

Protocol for the finishing stage

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ABSTRACT

Finishing is the most effective weapon in the battle against relapse. The choice of method depends on analyzing the type of relapse that is feared and the impact of aging, and on the help to be expected with retention.

The present article deals with the practical requirements of finishing: duration, pre-finishing assessment, final arch wire bending, possible occlusal buffing, and elastic vertical interarcade traction.

The theoretic protocol is illustrated by 3 cases followed up through finishing until appliance removal.

The stability of occlusal results of course depends on the accuracy and fineness of finishing, but also on overall treatment management: anterior dentition control, anchorage control during retraction period, and choice of devices and extractions.

Finishing can thus be said to be an important step - but one that begins on the first day of treatment.

KEY WORDS

Finishing, relapse, retention

INTRODUCTION

The choice of finishing strategy is indissociable from the analysis of relapse (and aging). The literature on relapse, however, provides little convincing information that might guide our approach to finishing^{2,3,5-8,10,11}.

It is difficult, in adapting treatment, to distinguish the effects of retention or aging from "real relapse"; there is also often confusion between relapse and what we would call "treatment failure".

Relapse is often assessed simply by measuring crowding.

There are few studies with high levels of evidence.

Many studies implicated occasional effects³, for example, of a certain treatment attitude, clinical choice, atypical growth, physiological or anatomic problem, etc. Such reports are often incomplete or low on level of evidence, but it is certainly helpful to take them on board in our therapeutic behavior.

Finishing differs from the main work in its timing (last touches), limited extent and, in our opinion, prime importance. Finishing is not a subsidiary but a major step.

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A perfectly finished program requires precautions taken during the main work itself, as mistakes cannot always be rectified by finishing. “Perfect” finishing in orthodontics thus depends on:

- initial treatment choices (control of anchorage, choice of extractions),
- and finishing itself.

In what follows, we shall briefly present our choices, the material procedures of finishing and their timing, richly illustrated from case reports.

We shall not enter into the intricacies of defining ideal occlusion, leaving the reader to refer to the criteria of the American Board of Orthodontics Grading System¹, which seem to command consensus in static terms.

Functional and dynamic imperatives and esthetic criteria, on the other hand, are not well-defined.

Our approach to perfect finishing consists in balancing the patient’s maxillofacial architecture, especially anterior dentition, as well as possible, respecting the recognized rules of occlusal dynamics, and adopting a cautious attitude toward known threats to stability of treatment: third molar progression, anterior interdental disharmony, late growth, etc.³

We shall then focus on our efforts to refine static occlusion.

To this aim, we present our finishing protocol.

GENERAL LINES

Duration: 6 months

Consecrating 6 months of treatment, with 4 or 5 appointments, is surely not excessive to deal in detail with static and dynamic occlusion: Poling⁹ advises 4 to 7 months. But this must not prolong the total treatment duration: to have 6 months for finishing, the other steps need to be performed as quickly as possible. Time-saving should begin from the outset of multibracket treatment, so as to achieve molar and canine class I relations with 2 mm incisor overbite, perfect alignment and leveling and closed spaces within a year and a half at most. The patient will then accept 6 months’ finishing without objection.

Thus rapidly achieving good “pre-finishing” occlusion is the first step toward perfectly “finished” occlusion.

Dissociation between dental finishing/correction and preparation

The transition to the finishing stage involves a break in the practitioner’s concerns: where we had been concerned with the main aspects of objective occlusion, we now turn to what is more esthetically and functionally important: intercuspatation, incisor alignment adjustment, artistic deformation, refining canine class I, adjusting the canine guide, etc. We need to look at what has been achieved, plan the finishing work

and take account of how long treatment has already lasted and how much cooperation can be expected of the patient, in order to estimate how much time we can reasonably allow for finishing.

One major function of finishing is to test the quality of malocclusion correction. Otherwise, there is a risk of removing devices as soon as they seem to have triumphed over class II and signs of class I occlusion are observed. Unfortunately, however, this is often just a case of "Sunday bite" induced by the maxillomandibular elastic bands and, no sooner have the devices been removed than the patient slips right back into class II with severe overjet.

Unfortunately, in some cases the finishing stage cannot be strictly defined: finishing work on the arch is required during the anterior retraction stage (case n° 1) to help correct malocclusion.

Analysis of occlusion status and finishing strategy

In our opinion, occlusion analysis does not require a complicated clinical form, but does include:

- static aspect, with articulating paper to trace the numerous contacts and intercuspals balance;
- dynamic aspect, with systematic examination of lateralities and especially propulsion.

For us, analysis of occlusion defects is in strict parallel to correction, systematizing intervention and avoiding a lot of points getting overlooked.

A radiological check-up is essential. A panoramic view serves to check tooth parallelism and excessive inter-root space if implant sites are to be prepared. It also avoids coronoradicular angles being detected too late when they might lead to threatening proximities: treatment in this case (figs 1-6) of severe class III, ended with perfect occlusion, with a slight linear and angular mandibular compensation that had to be accepted, and maxillary decompensation that doubtless ensured anterior stability; systematic end-of-treatment panoramic unfortunately showed severe mandibular canine angulation; it was too late to correct the tooth axes to achieve compromise after the devices had been removed.

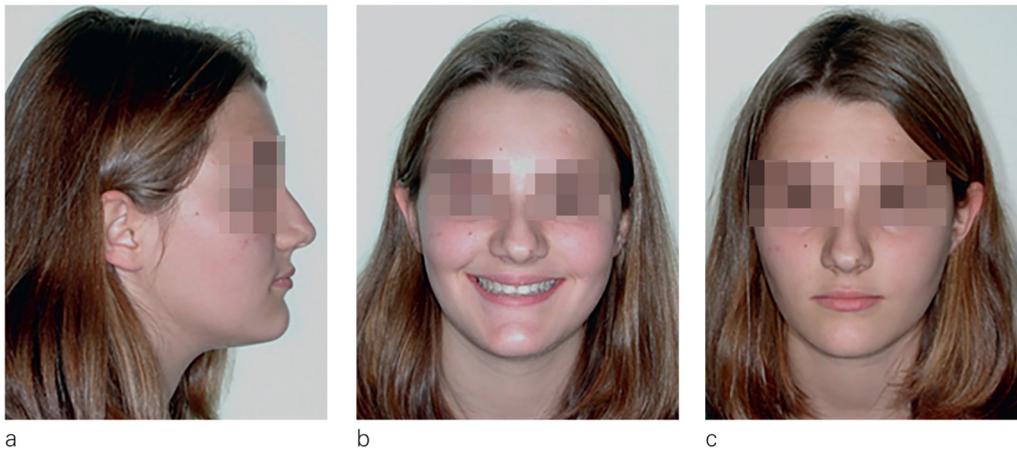


Figure 1
a, b, c: Lateral, three-quarter smile and frontal views. Fanny D., born Jan. 1988. End of treatment, 14 yrs 10 mo.



Figure 2

a, b, c: Right, frontal and left intraoral vestibular views. Fanny D., born Jan. 1988. End of treatment, Nov. 2002, 14 yrs 10 mo.

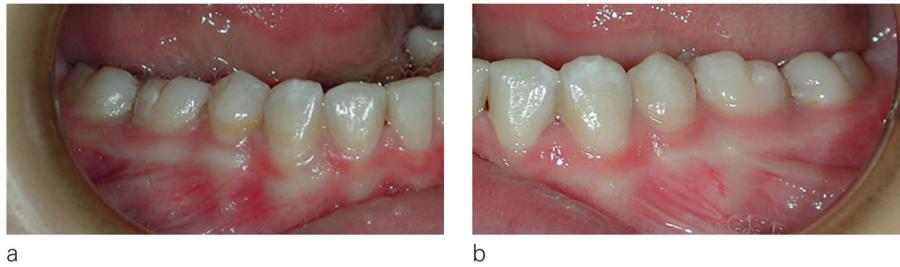


Figure 3

a, b: Intraoral views, canine region close-up, checking alignment, leveling and coronary axes. Fanny D., born Jan. 1988. End of treatment, Nov. 2002, 14 yrs 10 mo.

