cooperate either in wearing the facebow or a mobile functional like the Andresen, but found no difficulty in wearing a Herbst Hanks type, worn for only seven months.

Profilometric improvements and cephalometric changes are reported.

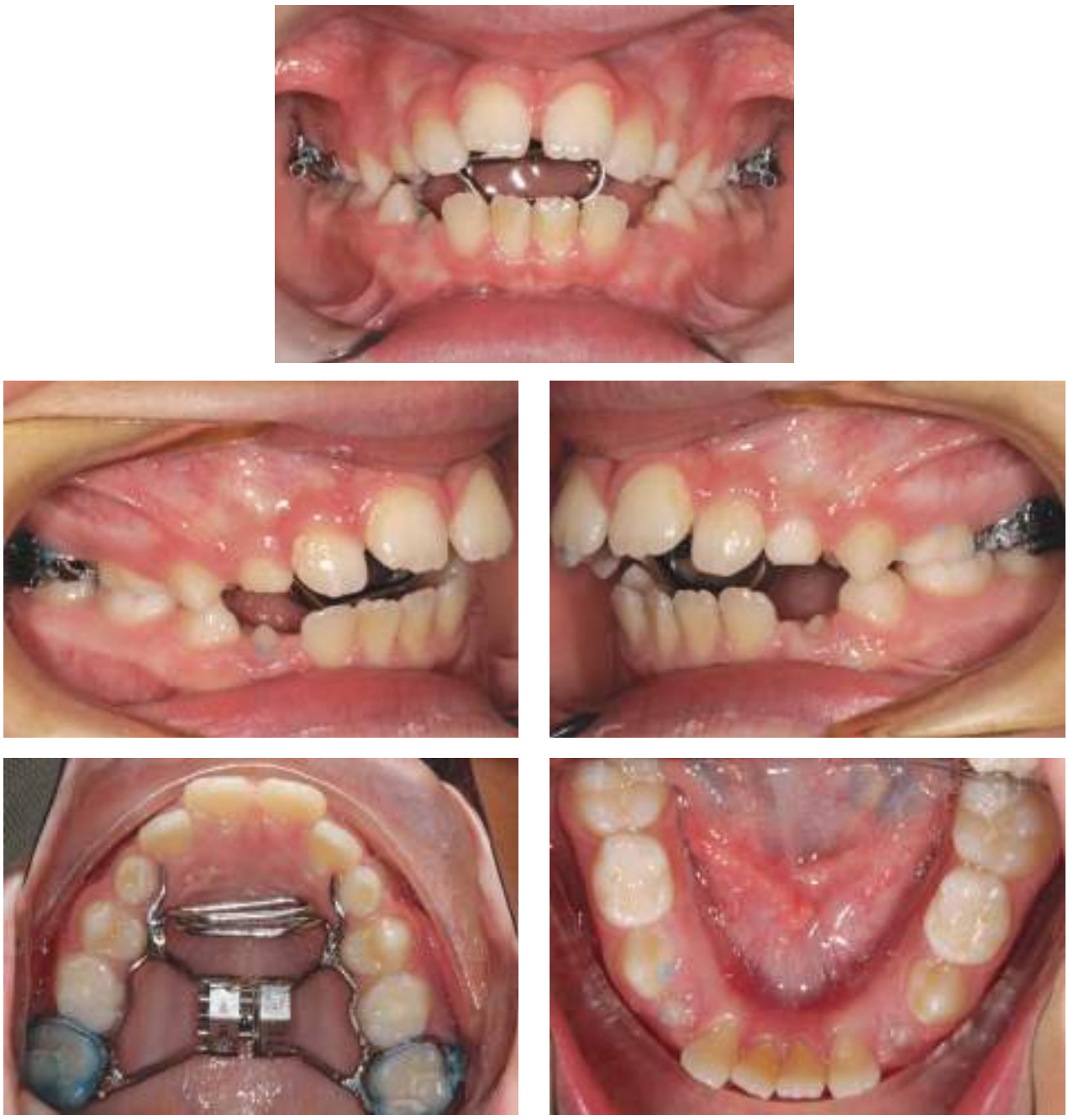
Figs. 1 a-e - initial documentation, **May 2019**: frontal and profile facial pictures

