

# Impact of anchorage miniscrews in multibracket treatments without extractions

P. Baron

*Private practice in Colomiers (Toulouse)*

*Head of the orthodontics department - Université Paul Sabatier - Toulouse*

## ABSTRACT

*Over the past decade, the interest for miniscrews is continuously growing as confirmed by the amount of recent published studies. In particular, their use allows to make corrections in a single phase and avoids extractions of premolars, while keeping usual goals of treatment. Main results of pilot studies and some clinical examples are presented here to illustrate our therapeutic approach for the treatment of tooth discrepancy in Class I, Class II and Class III situations.*

## KEY WORDS

*Miniscrews, mini-implant, Temporary Anchorage Device (TAD), non extraction, multibraces treatments, skeletal anchorage*

The use of anchorage screws is becoming a standard practice in orthodontics today. The growing interest of practitioners from around the world is obvious simply by counting the number of articles describing it published in the international literature during the last ten years. If we do a search on PubMed by using the key words ("Orthodontic Anchorage Procedures" [Mesh] AND [(orthodontic AND miniscrew) OR (orthodontic AND mini implant) OR (orthodontic AND skeletal anchorage) OR (orthodontic AND temporary anchorage device)] more than 320 publications appear

between 2002 and 2013. Since the very first clinical articles<sup>56,70</sup>, a great number of other treated cases have been published with sometimes outstanding results<sup>1,2,31-33,36,52,57,66,67</sup>. The list of comparative studies<sup>7,21,30,39,44</sup>, experimental studies<sup>26,45,51</sup>, some randomized clinical trials<sup>7,35,38,71</sup> and systematic reviews<sup>14,16,20,22,43</sup> has continued to grow over the years. This can be seen as evidence for an ongoing therapeutic revolution that is impacting all aspects of orthodontics and that is suggesting new solutions for the buccal technique<sup>8,15,28,34,36,46,55</sup> as well

Address for correspondence:

Pascal Baron  
118 route de Narbonne  
31062 Toulouse Cedex 9  
baron.pascal@free.fr

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as for lingual orthodontics<sup>4,29,37,41,69</sup>, for the aligner technique<sup>11,73</sup> or for orthopaedics<sup>13</sup>.

Among these anchorage screws, miniscrews, originally called mini-implants in Korea, are a minimally invasive surgical option, with a low failure rate<sup>9,47,59,72</sup> and with excellent patient acceptance<sup>5,27,33</sup>. Their potential has been demonstrated repeatedly during multibracket treatments for mesial movements<sup>3,23</sup>, for molar distalization<sup>25,53,61,62</sup>, for intrusion<sup>18,64,65</sup>, for extrusion<sup>10,12</sup>, for “in masse” retraction of anterior teeth<sup>19,57,69</sup>, or for maintaining anchorage in cases of premolar extractions<sup>35,39,44</sup>. A recent meta-analysis provides an update on their results compared to those obtained with extraoral force<sup>43</sup> and demonstrates greater anterior retraction and less loss of posterior anchorage with miniscrews. Their importance for

reducing treatment time as well as for providing “absolute” anchorage has been demonstrated many times over<sup>17,24,43,50,60,68</sup> and they are often used as a replacement for extraoral forces when managing extraction spaces.

Nevertheless, existing studies that highlight their use in cases without extraction are either rare or have limited readership<sup>6,40,54</sup>. However, it provides us with an extraordinary tool that makes it possible to respond to a whole series of typical clinical situations that are regularly treated by expansion with varying harmful consequences for the patient because it is based on concepts which neglect the anterior limits of the dentition, or sacrifice the premolars when these limits are respected.

## CHOOSING THE INSERTION SITE

The insertion site for the miniscrews stems from the convergence of three types of constraints (Fig. 1):

- the surgical demands;
- the biomechanical conditions;
- the orthodontic indication.

From this three-part perspective, we can determine the preferential insertion site and choose the right type of screw. Some manufacturers offer a single universal model that simplifies inventory management. On the other hand, with only one possibility the orthodontist doesn't have any latitude to choose his screws for optimal results. It is better to have several different diameters and lengths, and even to choose the head of the screw, in order

to best respond to each situation that is encountered. The surgical conditions must, in addition to following a well established placement protocol, respect anatomical demands for neutrality with regard to the mucosa, dental roots and vascular nerve endings.

The biomechanics must take into consideration the different elements of the force system especially the location of the center of gravity of the teeth and of tooth groups as well as their anchorage value. With this in mind, we, at the university of Toulouse, used a 3D imaging research method to generate a computerized reconstruction of the data<sup>48,49</sup>. The mechanics as such