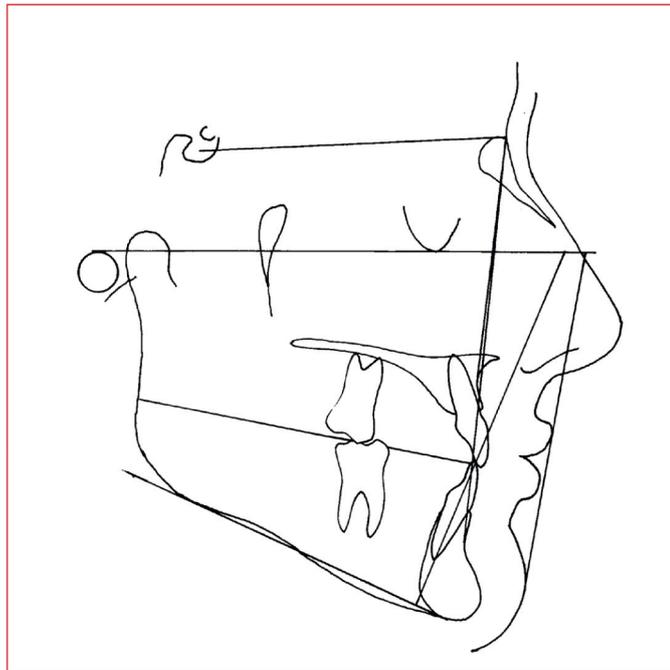


Figure 4

Lateral teloradiograph. Fanny D., born Jan. 1988. End of treatment, Nov. 2002, 14 yrs 10 mo.

Fanny D. née le 26/1/88. Fin de traitement, 11/02, 14a 10m

| | |
|------------------------|-------------|
| FMIA | 67 |
| FMA | 25 |
| IMPA | 88 |
| SNA | 80 |
| SNB | 81 |
| ANB | -1 |
| AoBo | -4 |
| Plan d'Occ | 11 |
| Angle Z | 80 |
| Upper lip | 14 |
| Total chin | 9 |
| Ht Faciale Post | 44.5 |
| Ht Faciale Ant | 62 |
| Index Post/ Ant | 0.72 |



| | |
|-----------------|--------------|
| SNA | 80 |
| SNB | 81 |
| ANB | -1 |
| SND | 80 |
| 1/NAmm | 4.5 |
| 1/NA° | 21 |
| 1/NBmm | 2 |
| 1/NB° | 16 |
| Pog/NB | 5 |
| 1/I | 143.5 |
| Occl/ SN | 13.5 |
| GoGn/SN | 26 |
| SE | 62 |
| SL | 18.5 |

Figure 5

Diagram and Steiner and Tweed analyses. Fanny D., born Jan. 1988. End of treatment, Nov. 2002, 14 yrs 10 mo

Fanny D., born Jan. 26, 1988. End of treatment, Nov. 2002, 14 yrs 10 mo

Plan d'Occ: Occ plane / Ht Faciale Post: Post facial height / Ht Faciale Ant: Ant facial height



Figure 6

Panoramic view. Fanny D., born Jan. 1988. End of treatment, Nov. 2002, 14 yrs 10 mo.

Main treatment procedures

The main therapeutic procedures comprise:

- elastic vertical traction, worn permanently. Traction should be exerted on the arch (welded brass spurs or pinched stops) rather than on this or that tooth: unitary dental displacement is governed by the arch (especially 2nd order shaping), whereas maxillomandibular traction controls extensive gaps (dental group or arcade sector or half-arcade).

Arch anchorages may seem to hinder implementing shaping at the same site, but this is not actually true: angulations can be introduced on either side of the weld without putting its at risk, to perform a step, for example (fig. 7).

- Occlusal sharpening regularizes anatomic abnormalities hindering occlusion. Occlusal adjustment should not replace finishing, often by inducing dental intrusion or extrusion in case of gauge error; buffing is

indicated in coronary dysmorphism causing a gap or occlusal trauma.

- Shaping on .019 x .026 arch, by 139-type forceps, is certainly the most precise method, enabling any practitioner to perform a release on the arch with 0.2 mm precision; it is the method we prefer.

Poling⁹ underlined the risk of weakening the arch at the torsion points, but we think the risk of fracture is virtually non-existent.

Some authors recommend an alternative solution, ungluing and regluing the bracket when badly positioned. This is attractive, being in line with the philosophy of a straight arch, but is open to theoretical and practical objections:

- If 13 shows 0.5 mm extrusion and 5° tip-forward, the bracket should be released and reglued with a 0.5-mm shorter gauge and in-built 5° tip-back. The problem is that, once the original bracket has been released, we have no reference for positioning the new one!

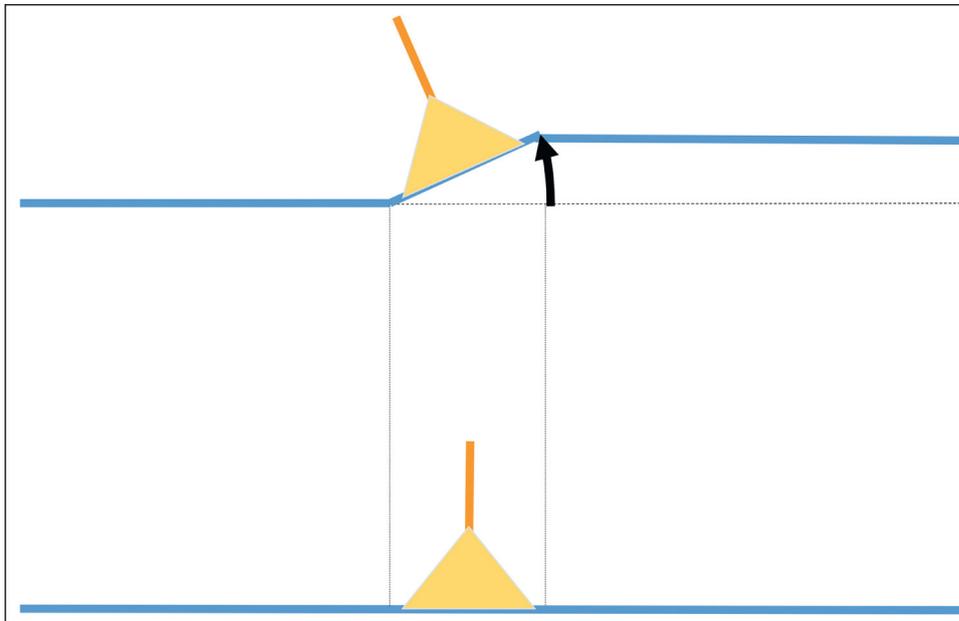


Figure 7

Introducing a step in an interdental space already bearing a welded spur: angles mesial and distal to the weld.

- Experience shows that practitioners usually glue the second bracket back precisely in the position of the first, exactly matching the anatomic data at first fitting⁹.
- The smaller the desired change in position, the less the precision of correction by regluing⁹.

We consider the “ungluing-regluing” method indicated only for big mistakes in positioning (>1.5 mm), which almost never happen.

Another argument supports the choice of “pliers shaping” rather than

“ungluing-gluing” as recommended by some: this is the spread of self-ligating brackets (which we have used for many years now); time saving compared to ablating and replacing an arch now leaves more time for “touching up” and a strategy of rational finishing (notably respecting the rule of the 3 orders) conducted methodically and rigorously. No-one would hesitate now to remove a terminal arch with a single application of pliers.