Figs. 2 a-g - initial documentation, **May 2019**: intraoral clinical pictures

Figs. 3 a-e - initial documentation: plaster models

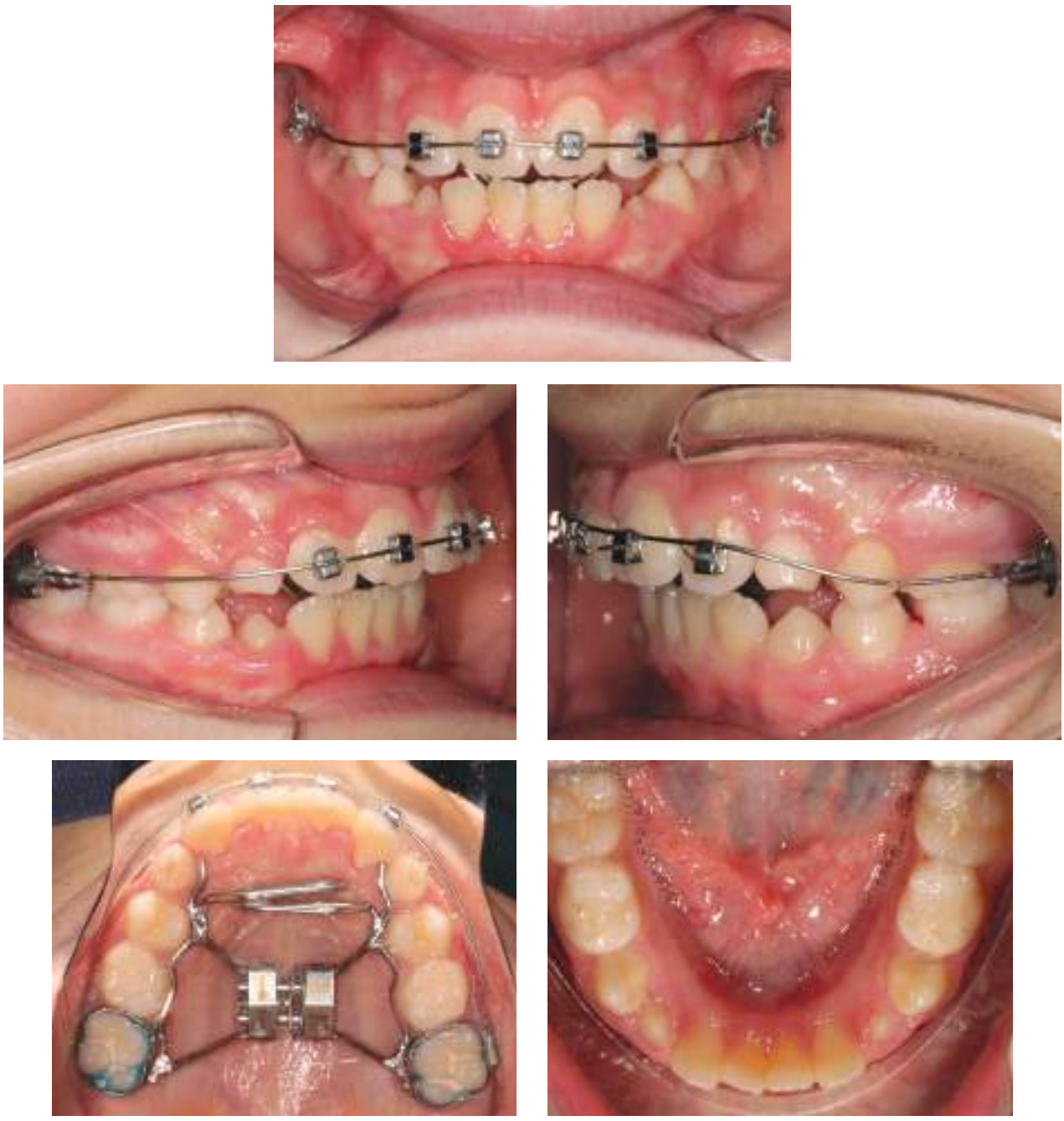
SNA	79°
SNB	72°
ANB	7°
Wits	4 mm
Sn-GoGn	39°
Gogn-ANS PNS	27°
1sup- ANS PNS	119°
1inf-GoGn	90°
1inf- APog	0 mm
OJ	8 mm
OB	-4 mm
>interincisive	114°

Figs. 4 a-c - initial documentation (in yellow the cephalometric values most deviating from the standard values)



Figs. 5 a-e - **September 2019:** a 6 mm, 450 g Leaf Expander is placed with a grid to prevent finger sucking, before removing the ligature holding the leaf springs in place

Figs. 6 a-e - in **October 2019**, the following month, a 2x4 (Tweed bracket) with a .014" Ni-Ti archwire is also placed



Figs. 7 a-e - **November 2019:** we switch to an upper .020" Ni-Ti archwire and deliver a TEO that, however, will never be worn

Figs. 8 a-e - **February 2020:** the dental Class, having never worn the TEO, has not changed; to accelerate the closing of the bite, the archwire is passed over the brackets. The Ni-Ti springs are fully opened. In the lower arch, mesial slicing is performed on the E-E

April 2020

After 6 months, the two appliances (Leaf and 2x4) are removed and he is given an Andresen which, like the TEO, will not be worn. The following year in **April (2021)**, after assessing the mandibular growth progress using the method of the second phalanx of the middle finger, he is fitted with a fixed functional (Herbst Hanks type) which he will wear for 7 months.