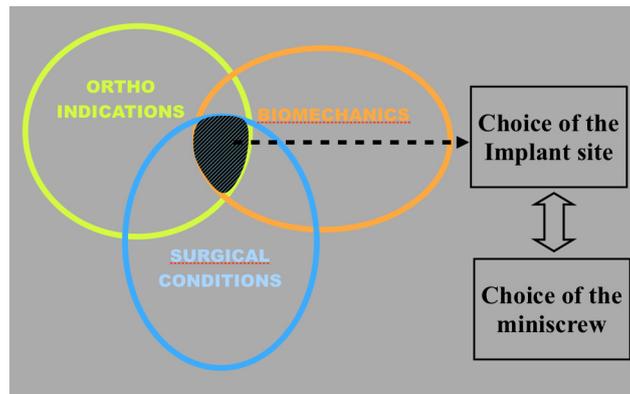


Figure 1

*Choice of the site and of the miniscrews conditioned on the three types of factors.*

can be performed with direct anchorage, with indirect anchorage or with a combination of both anchorage systems. The orthodontic indication also depends directly on the patient and on his malocclusion. Orthodontics proceeds sagittally with distalization and mesialization therapies accompanied by a clockwise or counterclockwise rotation of the occlusal plane. The miniscrews provide us with the

possibility that until now didn't exist to regulate the force by controlling the harmful secondary effects of the mechanics. Since there is crowding without extractions, it will be necessary to create space, most frequently in both the arches, in order to resolve the anterior arch length discrepancy while at the same time following the logic dictated by the occlusal imbalance.

## INDICATIONS FOR TYPES OF MINISCREW ANCHORAGE IN THE LATERAL POSITION FOR TREATMENT WITHOUT EXTRACTION

In general, miniscrews should be placed wherever anchorage is necessary. Therefore, when treating for an anterior space deficit, the anchorage will be insufficient in the posterior zone and so the screws should be optimally inserted in the lateral areas. Miniscrews provide adequate anchorage to reliably stabilize an arch that in turn serves as anchorage for the opposing arch, so only two miniscrews will be utilized for most treatments. Intermaxillary elastics will ensure the connection for a short

time during the leveling phase of the opposite (non-miniscrew) arch.

For a class II, the anchorage is critical on the upper jaw and the screws should be inserted into the maxillary bone, in the premolar or molar area. If it is class III, anchorage requirements are still posterior but in this case on the lower jaw and the screws should consequently be placed in the lower molar zone.

We can provide some specific indications that correspond to the type

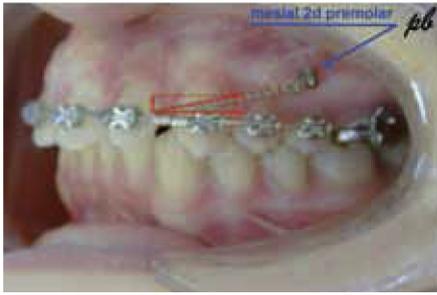


Figure 2  
Clinical situation.

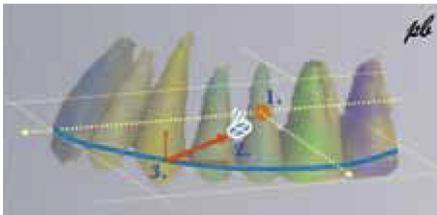


Figure 3  
Mechanical analysis. 1. Center of resistance of the arch. 2. Miniscrews. 3. Point of application, vertical and anteroposterior components of the force.

of tie that connects the miniscrews to arch system:

- with an elastic link (stretched spring – elastomeric module – power chain): we use direct mechanics since its impact can be analyzed by differentiating between the various forces exerted on the teeth (Fig. 2 and 3). This process allows for an *en masse* distalization, a vertical intrusion force and an increase of anchorage on the arch. Miniscrews can be inserted in inter-radicular sites in front of the second premolars – mesial position 5 (or **m5**) – or in front of the first molars – mesial position 6 (or **m6**). The typical indications are

comprised of a class II occlusion, a class I with moderate crowding, a bimaxillary protrusion. Taking into account the posterior crowding and the extent of the required distalization, the orthodontist will have to consider extraction or non-extraction of the toothbuds of U8/L8 or extraction of U7/L8 when the substitution of U7 with U8 is possible:

- with a rigid link: the miniscrew is attached to the archwire with a metallic ligature that will perform a archwire-teeth-miniscrew system capable of moving in rotation around a fixed point represented by the miniscrew. We use indirect mechanics with a premolar by pass and a compressed spring at this location on the archwire to move teeth by groups, depending on the balance of forces achieved (Fig. 4 and 5). Here also the miniscrews can be placed in the mesial 5 (**m5**) or in the mesial 6 (**m6**) and the need for enucleation of the wisdom teeth and substitution of the second molars has to be studied. The intensity of forces is applied by the degree of compression of the spring. Posteriorly, the molar receives a



Figure 4  
Indirect anchorage system: buccal technique.

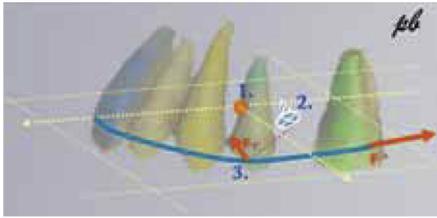


Figure 5

*Mechanical analysis. 1. Center of resistance of the arch displaced towards the front. 2. Miniscrews. 3. Application point, tangential component of intrusion and molar distalizing force.*

horizontal distalizing force. Anteriorly, only a tangential component persists and its impact can vary based on the number of teeth engaged in the system, from the position of the point of application of force and the position of the miniscrew. Therefore, we will have optimal indications for this type of mechanics when the goal is the distalization of molars, movements for sectional intrusion of tooth groups and an increase in anchorage, especially in the vertical direction. These indications are appropriate for skeletal and dental class skeletal and dental class II malocclusions, for class I malocclusions with arch length discrepancy and vertical discrepancies particularly incisor overbite.