CHECKS

At each stage, of course, we check the result of the previous stage, statically and dynamically; the protocol can be revised at any time.

Hierarchy of interventions on the arch

Intervention should follow a rigorous protocol. Three chronological rules are to be observed

- intervention according to arcade: first intervention on mandibular arcade, then on maxillary arcade;
- intervention according to order: first, 1st order; second, 2nd order; third, 3rd order;

- intervention according to extension or location: first intervention for a general problem; second intervention for a localized problem.

For example, in case of bilateral tip-to-tip, with clear crossed occlusion only in 14/44-45 and 25/35-36, we begin by overall maxillary expansion (and possibly mandibular contraction); then secondly we correct remaining crossed occlusions by individual inset/offset procedures.

FINISHING ARCHES

Some schools recommend “loosening the bridle” during finishing, using more elastic material and under-sized arches in titanium or nickel-titanium of .018 x .025 or .016 x .022 section or round .016 or .014 arches, in the hope that nature will finish occlusion.

In contrast, we think that, near the end of treatment, position control needs to be maintained or increased to correct the last remaining little imperfections.

Finishing thus uses .019 x .026 nickel-chromium arches in 95% of cases.

Full-groove steel arches, section .022 x .028

We only use full-groove arches for severe general problems of arcade shape.

Transversally, bilateral crossed occlusion problems can be easily resolved by maxillary expansion or mandibular contraction or both, with either a .022 x .028 active arch or 2 arches.

Vertically, in case of strong mandibular Spee curve, a full-groove arch solves the problem quickly.

Steel arch, section .019 x .026

A .019 x .026 arch has the advantage of enabling most finishing corrections to be performed in a single procedure, without risk of bracket detachment.

It is possible to introduce 1st or 2nd order shaping in the arch up to 1 to 1.5 mm (step-up/step-down or inset/offset).

Shaping on this scale with a full-groove arch would inevitably lead to detachment.

But it can also be introduced in 2 stages (fig. 8: 0.75 mm step, increased to 1.5 mm at next appointment).

The .019 x .026 arch is the optimal compromise between malleability and elasticity for occasional finishing.

Moreover, loss of position control is minimal with a .019 x .026 arch in a .022 x .028 groove: negligible for axial rotation or mesio-distal tilt, and only 7° for torque.

If the power of a full-groove arch is needed (e.g., strong Spee curve), it should be introduced first, and then, for occasional finishing, either revert to a .019 x .026 arch or finish with a full-groove arch in 2 stages (cf. below and fig. 8).

FREQUENCY OF INTERVENTION

The frequency of finishing operations depends on the large number of occlusal contacts. Ranking according to order is as follows:

2nd order: approx. 70%

These are general interventions, notably correction of strong Spee curves; they are often occasional, especially to intrude/extrude single teeth in the lateral sectors (step-up or step-down); axial corrections (tip back/tip forward, with 2 identical consecutive steps) are more frequent in the anterior sector, for esthetic reasons, optimizing the "esthetic shaping" already included in the brackets.

1st order: approx. 30%

General interventions (arch expansion/contraction) are frequent.

Occasional interventions are rarer: slight vestibular or palatal displacement (offset + inset » or inset + offset), to correct, for example, an overly vestibular lateral incisor (residual class II division 2 occlusion), or axial rotation due to general gluing error (inset + inset or offset + offset).

3rd order: exceptional

Third-order intervention is very rare in our practice. Torque control with a .019 x .026 arch in a .022 x .028 groove is excellent, with just 7° play or loss of control.

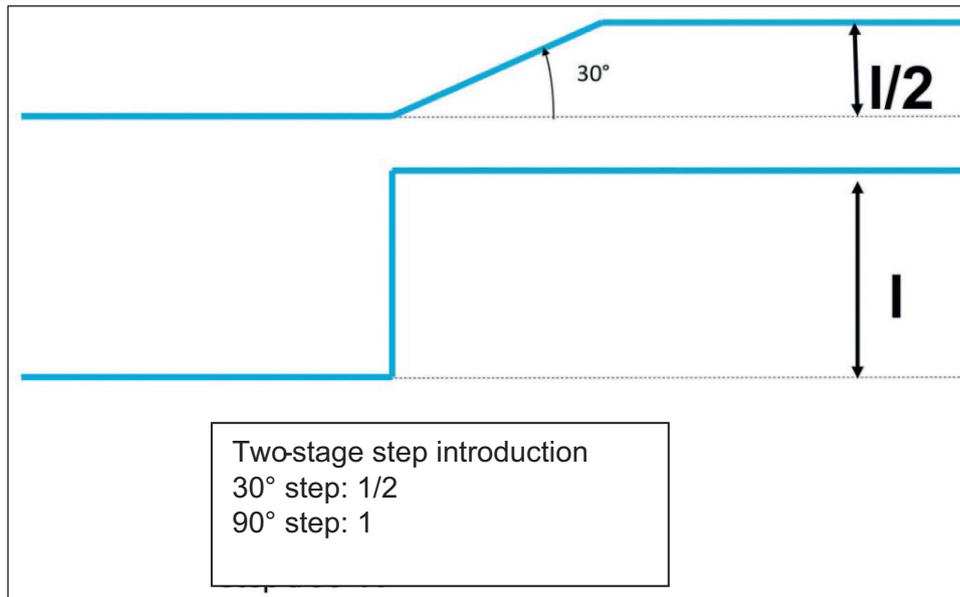


Figure 8

Introducing a large step in 2 stages: 30° then 90° ($h = 0.75$ mm then 1.5 mm).

With Roth prescription, a severely retracted superior central incisor at risk of “under-version” ends up at 14° minus $7^\circ = +7^\circ$ ($+14^\circ$: incorporated Roth torque; -7° loss of undersizing control); residual version greatly exceeds the natural version of 1° to 2° .

These rare interventions usually concern incisor groups, to achieve angular under-compensation or over-decompensation. What is sought is a final position in angular over-decompensation: in severe skeletal class II, for example, final slight incisor angular superior protrusion ($+3^\circ$ to $+5^\circ$) and slight inferior retrusion (-3° to -5°), or class III compensation, is recom-

mended by some authors (Planché, Andrews) to guard against any slight tendency to relapse. Such angular over-decompensation comes obviously at the price of linear over-compensation; likewise, over-decompensation of bilabioversion requires reduced superior and inferior incisor torque.

Occasional intervention may exceptionally be needed to correct ectopic included canines that have undergone difficult traction (e.g., vestibular maxillary canines) to avoid fenestration. In such cases, it is wise to provide “torque breakers” to soften the impact of torque correction.

CONCLUSION

A long finishing stage using pliers provides perfect static occlusion, rigorous intercuspation and canine and molar class I relations, while ensuring functional and esthetic excellence.

This stage is not enough in itself to ensure stability, which depends also on the architectural balance of the face and anterior dentition: i.e., the critical therapeutic choices regarding extraction and mechanics, anchorage, final incisor positioning and functional balance, etc. Thus, finishing begins on the day when the brackets are fitted;

the first steps are critical as initial mistakes preclude perfect occlusion, and any delay leaves less time for finishing.

Even with perfect treatment strategy and rigorous finishing, definitive stability is not guaranteed, and final occlusion may “wobble”, either for functional reasons (recurrent dysfunction) or simply with aging.

Even so, a rigorous protocol, close attention and time spent on finishing help conjure the specter of relapse, or at least reduce its frequency and severity.