Figs. 9 a, b - **April 2021:** Fränkel manoeuvre pre-positioning of the functional

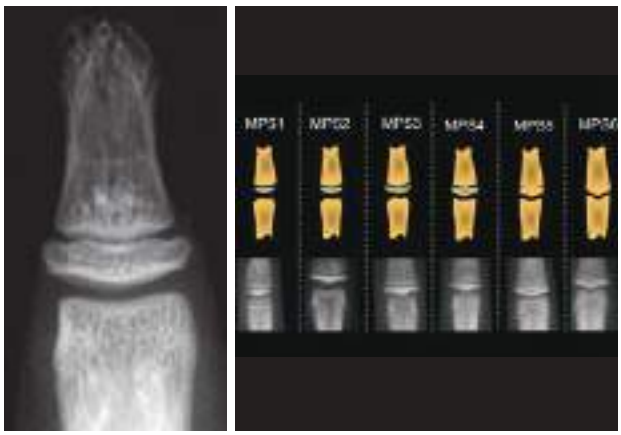


Fig. 10 a, b - **April 2021:** radiogram of the second phalanx of the third finger; the patient is in the "advanced" MPS2 phase, i.e. he is close to the mandibular growth peak. Opposite is a summary diagram of the 'second phalanx of the middle finger method'.

Figs. 11 a-c - **April 2021:** Herbst Hanks type is applied

Figs. 12 a-e - **November 2021:** premature removal of Herbst after 7 months due to breakage

SNA	79°		78°
SNB	72°		76°
ANB	7°		2°
Wits	4 mm		1 mm
Sn-GoGn	39°		38°
Gogn-ANS PNS	27°		26°
1sup- ANS PNS	119°		104°
1inf-GoGn	90°		98°
1inf- APog	0 mm		2 mm
OJ	8 mm		3 mm
OB	-4 mm		0,5 mm
>interincisive	114°		109°

Figs. 13 a-e - cephalometric changes: skeletal ratios in the sagittal plane have normalised; skeletal Class II has become I

Figs. 14 a-e - **September 2023:** final documentation of the face; pictures d-e show the profilometric changes that occurred with the treatment

Notes on functional treatment (and Herbst in particular)

Wilhelm Balters
1893-1973

Functional appliances are devices, originally developed in Europe at the beginning of the last century, with the aim of correcting second classes in the growing patient by posturing the jaw forward.

Their mechanism is based on the effect of pressure caused by muscular stretching resulting from the advanced mandibular position, which, transmitted to the teeth and skeletal structures, modifies the tooth position and growth pattern of the maxillofacial district.
As they are nowadays used in different clinical situations, from Class II to Class III, in subjects with altered skeletal divergence or to re-balance the oral musculature as a whole, a more coherent definition is the one proposed by Mitchell L.,[1] i.e. *"appliances capable of modifying the musculature, the dental eruption and with it the occlusion and growth of the maxillofacial complex".*

The Herbst is a fixed functional appliance proposed in the early 20th century in growing subjects with mandibular retrusion that found much acceptance among clinicians because it did not require any patient compliance. It was a device that constantly kept the mandible moving forward by means of telescopic guides. Having fallen into oblivion, it was resurrected by Hans Pancherz at the end of the 1970s becoming very popular and being offered in several versions.[2,3]

Rolf Fränkel
1908-2001

The case illustrated is a Herbst Hanks type which has these features: four bands are cemented on the molars, the lower ones with a cantilever that extends to the first lower premolars. At the ends of the cantilevers (right and left), as well as on the bands, there are nuts into whose threads the screws forming part of the telescopic system are screwed. This is a component that incorporates in one piece a double tube, the piston and the two screws. These, in turn, connect to the threads of the nuts by means of a gimbalsystem, i.e. a cavity into which the head of the screw is inserted, which is able to rotate in the three planes of the 35° space and which is screwed into the nuts of the bands and cantilevers (Figs. 11 a-c).[3]

Research with CBCT has clearly underlined both skeletal and dento-alveolar changes induced by Herbst, at least in the short term. If from a skeletal point of view there is a condyle growing posteriorly and upwards with concomitant remodelling of the glenoid fossa and mandibular advancement, while the maxillary upper jaw distalises and lowers, from a dento-alveolar point of view, on the other hand, there is molar distalisation with straightening of the incisors and proinclination of the lower.[4]