Placing a system on the inferior arch is delayed. Treatment management can be carried out with good

results when the molar and premolar relationships are such that a distalization of this arch is possible, by providing, after being uprighted, space for the resolution of anterior crowding or for the levelling of the Curve of Spee. It's not necessary to use additional miniscrews for this phase. Vertical intermaxillary elastics or class III elastics worn cooperatively will ensure adequate control of the incisor position that is consistent with the treatment goals (Fig. 6). This means that for most cases the patient must wear the elastics for a period of one to four months. They are generally well-tolerated and the wear time is short in comparison with the demands required for a class II intermaxillary mechanics that in this case is not necessary. In fact, the discrepancy of a class II is quickly corrected at the beginning of treatment by the multiple actions of the mechanics on the miniscrews. Moreover, this correction takes place without any extraoral force, without wearing elastics, without any volumetric expander system or in other words without any discomfort for the patient. Cooperation is mainly focused on hygiene and on respecting the prescribed wear time of the appliance. In the same way, when there are asymmetric relationships, differential activations can be made from one side to the other.

## EFFECTS OF THE MECHANICS

The movements on the upper arch are controlled both by the mechanics of the arch wire and by the force system whose parameters can be

modulated. The sequence of therapeutic steps is well established with perfectly reproducible results. The indications make it possible to

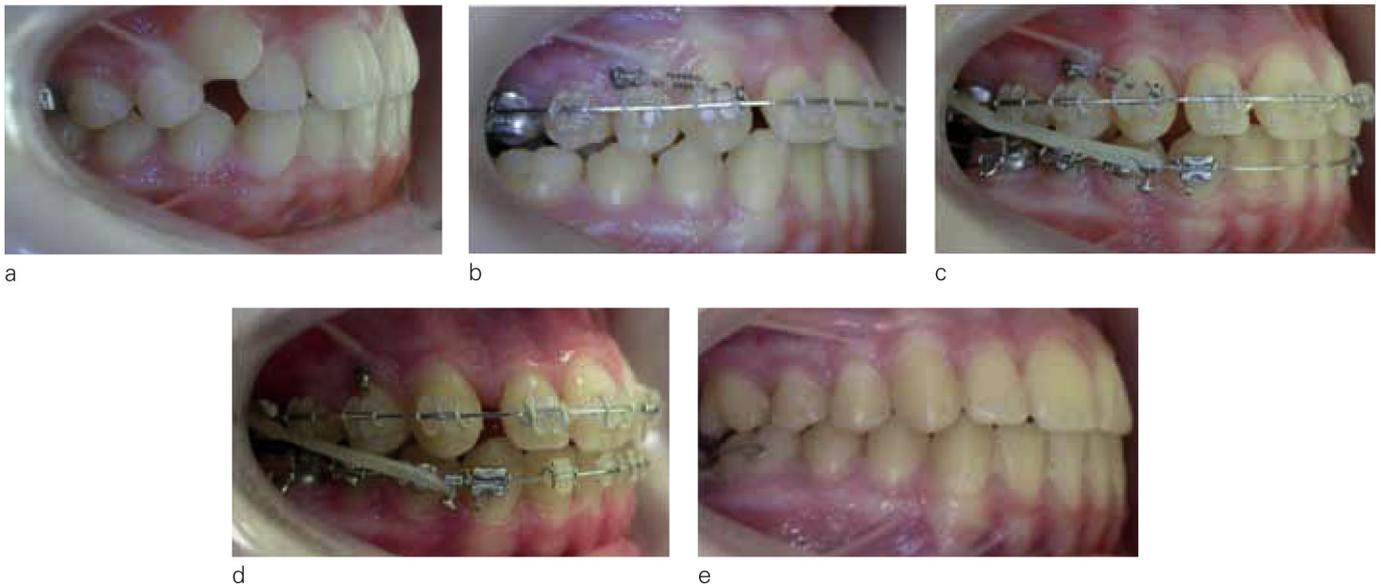


Figure 6

*a: initial situation with minor class II and crowding on both arches. b: correction using miniscrews (m5 – direct anchorage); the crowding and the class I are overcorrected in a few months (+ 6 months). c: lower premolar and lower canine disalization incisor Class III elastics. d: incisor alignment after distal uprighting/straightening of the lateral groups: total wear of the elastics = 3 months. e: final (+ 18 months).*

treat a wide range of clinical cases especially class II malocclusions. The findings of several studies our several studies<sup>6,40,54</sup> converge and show the main results that we can expect from this type of therapy. In 2008, in the context of a clinical research report written at the end of a post-graduate, we compared the cephalometric tracings before/after treatment of 30 patients ages 11 to 15 at the beginning of treatment. All the cases were randomly chosen from a cohort of 96 treated patients, selected according to exclusion and inclusion criteria, who had all been successfully treated with miniscrews using direct or indirect mechanics. The screws were symmetrically inserted in position **m5** or **m6**. The local superimpositions were done based on the bi-spal plane registered on the anterior naso-pala-

tal canal. The results show a 10° distal torque of the molars, nearly 2 mm of intrusion and more than 3mm distalization of the mesial cuspid (Table I).