CASE 1

Diagnosis

Manon G. consulted in May 2011 at the age of 13 years 8 months. Her face presented as class II hyperdivergent; intraoral examination, however, found molar class I with only moderate overjet (figs 9-12). Cephalometry

confirmed the severity of skeletal class II, “borderline surgical”, and the degree of linear and especially angular compensation trying to hide it. Bilabioversion related to DMD was superimposed on class II (T1 and T2) linear compensation.



Figure 9

a, b, c: Lateral, smile and frontal views. Nov. 5 (13 yrs 8mo); 1st documents.



Figure 10
a, b, c: Right, frontal and left intraoral views. Nov. 5 (13 yrs 8mo); 1st documents.



Figure 11
a, b, c: Molds, right, frontal and left views. Nov. 5 (13 yrs 8mo); 1st documents.



Figure 12
a, b, c: Occlusal maxillary and mandibular views and Spee curve. 5 (13 yrs 8mo); 1st documents.

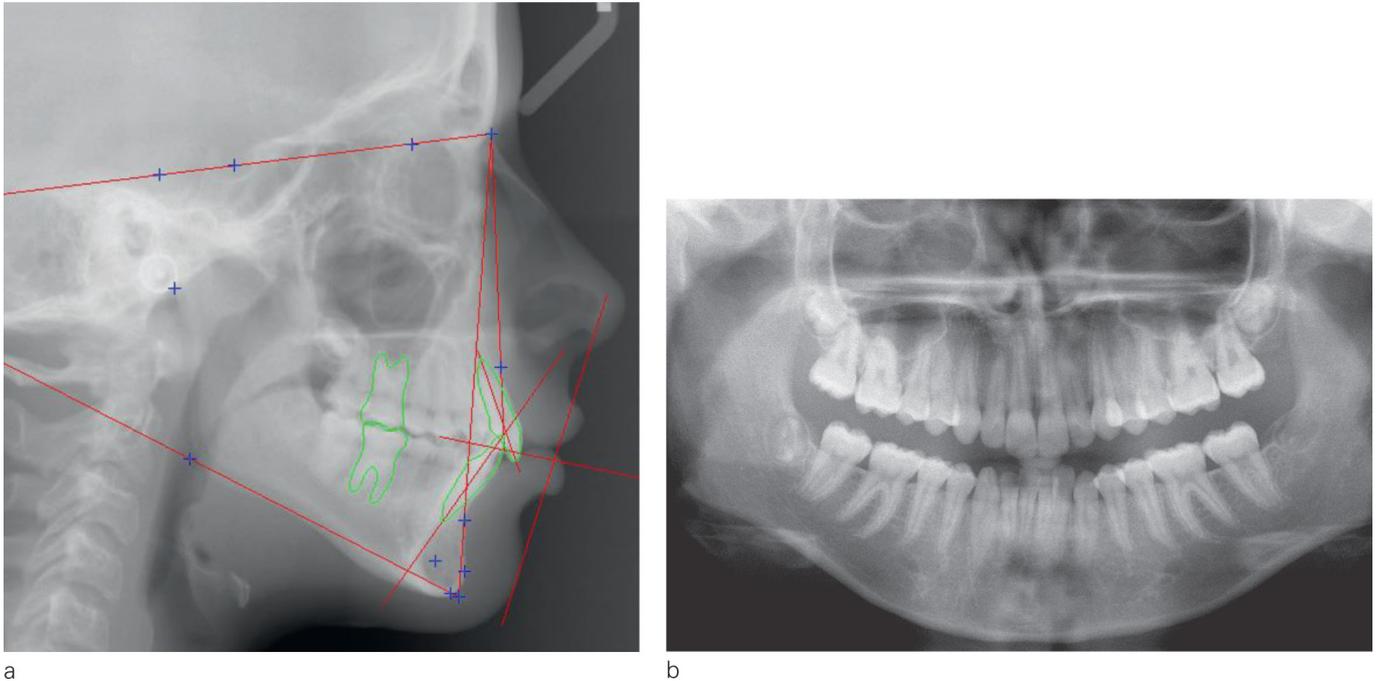


Figure 13

a, b: Teleradiograph with Steiner lines and panoramic view. 5 (13 yrs 8mo); 1st documents.

Treatment plan

The incisor positioning objective involved a very slight compromise to balance a difficult “frame”; at the cost of heavy devices (miniscrews to avoid any loss of anchorage) in a difficult case (figs 14 and 15).

Achieving perfectly finished stable occlusion required extreme mechani-

cal precautions to maintain anchorage, enabling rigorous control of skeletal and dental class II correction and correction of linear bilabioversion.

We used straight arch attachments, with .022 x .028 groove, Roth prescription and inbuilt -10° and -15° tip-back on the mandibular molars (passive self-ligating brackets).

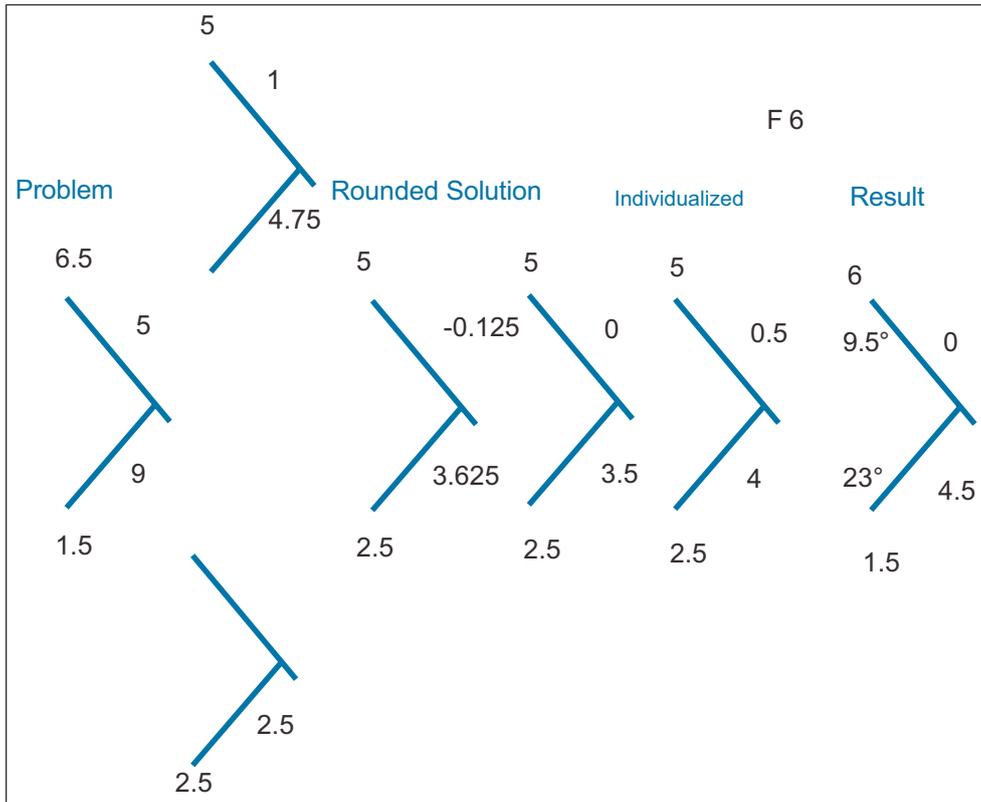


Figure 14
Steiner chevrons.

| | | |
|--------------|----------------------|------------|
| Discrepancy | -4 | |
| Spee curve | -1 | |
| Relocation i | -11 -> -10 | |
| Extraction | -5 -> 0 | +15 |
| IMT II | | |
| Relocation 6 | | |
| Total | -21 -> -15 | +15 |

| | |
|-------------------------|-------------|
| Available space | 0 |
| Diameter of 8s | -22 |
| Present deficit | -22 |
| Residual growth* | +9.5 |
| Anchorage loss | +4 |
| Expected deficit | -8.5 |

• According to: $Space\ gain = 33 - 1.722 \times age$

Figure 15
Steiner "box" and posterior space "box"

Treatment and finishing:

**Aug. 2011 (13yrs 11mo) –
Aug. 2014 (16yrs 11mo)**

The degree of anterior retraction to be achieved, especially on the maxilla, required early finishing operations, during the actual retraction stage, although we would usually try to avoid this. Finishing will optimally adjust occlusion when malocclusion correction has been completed.