As reported in all the international literature, the undoubted efficiency of Herbst is undermined by frequent breakages, which pose quite a few problems for the clinician.[5]

1. Mitchell L. An introduction to orthodontics Fourth Edition. (2013) *Oxford University Press* (UK).
2. Pancherz H. The mechanism of Class II correction in Herbst appliance treatment. A cephalometric investigation. *Am J Orthod.* 1982 Aug;82(2):104-13.
3. Pacha MM, Fleming PS, Shagmani M, Johal A. The skeletal and dental effects of Hanks Herbst versus twin block appliances for class II correction in growing patients: a randomized clinical trial. *Eur J Orthod.* 2024 Jan 1;46(1).
4. Souki BQ, Vilefort PLC, Oliveira DD, Andrade I Jr, Ruellas AC, Yatabe MS, Nguyen T, Franchi L, McNamara JA Jr, Cevidanes LHS. Three-dimensional skeletal mandibular changes associated with Herbst appliance treatment. *Orthod Craniofac Res.* 2017 May;20(2):111-118.
5. Proffit WR, Fields Jr HR,Larson BE ,Sarver DM. Ortodonzia moderna 6ª edizione italiana 2021 *Edra edizioni.*

Practical classification of functional appliances used at the Scuola Pratica di Ortodonzia di Cittadella

1. **jaw forward posture devices** including **mobile devices** (Andresen, Twin Block, Sander, etc) and **fixed with telescopic mechanism** (type Herbst, Forsus, Go to One, etc);

2. appliances that work on the **dynamic space of the mouth** by re-balancing the musculature (Bionator, Fränkel, ELN di Bonnet);

3. **devices with metal bites to avoid occlusal relationship between the upper and the lower jaw** (Cervera, Bracco and Planas).