In 2009, another study was conducted on a series of 22 consecutive cases, ages 12 to 15, all of whom had been successfully treated with the same mechanics, showed very similar results measuring 8° distal torque, 1.8 mm of intrusion and 2.5 mm of distalization of the maxillary first molars. A Procrustes analysis of the data using geometric morphometry shows, concomitantly with the retraction and molar retraction, an backwards elevation of the occlusal plane that accompanies a mandibular anti-rotation.

In 2012, a third research work that also used a Procrustes analysis, on a

|      | Average | Std. Dev. | Std. Error | Minimum | Maximum |
|------|---------|-----------|------------|---------|---------|
| d V6 | 10,226  | 6,699     | 1,223      | -3      | 19      |
| d I6 | 1,877   | 1,376     | 0,251      | 0       | 5       |
| d R6 | -3,145  | 1,401     | 0,255      | -6      | -1      |

Table I  
Movement of the maxillary first molar before/after treatment (N = 30), 2008.

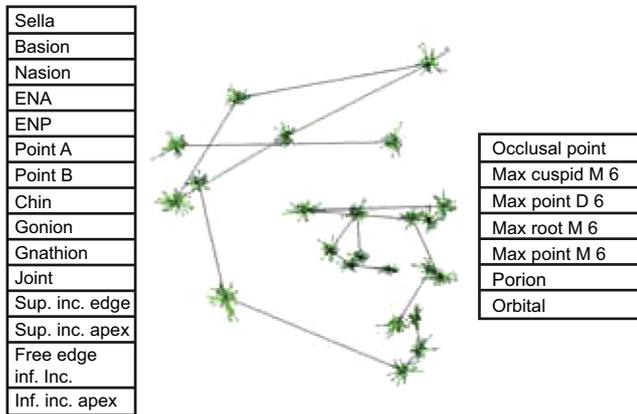


Figure 7

Variability of the points from the study before treatment (N = 30) 2012 – with Procrustes analysis software = APS v2.4 (Dr. Penin).

series of 30 consecutive cases had findings showing the same therapeutic benefits illustrated in Figures 7 and 8.

These pilot studies suggest that we have achieved excellent control of the maxillary arch where the miniscrews are implanted, adequate

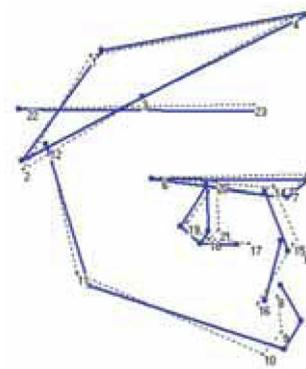


Figure 8

Schematic of the variations before treatment (dashed graph lines)/after treatment (blue) showing the intrusion and the distalization of molars, retraction of the incisors, the projection of the pogonion due to mandibular anti-clockwise rotation.

anchorage for the management of the opposite arch and that the effects go well beyond dental movements, especially due to very significant skeletal repercussions in the treatment of class II discrepancies or in cases of anterior crowding.

## CLINICAL CASES

These mechanics present the advantages of creating available space on the arch, that radically changes the therapeutic extraction approach.

The following clinical examples show the results for three different types of malocclusion.



Figure 9  
Pre-treatment: occlusal relationships at the end of the mixed dentition.

### Case n° 1

Cassiopé, a young girl, 11 years old, presents with severe crowding on the mandibular arch in the mixed dentition. The anteroposterior relationships are in class I (Fig. 9). Without incurring any particular risk, the

treatment will be delayed until the permanent dentition phase. We will only install a lingual arch wire in the meantime, in order to conserve the *E space* on the lower arch.

Figures 10, 11 and 12 present the basic elements of the clinical picture. The relationships are in class I



Figure 10  
Extraoral views before treatment.



Figure 11

*Intraoral views before treatment clearly showing the class I and the mandibular crowding.*

occlusion with bimaxillary protrusion of the incisors; the mandibular crowding is 6 mm. The objectives of treatment aim to correct the malocclusion, improve the skeletal

structure and respect the parameters of the arch. The slightly protruded mandibular incisors will not be repositioned given the whole complex of dento-alveolar relationships.