Early finishing operations were needed as incisor retraction was blocked by closed bite (figs 16 and 17), due to slight excess of maxillary incisors gauge and arcade flexion induced by the retraction imposed (.019 x .026 arch); reshaping comprised 2nd order action (maxillary incisor intrusion, especially of 11-21) and radiculo-palatal torque (figs 18-21).



Figure 16

a, b, c Right, frontal and left vestibular intra-oral views, Aug. 2012 (14yrs 11mo); direct mechanical incisor retraction blocked by closed bite.



Figure 17

a, b, c Right, frontal and left vestibular intra-oral views, Aug. 2012 (14yrs 11mo); incisor retraction: introduction of step-up 3-2.



Figure 18

a, b, c Maxillary, mandibular arches and coordination.



Figure 19
a, b, c: Maxillary arch seen from right, front and left.



Figure 20
a, b, c: Maxillary arch, close-up of flat part, seen from right, front and left.

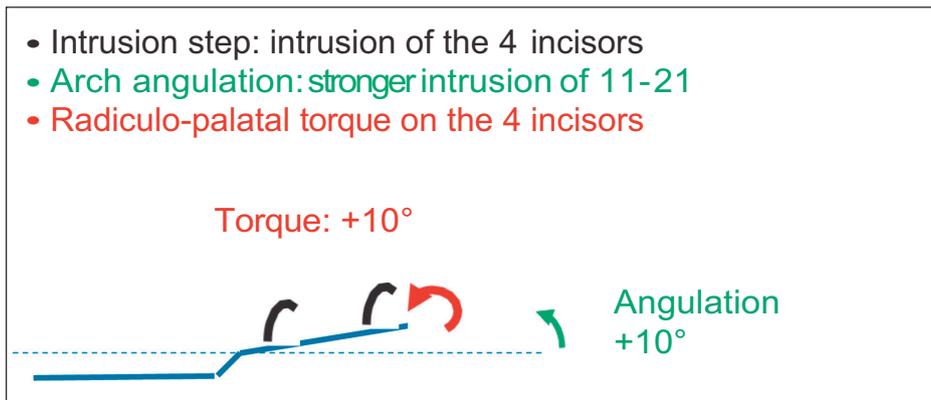


Figure 21
Diagram of mechanical analysis.

Retraction was completed without difficulty, and individual finishings were added.

Final documents (figs 22-26) show over-decompensation:
– of bilabioversion (especially angular);

– and of initial class II compensation: mandibular incisor reduced from 31°-9 mm to 23°-4.5 mm (fig. 27).

Final (figs 22-26 and Tables 1-2) and post-treatment documents show occlusion stability.



a

b

c

Figure 22

a, b, c: Lateral, smile and frontal views; Aug. 2014 (16yrs 11mo); ablation.



a

b

c

Figure 23

a, b, c: Right, frontal and left vestibular intra-oral views; Aug. 2014 (16yrs 11mo); ablation.



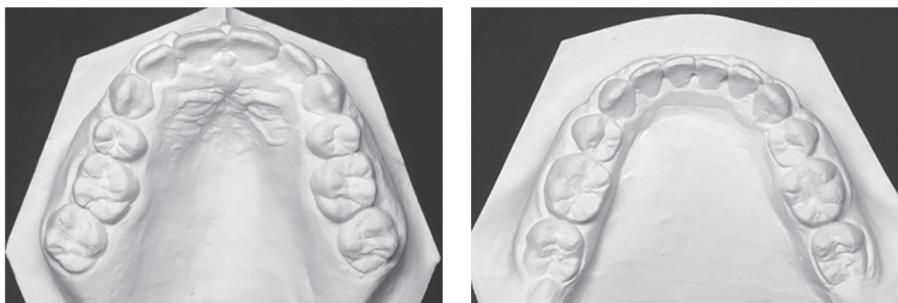
a

b

c

Figure 24

a, b, c: Molds: Right, frontal and left vestibular views; Aug. 2014 (16yrs 11mo); ablation.



a

b

Figure 25

a, b: Molds: occlusal, maxillary and mandibular views; Aug. 2014 (16yrs 11mo); ablation.

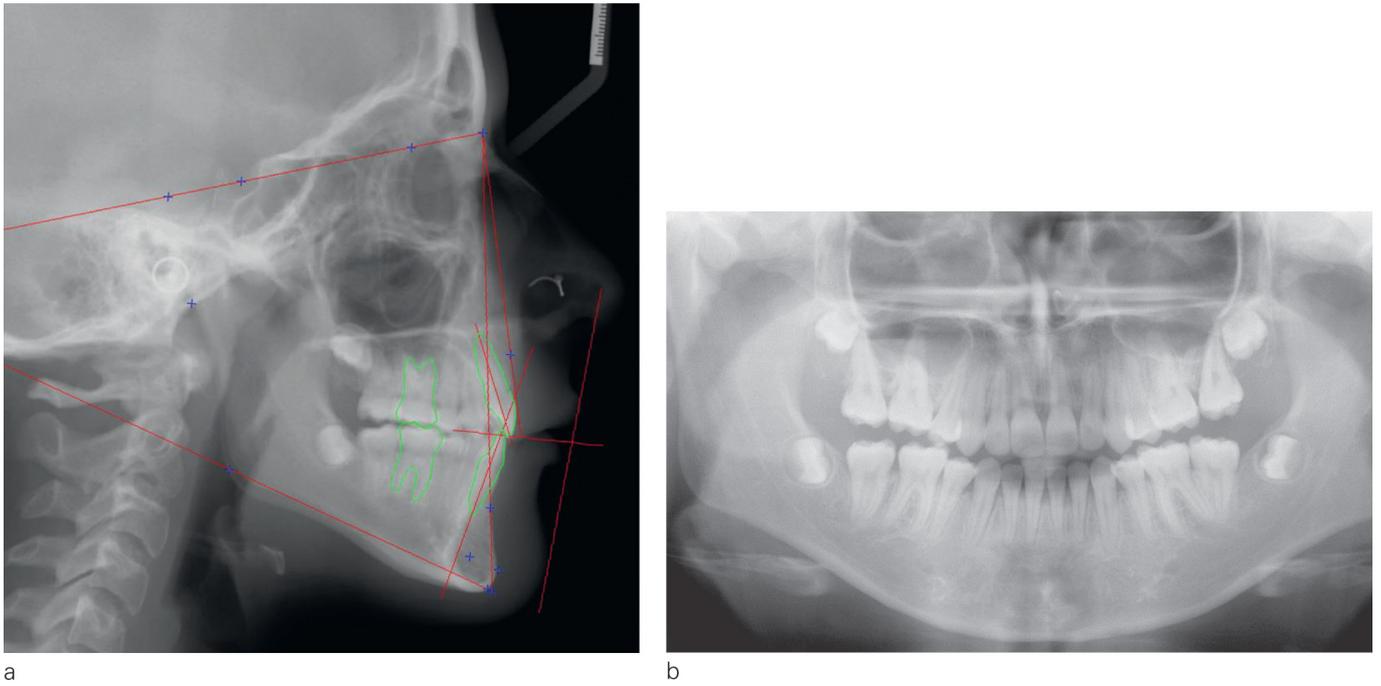


Figure 26
 a, b: Teleradiograph with Steiner lines and panoramic view at end of treatment;
 Aug. 2014 (16yrs 11mo); ablation.