POSTERIOR CROSS-BITE
AT THE END OF DENTITION CHANGING IN CLASS I

Case treated with Leaf Expander and Straight Wire appliance

CLINICAL CASE no. 21

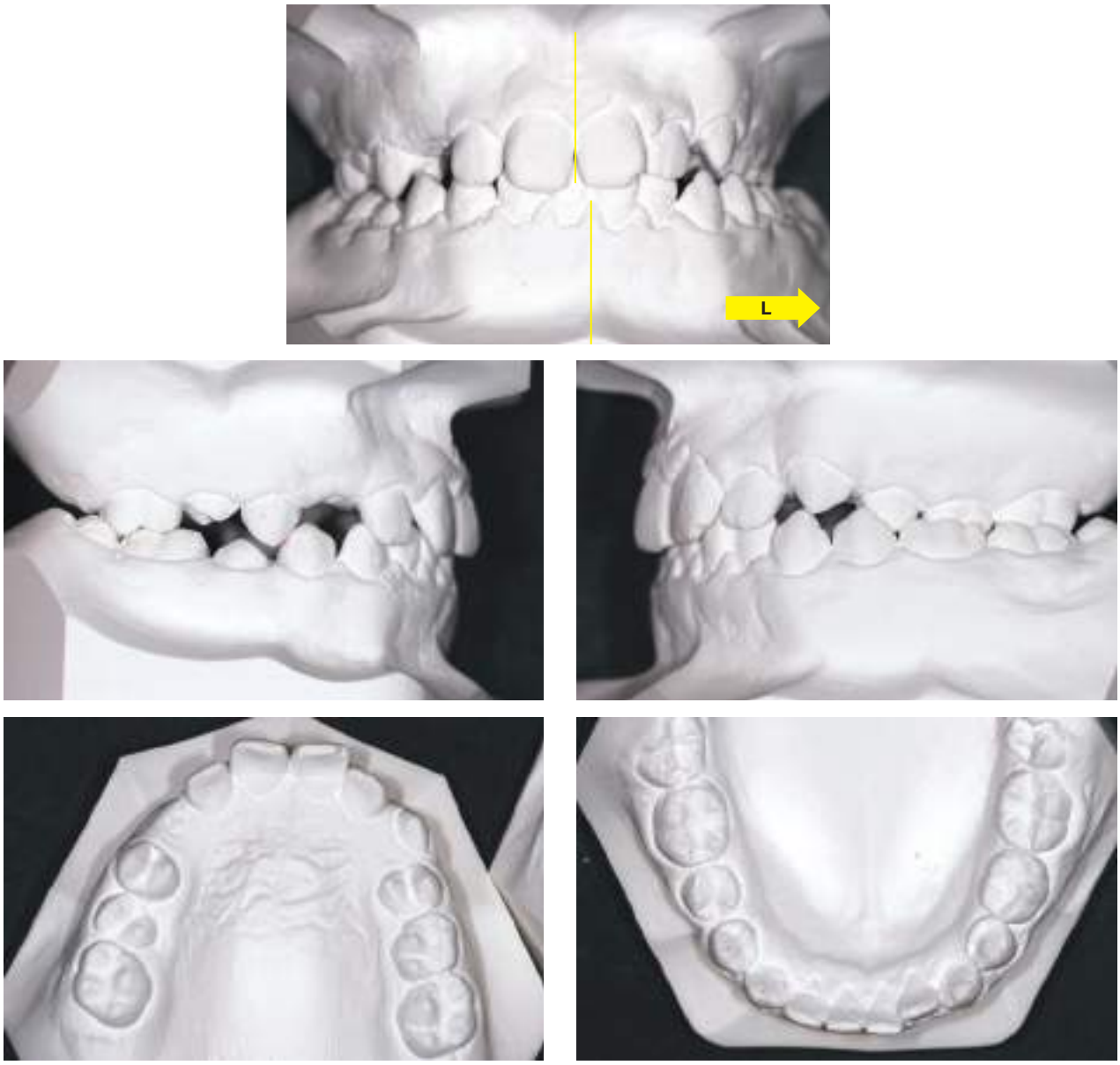
James
age 12

A 12-years-old subject showing a functional left posterior cross-bite in dental Class I, treated in 8 months with a 6 mm and 450 g Leaf Expander.

Once the transversality was corrected, the patient underwent fixed treatment using the Straight Wire technique (STEP system).

Figs. 1 a-e - **September 2015,** initial documentation: frontal and profile facial pictures

Figs. 2 a-f - initial documentation, **September 2015**: intraoral clinical pictures



Figs. 3 a-e - initial documentation: plaster models. In the picture of the frontal model, the two medians are drawn; the arrow indicates the mandibular positioning to the left

SNA	82°
SNB	80°
ANB	1°
Wits	2 mm
Sn-GoGn	31°
Gogn-ANS PNS	25°
1sup- ANS PNS	113°
1inf-GoGn	89°
1inf- APog	1 mm
OJ	4 mm
OB	5 mm
>interincisive	132°
Co–Go–Me	131°

Figs. 4 a-c: initial documentation - radiographic examinations

Fig. 5 - **November 2015:** a 6 mm, 450 g Leaf Expander is cemented (no occlusal picture was documented)

Figs. 6 a-d - 3 months later, in **February 2016**: Leaf Expander is re-activated

Figs. 7 a-d - **April 2016,** check; the Leaf Expander is re-opening

Figs. 8 a-e - **July 2016:** the Leaf Expander is removed, after 8 months

Figs. 9 a-d - **December 2016:** brackets placement on the upper arch with .016" Ni-Ti archwire and canine enameloplasty is performed

Figs. 10 a-e - **May 2017:** working archwires are positioned at both arches; at the upper one a posted with elastic tie-back is inserted to close the gaps

Figs. 11 a-e - **October 2017:** reactivated elastic tie-back only on the left side; continues with class elastic on the left and intercuspation elastics on the right

Fig. 12 a-c - **November 2017:** settling of the arches; upper from cuspid to cuspid .016" Ni-Ti archwire; triangle elastics on both right and left to improve intercuspation

Figs. 13 a-e - **January 2018:** treatment completed

Figs. 14 a-d - **January 2018:** treatment completed

Bibliographic notes and author's commentary on the prevalence of cross-bite in the Veneto Region

The Author together with his collaborators,(1) by means of a survey on the prevalence of malocclusions in a population of 400 fourteen-years-old in the Veneto Region who were **not orthodontically treated** (of whom museum models were available), found an overall **prevalence** of **cross-bite** of 7.7% (see table below).

type of cross-bite	males %	females %	media %
unilateral	2,4	7,6	5
bilateral	1,9	3,5	2,7

In the same geographical area, a survey was also carried out, by the same team, on the prevalence of cross-bite in deciduous teeth among 1960 children in 27 kindergartens (see table below).[2]

	age		
	3 years	**4 years**	**5 years**
posterior right cross-bite	4,0%	4,1%	3,0%
posteriore left cross-bite	2,9%	3,0%	2,8%
bi-lateral cross-bite	1,0%	0,6%	0,4%
total	7,9%	7,7%	6,2%

As the range of cross-bite prevalence in the literature is very wide,[3] the author wanted to compare data from two cross-sectional studies conducted in the Veneto region, despite of concerning two different populations (deciduous and permanent dentition subjects).
For the author, however, the results are indicative of a rather low prevalence of cross-bite, especially with reference to data that speak of double-digit prevalence (22%).[4]