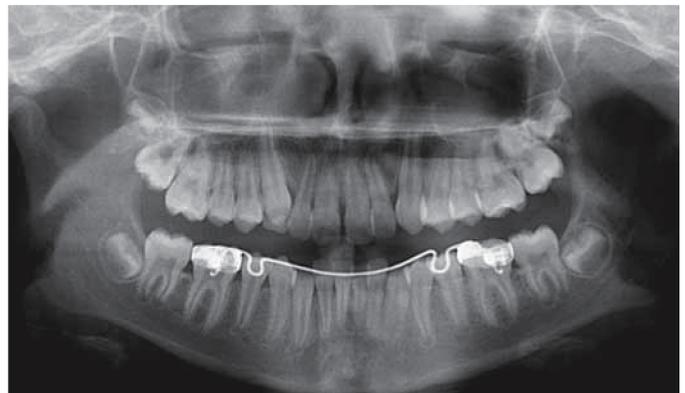
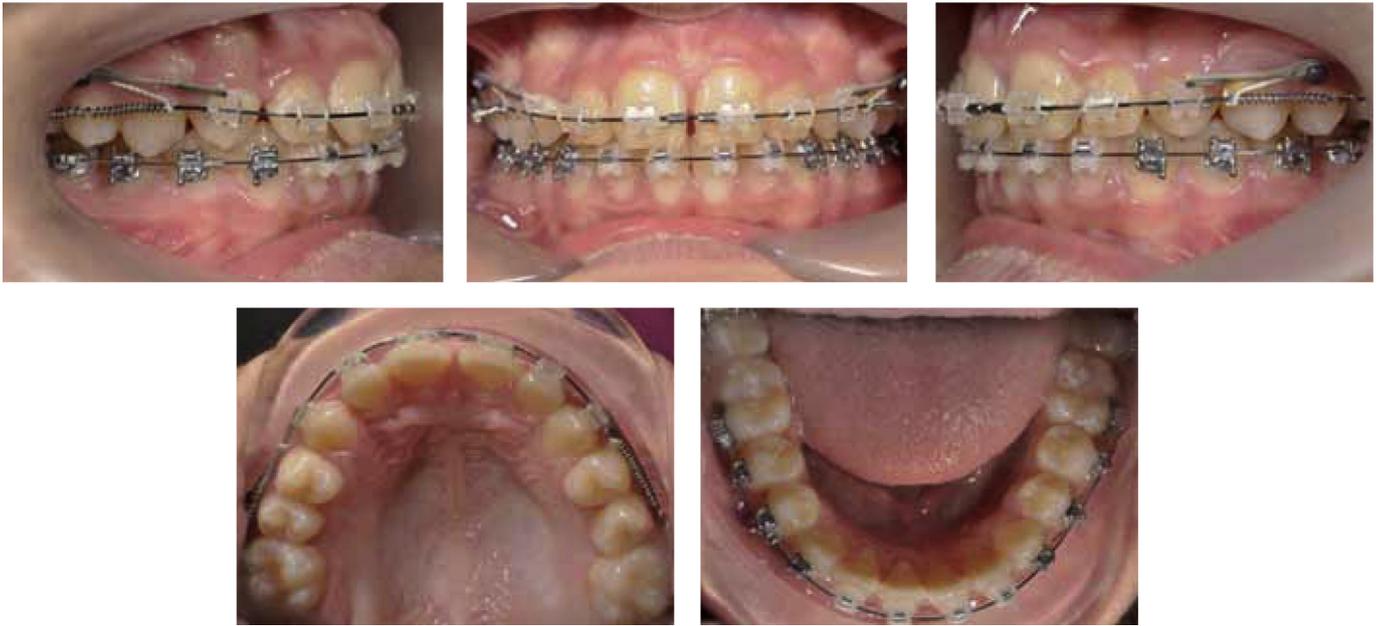


Figure 12

*Xrays before treatment.*

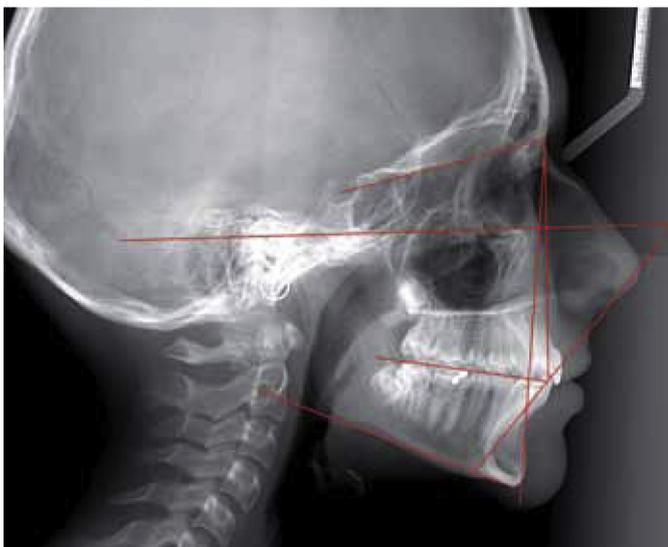


*Figure 13*  
Therapeutic phase of anterior retraction.

The treatment plan specifies the use of miniscrews (1.2 mm diameter – 7 mm long) in the m6 position (Fig. 13).

The end of treatment is reached in less than two years. The anterior

relationships are corrected and the arches are aligned (Fig. 15 and 16). The position of the inferior incisor has been controlled (Fig. 14). Two maxillary miniscrews were



*Figure 14*  
Xrays after treatment.



Figure 15  
Intraoral views at the end of treatment: duration = 22 months.



Figure 16  
Extraoral views after treatment.

used; Class III elastics were worn for 3 months during the mandibular preparation. No other removable appliance was necessary. The wisdom teeth should be regularly monitored.

## Case n° 2

The miniscrews used according to our protocol are exceedingly important for the treatment of class II malocclusions. In a normodivergent facial



*Figure 17*  
*Extraoral views clearly showing the disruption of the profile and the smile.*