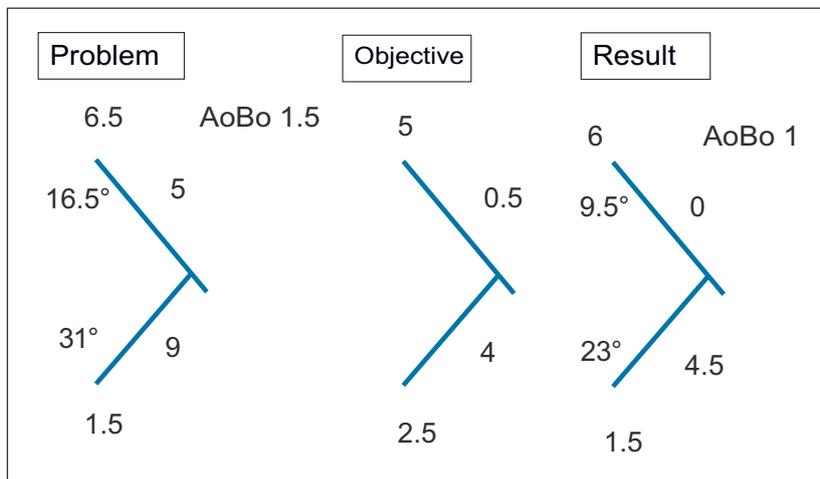


Figure 27
 Check of anterior dentition.

Table 1: Steiner analysis.

| Manon G. born Sept. 1997 | | Steiner Cephalometry | |
|--------------------------|------|----------------------|-------------------|
| Cephalometry | Norm | May 2011 13y 8mo | Aug 14 16y 11m |
| SNA | 2 | 85 | 85.5 |
| SNB | 80 | 79 | 79.5 |
| ANB | 2 | 6.5 | 6 |
| SND | 76 | 75.5 | 77 |
| 1/NAmm | 4 | 5 | 0 |
| 1/NA° | 22 | 16.5 | 9.5 |
| 1/NBmm | 4 | 9 | 4.5 |
| 1/NB° | 25 | 31 | 21 |
| Pog/NB | / | 1.5 | 1.5 |
| 1/1 | 131 | 126 | 143.5 |
| Occl/ SN | 14 | 19 | 17.5 |
| GoGn/SN | 32 | 34.5 | 36.5 |
| SE | 51 | 49 | 43.5 |
| SL | 22 | 20.5 | 18.5 |

Table 2: Tweed analysis.

| Manon G. born Sept. 1997 | | Tweed Cephalometry | |
|--------------------------|----------|--------------------|-------------------|
| Cephalometry | Norm | May 11 13y 8m | Aug 14 16y 11m |
| FMIA | 27°+/-3 | 53.5 | 68.5 |
| FMA | 25°+/-3 | 31 | 29 |
| IMPA | 88°+/-3 | 95.5 | 82.5 |
| SNA | 82° | 85 | 85.5 |
| SNB | 80° | 79 | 79.5 |
| ANB | 2°+/-2 | 6.5 | 6 |
| AoBo | 2 mm + 2 | 1.5 | 1 |
| Occlusion plane | 10° | 13 | 8 |
| Angle Z | 75 +/-5 | 61.5 | 75.5 |
| Upper lip | / | 17.5 | 16.5 |
| Total chin | / | 16 | 14.5 |
| Post facial height | 45 mm | 49 | 42.5 |
| Ant facial height | 65 mm | 71 | 66 |
| Post/Ant Index | 0,69 | 0.7 | 0.6 |
| Progression ratio | 2/1 | | |

CASE 2

Diagnosis

Carol T., born January 1995, consulted in February 2007, aged 12 years 1 month.

Facial examination found class III with notable cheek-bone aplasia (fig. 28).

Intra-oral examination confirmed this impression, with slight molar class III, despite overjet in 11-21, due to crowding (fig. 29). Cephalometry (figs 31 and 32) confirmed slight hyperdivergent



Figure 28

a, b, c: Lateral, smile and frontal views. 1st documents. Dec. 2007 (12y 11m).



Figure 29

a, b, c: Right, frontal and left vestibular views. 1st documents. Dec. 2007 (12y 11m).

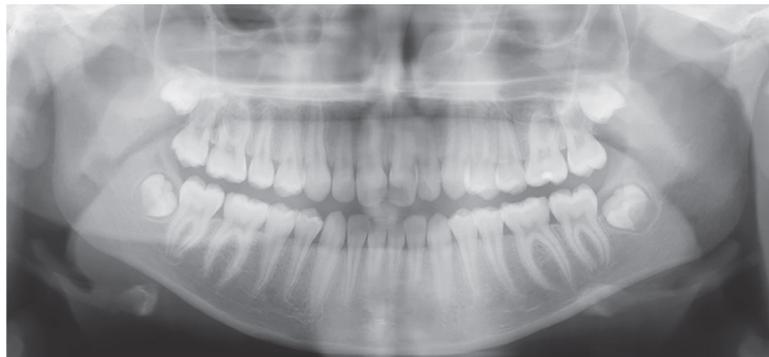


Figure 30

Panoramic view. 1st documents. Dec. 2007 (12y 11m).

class III and strong bilabioversion, reducing, as is often the case, the sensation of slight skeletal dysmorphism and "saving" the class III.

Bilabioversion was stronger in the maxilla than mandible, due to class III compensations superimposed on the bilabioversion.

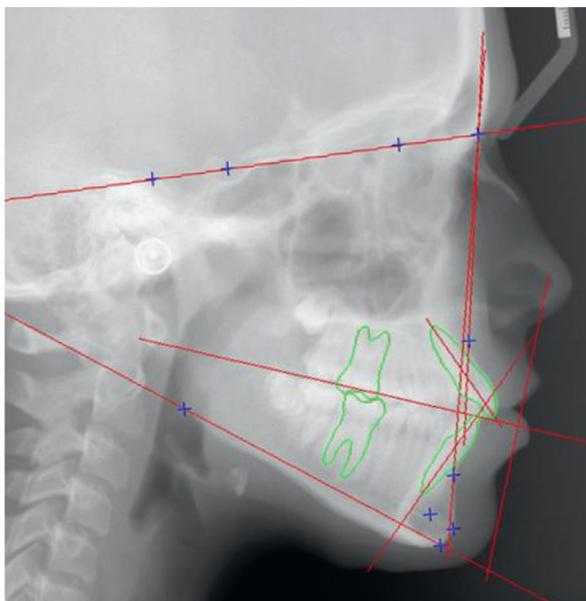


a

| Analyse de Tweed : | | | |
|--------------------|---------|--------|----------|
| Angle FMA | 25.00° | 28.01 | (+3.01) |
| Angle FMIA | 68.00° | 55.59 | (-12.41) |
| Angle IMPA | 87.00° | 96.40 | (+9.40) |
| Angle SNA | 82.00° | 79.54 | (-2.46) |
| Angle SNB | 80.00° | 77.96 | (-2.04) |
| Angle ANB | 2.00° | 1.58 | (-0.42) |
| AO-BD | 0.00mm | -4.67 | (-4.67) |
| Occlusal - SN | 14.00° | 21.10 | (+7.10) |
| Occlusal - FH | 10.00° | 12.59 | (+2.59) |
| Inter-incisif | 135.00° | 110.42 | (-24.58) |
| total chin | 11.00mm | 13.74 | (+2.74) |
| upper lip | 13.00mm | 13.56 | (+0.56) |
| Angle Z | 78.00° | 70.46 | (-7.54) |
| Nasion - ENA | 0.00mm | 51.76 | (+51.76) |
| Menton - ENA | 65.68mm | 71.21 | (+5.53) |
| HFP | 45.00mm | 42.37 | (-2.63) |
| HFA | 65.00mm | 69.44 | (+4.44) |
| HFP / HFA | 0.70 | 0.61 | (-0.09) |