Moreover, in a longitudinal study published in 2015 by Swedish authors,[5] in addition to confirm how the prevalence of cross-bite changes with the transition between the various dentitions, it was found that, once the dentition changing was complete, in the sample examined (277 children followed for more than 8 years), the prevalence of cross-bite was at a percentage not far from that found by the Author et al. in the Veneto region (see table below).

	age		
	3 years	**7 years**	**11,5 years**
XB unilateral	12,8	15,1	5,1
XB bilateral	6,5	2,9	0,0
scissor bite	0,0	0,0	0,7

1. Ferro R, Besostri A, Olivieri A, Stellini E. Prevalence of occlusal traits and orthodontic treatment need in 14 years-old adolescents in Northeast Italy. *Eur J Paediatr Dent.* 2016 Mar;17(1):36-42.
2. Ferro R. Besostri A *et al.* Prevalence of cross bite in a sample of Italian preschoolers *Eur J Paediatr Dent.* 2016 Mar;17: 307-309.
3. Ferro *et al.* L'ortodonzia pediatrica delle prime due dentature, con poco...tanto *Aries 2 Milano* 2018.
4. Petrén S, Bondemark L, Söderfeldt B. A systematic review concerning early orthodontic treatment of unilateral posterior crossbite. *Angle Orthod.* 2003 Oct;73(5):588-96.
5. Dimberg L, Lennartsson B, Arnrup K, Bondemark L. Prevalence and change of malocclusions from primary to early permanent dentition: a longitudinal study. *Angle Orthod.* 2015 Sep;85(5):728-34).

Author's final comment

IF I HAVE TO EXPAND, **I USUALLY DO IT WITH LEAF EXPANDER**

In this atlas, 30 cases of Leaf Expander use from deciduous to permanent and especially in mixed dentition have been reported. Some cases have been completed and followed up over time, others are still in progress. Alone or in combination with other device, the Leaf has always proved to be an efficient device, effective in the short term. In a few cases, expansion has not been sufficient, but this is not due to inefficiency of the device, but rather to clinical error in assessing the need for expansion.

The Leaf Expander is an appliance that, in the Author's professional practice, has progressively replaced the rapid expander, so much so that it is considered the method of first choice when one wants to correct an upper jaw discrepancy in the transverse plane **from deciduous dentition to early adolescence.**

There are various reasons for this professional shift.

- As reported by Kennedy and Osepchook (2005)[1] the vast majority of cross-bite in the first two dentitions is functional in nature.
- Why, therefore, must the median palatine suture and circum-maxillary sutures be 'inconvenienced' by *traumatising a child's face* in order to correct the interdental diameters between the two jaws?[2]
- And again, why exploit, at a pre-adolescent age, an even more invasive and bloody methods than the RPE itself such as expander anchored with TADs on the palate which have not clinically proven any additional advantage?[3]
- It should be emphasised that the most recent meta-analysis on posterior cross-bite correction (Ugolini *et al* - Cochrane 2021)[4] concluded that, in addition to the rapid expander, in children aged 7 to 11 years, **the use of light forces** produced by appliances such as the quad-helix and/or removable appliances with a central expansion screw is an equally efficient choice (it should not be underlined that the RPE to distract the suture needs, instead, **heavy forces (4.5-9 kg)**[5] which are discharged onto the teeth and, after having hyalinised the periodontal ligament, are transmitted to the suture itself causing a dimensional increase - through osteogenetic distraction -, an increase that is intended to be halved within 2 months).

- Regarding, moreover, to the chapter on post-treatment stability of the cross-bite both orthopaedic and orthodontic in nature, since it depends on achieving a correct cusp-fossa ratio[6] the result in the long term does not change unless growth abnormalities such as in the case of progenisms happen.

- Another advantage of this device is that it is a *non-parental compliance method*, i.e. it does not need to bother the parents or whoever to activate the screw as in the case of the rapid expander, an action that often causes a great deal of anxiety among family members and is sometimes not at all comfortable to perform, so much so that it is not performed at all (see picture sequence 1).

- And finally, when using it, one has certainty about the amount of the transverse expansion. Unlike the rapid expander which, by causing a V-shaped opening of the upper jaw, makes it impossible to exactly know the perimeter expansion. With the Leaf Expander the distancing of the two processes takes place in parallel, thus being able to know in advance the amount of the expansion in the transverse plane (Fig. 1).