*Figure 18*  
*Intraoral views of the bilateral class II occlusion.*

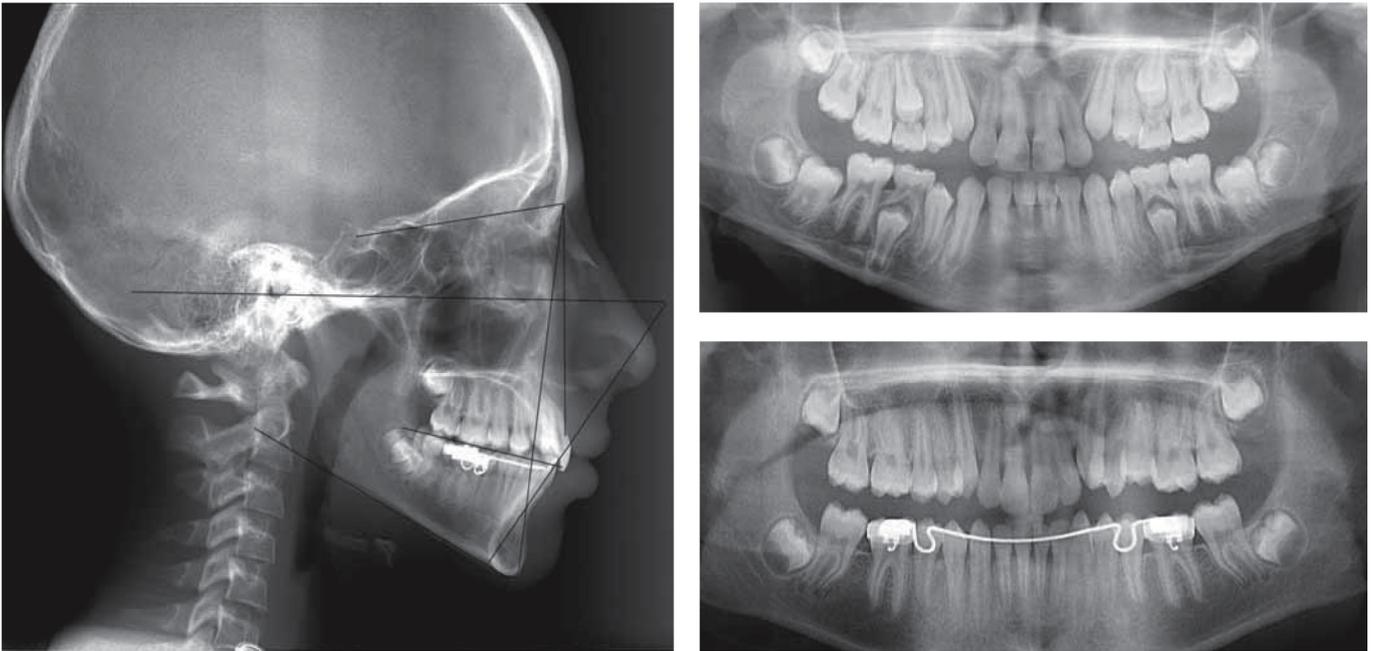


Figure 19  
Xrays before treatment.



Figure 20  
End of the phase of mandibular leveling.

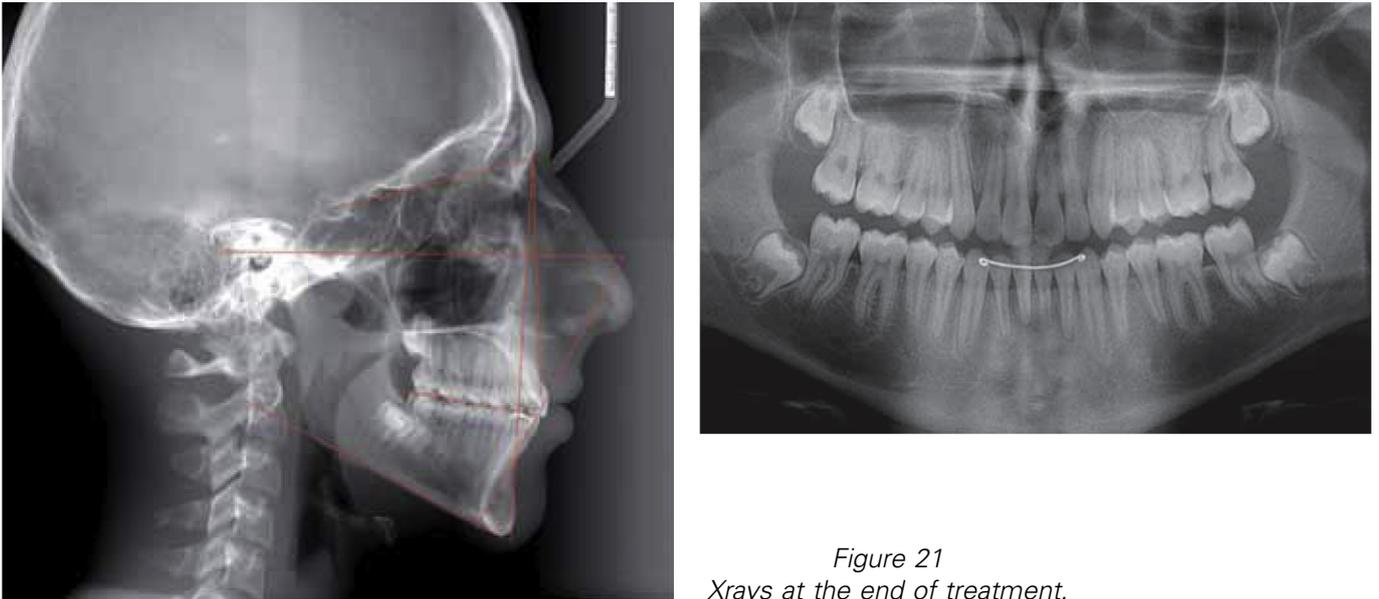


Figure 21  
Xrays at the end of treatment.