b

Figure 31
a and b: Teleradiography and Tweed cephalometry. 1st documents. Dec. 2007 (12y 11m).
Tweed analysis
Inter-incisor
Chin



a

| Analyse de Steiner : | | | |
|----------------------|---------|--------|----------|
| SNA | 82.00° | 79.54 | (-2.46) |
| SNB | 80.00° | 77.96 | (-2.04) |
| ANB | 2.00° | 1.58 | (-0.42) |
| SND | 76.00° | 74.84 | (-1.16) |
| SL | 51.00mm | 51.00 | (0.00) |
| SE | 22.00mm | 22.36 | (+0.36) |
| GoGn to SN | 32.00° | 36.17 | (+4.17) |
| I to NA mm | 4.00mm | 8.46 | (+4.46) |
| i to NB mm | 4.00mm | 5.90 | (+1.90) |
| Pog to NB | 0.00mm | 0.90 | (+0.90) |
| Pog to iNB | 0.00mm | 5.00 | (+5.00) |
| I to NA ° | 22.00° | 37.10 | (+15.10) |
| i to NB ° | 25.00° | 30.89 | (+5.89) |
| I to i ° | 131.00° | 110.42 | (-20.58) |
| Occl to SN | 14.00° | 21.10 | (+7.10) |

b

Figure 32
a and b: Teleradiography with Steiner lines, and Steiner cephalometry. 1st documents. Dec. 2007 (12y 11m). Steiner analysis.

Treatment plan

Space calculations were very negative in the anterior (fig. 33) and posterior sectors (fig. 34), and extraction of the 4 first premolars and 4 third

molars was inevitable (figs 30-34). Sacrificing the premolars enabled an anterior strategy free of compromise, with rigorous anchorage (fig. 32).

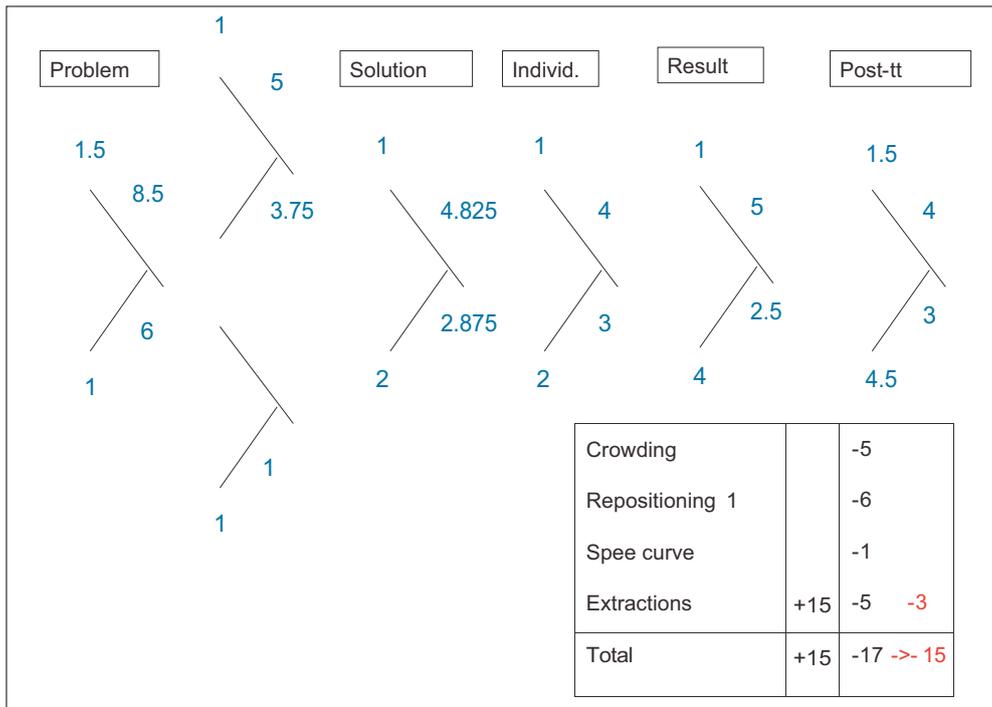


Figure 33
Steiner chevrons and anterior "box."

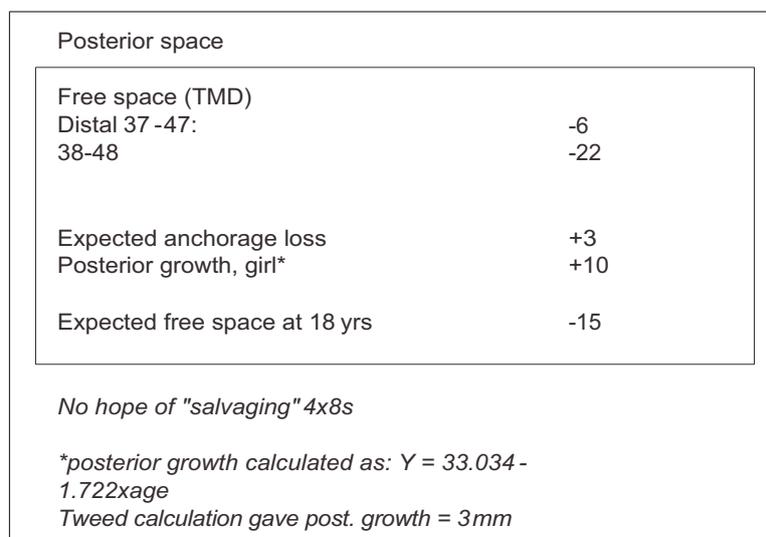


Figure 34
Posterior space "box."

Multibracket treatment and finishing (March 2008 (13y 2m) – Oct. 2010 (15y 9m))

Straight arch attachments with Roth prescription and -10° and -15° built-in tip-back on mandibular molars improved anchorage (passive self-ligating brackets).

Intercuspatation finishing was of course rigorous. The terminal arch (fig. 35-38) comprised mainly 2nd order shaping (steps, accentuated maxillary and inversed mandibular Spee curve, tip-back on 11, etc.), but also 1st order (fig. 36b) and even 3rd order (fig. 37a and c, and fig. 45).



Figure 35

a, b, c: Right, frontal and left vestibular views. Finishing: Aug. 2010, 15y 7m.



Figure 36

a, b, c: Right frontal and left view, maxillary arch: Finishing: Aug. 2010, 15y 7m.

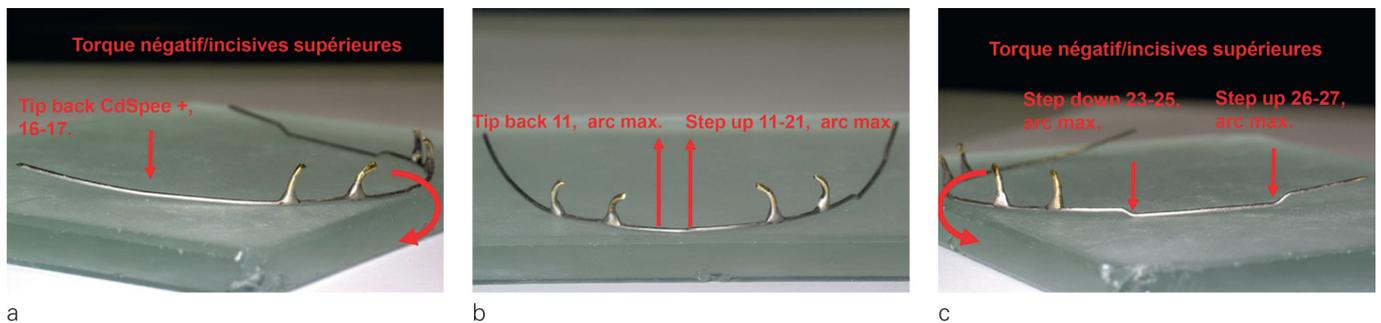


Figure 37

a, b, c: Right frontal and left view, maxillary arch. Finishing: detail of 2nd order control: Aug. 2010, 15y 7m.