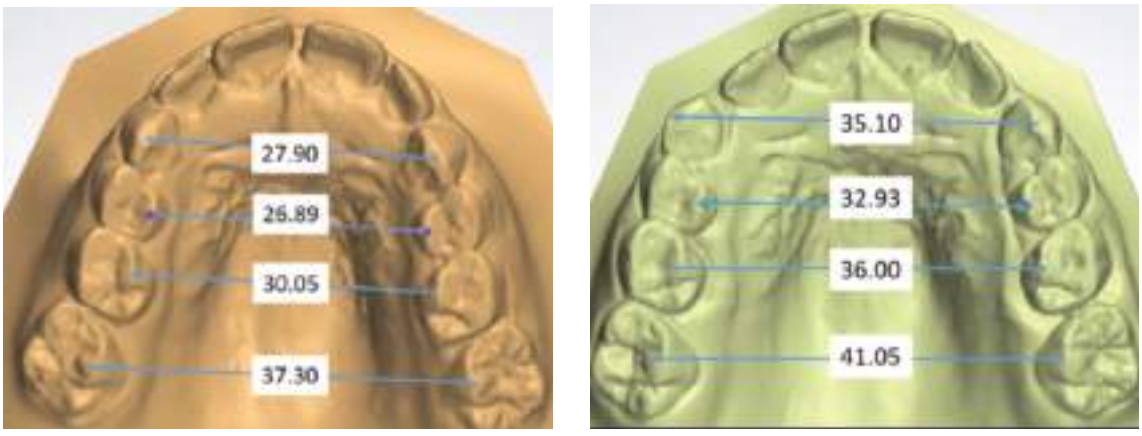


Fig. 1 - *(courtesy of Dr Valentina Lanteri).*
In the superimposition of three-dimensional digital models (study conducted on 10 patients with mixed dentition) after expansion with a 6 mm, 450 g Leaf Expander anchored at the E, the increase in the width of the transverse diameters is more or less constant proceeding from the C to the E; the increase in the transverse diameter of the molars, which is smaller, is due, as in the case of rapid expansion, to a remodelling of the upper jaw (Lanteri V. 2017, 2018)

Bibliography

1. Kennedy DB, Osepchook M. Unilateral posterior cross-bite with mandibular shift: a review. *J Can Dent Assoc* 2005; 71: 569-73.

2. Habersack K et al. High resolution multislice computerized tomography with multiplanar and 3-dimensional reformation imaging rapid palatal expansion. *Am J Orthod Dentofac Orthop* 2007; 131:776-781.

3. Bazargani F, Vanessa Knode V, Plaksin A, Magnuson A, Ludwig B. Three-dimensional comparison of tooth-borne and tooth-bone-borne RME appliances: a randomized controlled trial with 5-year follow-up, *Eur J Orthod* 2023.

4. Ugolini A, Agostino P, Silvestrini-Biavati A, Harrison JE, Batista KBSL Orthodontic treatment for posterior crossbites. *Cochrane Database of Systematic Reviews* 2021.

5. Isaacson, RJ, Ingram AH. Forces Produced By Rapid Maxillary Expansion. *Angle Orthod.* 1964, 34: 261–270.

6. Van der Linden FPGM. Facial growth and facial orthopaedics *Quintessence Pub. Co.* Chicago 1986.

7. Lanteri V. Cambiamenti tridimensionali del mascellare superiore dopo espansione con Leaf Expander in un campione di pazienti in età evolutiva: valutazione mediante sovrapposizione di modelli digitali e di CBCT. *Tesi di Dottorato di Ricerca in Scienze Odontostomatologiche. Università di Milano, XXIX Ciclo,* 2017.

8. Lanteri V, Gianolio A, Gualandi G, Beretta M. Maxillary tridimensional changes after slow expansion with Leaf Expander in a sample of growing patients: a pilot study. *Eur J Paediatr Dent* 2018; 19(1): 29-34.