Figure 22  
Normalization. Post-treatment intraoral views (+ 23 months).



Figure 23  
Post-treatment extraoral views.

pattern, D. Joris, 13 years old, presents with retruded mandible with a sagittal occlusal discrepancy of 7 mm, anterior alveolar compensations and crowd-ing in both arches (Figs. 17 and 18). The *E space* has been preserved to minimize the lack of space on the mandibular arch (Fig. 19). However, a 3 mm discrepancy persists at the beginning of treatment.

The treatment plan is established with the objectives of reducing the skeletal class II, normalizing the occlusion, uprighting the mandibular incisor. No extraoral or intraoral appliance is part of the treatment program, since the correction of the discrepancy will be managed by the specific mechanics with miniscrews. The miniscrews (1.2 mm diameter – 7 mm long) are inserted mesially into the maxillary molars (**m6**) and alternately use indirect and direct mechanics, with premolar by pass (Fig. 20). The post-therapeutic assessment was the following (Figs. 21 to 23):

- reduction of the class II: final ANB = 4.5°; initial ANB = 8°;

- uprighting of the incisor: final FMIA = 60°; initial FMIA = 55°;
- maintaining the vertical dimension: final FMA = 26°; initial FMA = 27°;
- length of treatment = 24 months;
- wearing class II elastics = 0;
- wearing extraoral force = 0;
- wearing class III elastics = 2 months;
- retention = bonded retainer from 33 to 43.

### Case n° 3

Some cases of class III can also benefit from the advantages of this therapy that can be carried out in many possible combinations. We can insert the miniscrews on the inferior arch in a zone with or without teeth, for *en masse* or sectional retraction, with direct or indirect anchorage.

Laetitia is 13 years old and displays the morphological characteristics of a class III (Fig. 24). Facially, the deformation is moderate with, however,



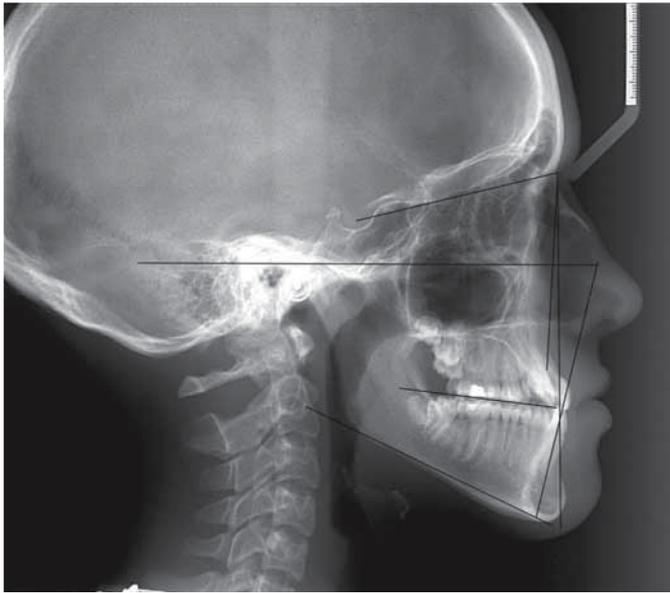
Figure 24  
Extraoral views demonstrating a mild discrepancy between the jaws.



Figure 25  
Intraoral views showing the anterior misalignment of 12 and 22, a slight left crossbite, a deviation of the midlines, a bilateral canine and molar class III and mandibular crowding of 5 mm.

some growth to come; she has class III occlusal dental arch relationships, with no significant transverse problem and with crowding in both arches (Fig. 25). A lateral cephalometric xray shows a negative ANB of  $-4^\circ$ , no

vertical disharmony and some slight alveolar compensations that are barely defined (Fig. 26). Without miniscrew anchorage, we can legitimately ask the question whether the four premolars should be extracted. Since the



*Figure 26*  
Xray before treatment that confirm the skeletal class II (ANB =  $-4^\circ$ , AoBo =  $-10\text{mm}$ ).

esthetic effects of the deformation are mild, a non-surgical treatment can reasonably be planned. In this case, the miniscrews will help provide the necessary anchorage to solve this problem without surgery, without extraction or any special patient cooperation.

A panoramic xray before treatment shows the presence of 3 wisdom teeth far enough impacted that should not interfere with the mandibular distalization. The space between the mandibular first and second molars is wide enough to become the most preferred insertion site for the miniscrews. The treatment plan is established as follows:

- levelling and aligning in the lower jaw, maxillary levelling/(1.5 diameter-7 mm long) mesially to 37 and 47 (mL7);

- correction of the molar and premolar relationships (Fig. 27);
- retraction of 33/43 with intramaxillary traction/incisor alignment;
- intercuspation.

The planned time frame is from 18 to 21 months.

The post therapeutic result is in line with our expectations. The objectives of creating normal occlusion, correcting the crowding without anterior displacement and not degrading facial relationships were all achieved with only one phase of therapy that was completed in 22 months (Figs. 29 and 30). The skeletal class III was improved, AoBo reduced from  $-10\text{ mm}$  to  $-3\text{ mm}$ , the ANB going from  $-4^\circ$  to  $-2^\circ$  by reducing the SNB angle. The axial position of the mandibular incisors was unchanged (FMIA =  $76^\circ$ ) (Fig. 28).