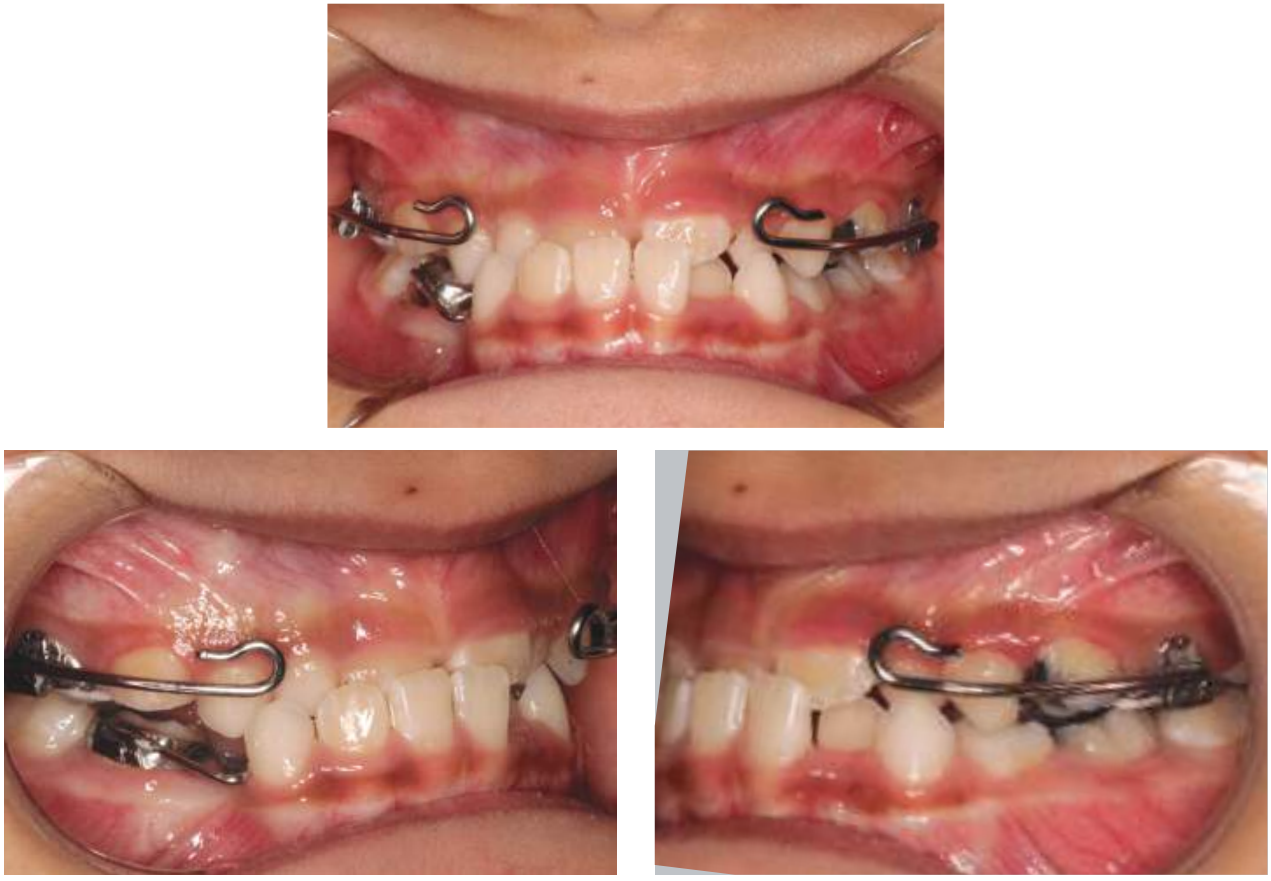
Picture sequence 1

Roberto
age 6,1

The picture sequence illustrates an experience of a subject with an anterior cross-bite who went head-to-head with the mandibular retropulsion manoeuvre; treated with RPE, Delaire's mask and 2x5, the parents failed to activate the expander.

Figs. 1 a, b - initial documentation: frontal facial pictures

Figs. 2 a-c - intraoral clinical pictures



Figs. 3 a-c - **February 2015:** cementing RPE with face mask arms...

Fig. 4 - **February 2015:** ...asking to activate the expander screw

Fig. 5 a-c - **March 2015:** check, when we decide to...

Figs. 6 a-c - ...place a 2x5 with a .012" Ni-Ti archwires inviting to wear the face mask. Meanwhile, the RPE has not yet been activated

Figs. 7 a-c - **April 2015:** the cross-bite was solved but the parents were never able to activate the RPE

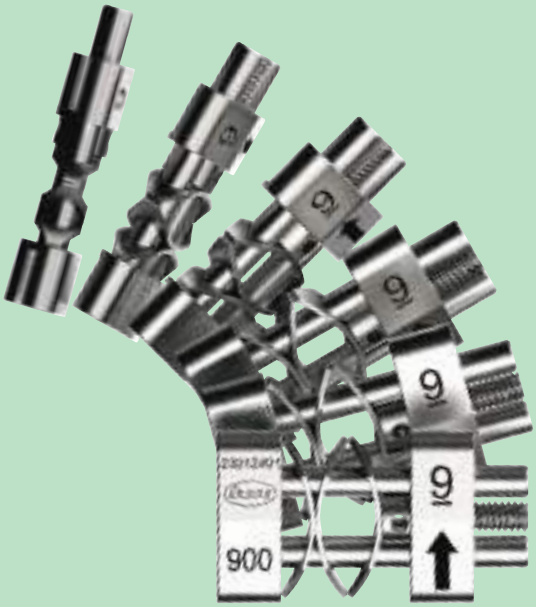
Figs. 8 a-c - **May 2015:** repositioned bkt on 11

Figs. 9 a-c - after appliance removal, waiting for growth and dentition changing

Roberto FERRO

LEAF EXPANDER®

Clinical atlas



ISTITUTO STUDI ODONTOIATRICI