Figure 27

Phase of simultaneous leveling on the two arches under posterior-anterior traction with miniscrews in the mL7 position.

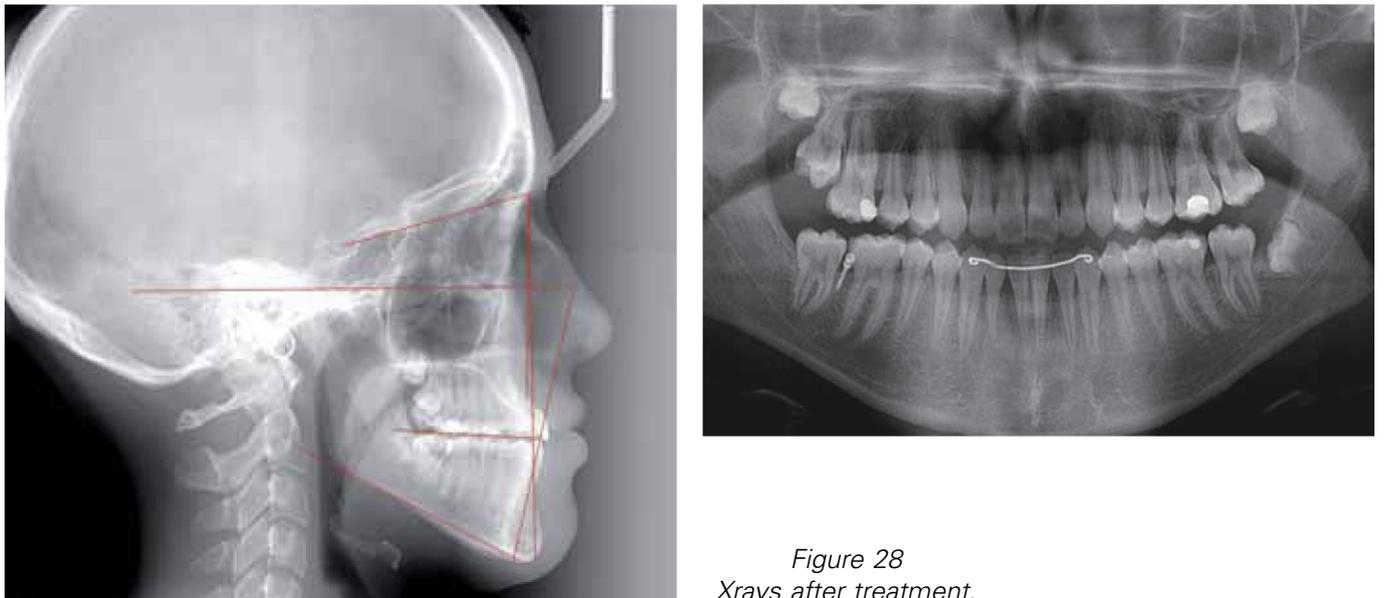


Figure 28  
Xrays after treatment.



Figure 29  
Post-treatment intraoral views with corrected arch relationships.



Figure 30  
Post-treatment extraoral views.

## PERSPECTIVES

Multibracket treatments with miniscrews are increasingly used on a daily basis by many clinicians. Our personal experience began in 2003 and for many years now we use

them routinely in our practice and have a very clear protocol in place. Several studies that were testing our own therapeutic concepts, based on significant sampling of cases,

obtained consistent results every time. So now, we would like to highlight some strong points:

- it is possible, using miniscrews in a well thought out manner and by respecting mechanical principles taking into account the principal existing factors, to achieve results that are completely reproducible from one patient to the next;
- it is possible to easily achieve increase of anchorage in addition to the classically recognized conservation of anchorage. We observe an “absolute” resistance to the forces used on the one hand, and we can create available space in the arch on the other hand;
- undoubtedly the most important fact, that we also find reported by other authors<sup>63,74</sup>, is that now it

becomes possible to achieve retrusion and significant molar distalization especially on the upper arch; this opens up the field of indications and makes orthodontic treatment effective in a totally new way that takes it to the next level;

- the skeletal effects that we observed are extremely interesting and the first recorded data should be corroborated by randomized controlled trials with high external validity;
- miniscrews provide non-invasive anchorage that can be systematized for any type of patient (during growth, in the young adult or in the senior) and for any type of sagittal and transversal discrepancies.

## CONCLUSION

The few cases that we presented here provide a clinical translation of the many effects orthodontists can expect when they use miniscrews in orthodontic treatment. These cases show how the use of anchorage screws can positively impact the therapeutic outcome of treatment to correct dental and arch length discrepancies associated with Angle’s Classes I, II and III. In addition to correcting the morphology, the length of treatment is shortened, the need for cooperation is reduced, the mechanics are controlled.

A new kind of orthodontics emerged from Asia ten years ago and its use is becoming more widespread every day.

The Newtonian duality of action-reaction is no longer relevant for mechanical orthodontics. Make room for Archimedes and his theory of levers and his screw. Now we can move teeth or groups of teeth with no secondary effects on the anchorage teeth. Moreover, we can achieve movements that have been impossible until now such as intrusion and molar distalization. All of this offers new therapeutic perspectives and makes it possible for orthodontists to use miniscrews to develop a radically different and very effective approach to treatment when caring for children as well as adults.

Conflicts of interest: The author declares no conflict of interest.

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