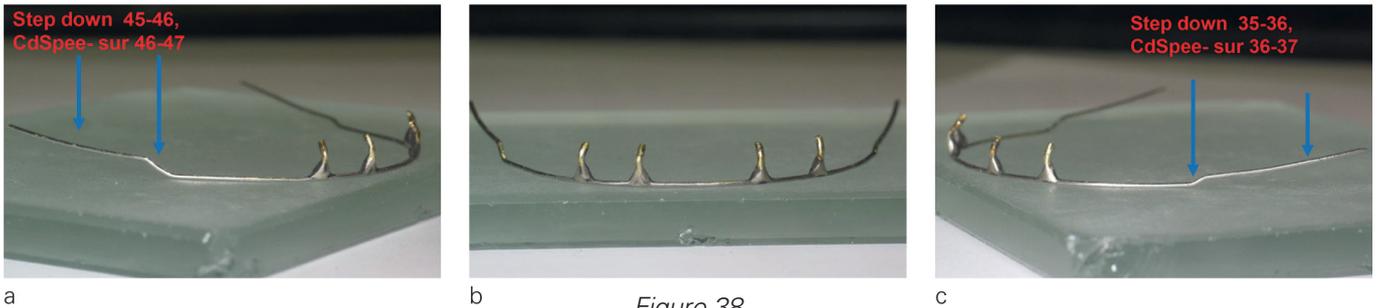
Ablation documents (figs 39-45) confirmed precise static occlusion adjustment.

Finishing comprised class III over-decompensation, especially maxillary, where linear and particularly angular protrusion was very strong (torque

over-correction), to counter possible slight late type-C relapse (figs 44-46).

Third molars were extracted (fig. 48), as planned since the outset in September 2011 (fig. 34).

Post-treatment stability was excellent (figs 47 and 48).



a

b

c

Figure 38

a, b, c: Mandibular arch, right, frontal and left views: Finishing: Aug. 2010, 15y 7m
Inverted Spee curve on 46-47 / Inverted Spee curve on 36-37



a

b

c

Figure 39

a, b, c: Lateral, smile and frontal views; ablation, Oct. 2010, 15y 9m.



a

b

c

Figure 40

a, b, c: Right, frontal and left vestibular views; ablation, Oct. 2010, 15y 9m.

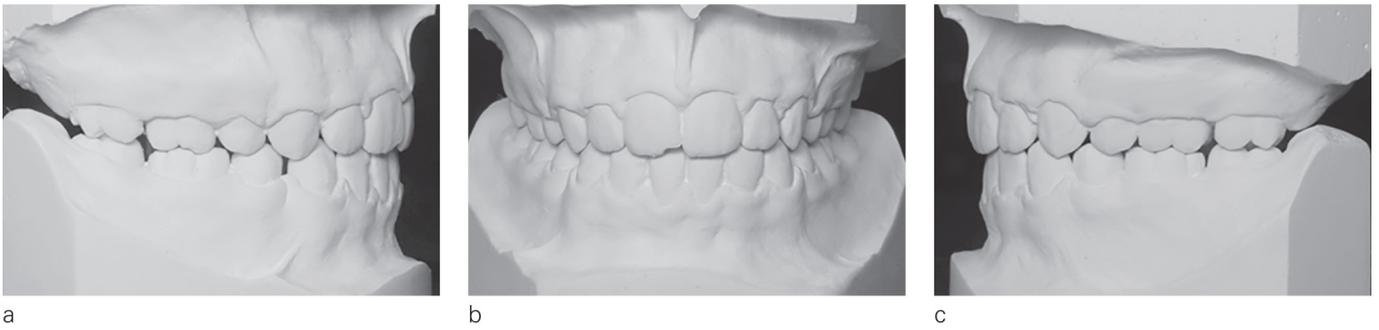


Figure 41

a, b, c: Molds: Right, frontal and left vestibular views; ablation, Oct. 2010, 15y 9m.



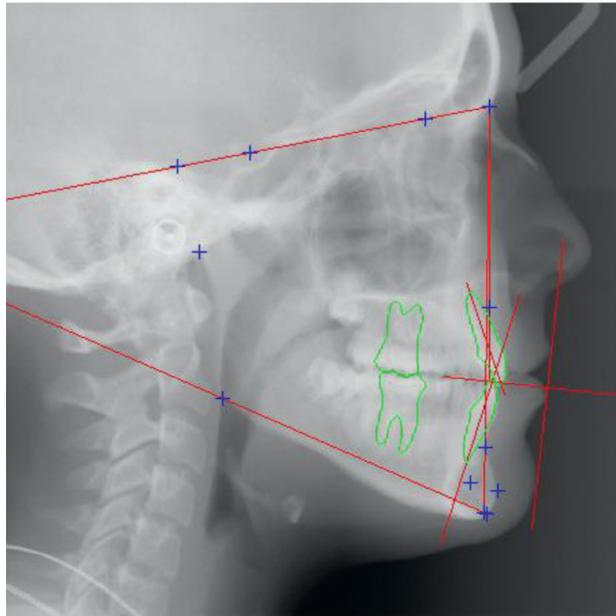
Figure 42

a, b, c: Molds: occlusal, maxillary and mandibular (with Spee curve) views; ablation, Oct. 2010, 15y 9m.



Figure 43

Panoramic end of treatment view; ablation, Oct. 2010, 15y 9m.



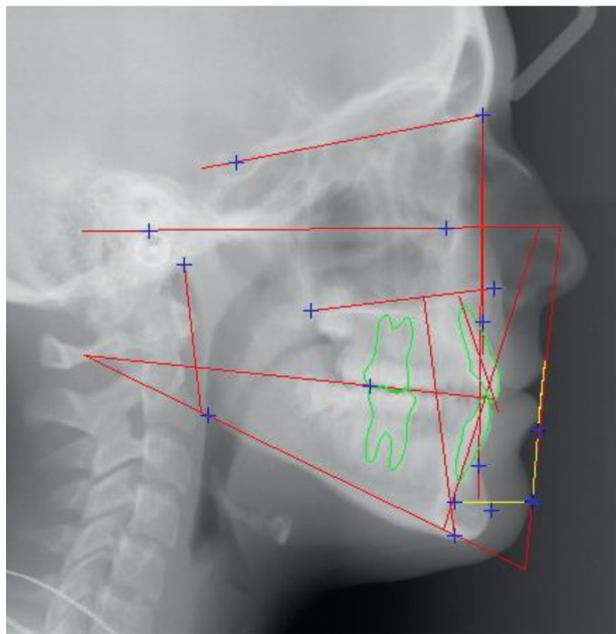
a

| | | | |
|-------------|--------|-------|------|
| SNA | 82.0° | 79.0 | -1.0 |
| SNB | 80.0° | 78.3 | OK |
| ANB | 2.0° | 0.8 | OK |
| SND | 76.0° | 76.1 | OK |
| SL | 51.0mm | 55.0 | 1.0 |
| SE | 22.0mm | 22.6 | OK |
| GoGn to SN | 32.0° | 34.8 | 0.8 |
| I to NA mm | 4.0mm | 4.8 | OK |
| i to NB mm | 4.0mm | 2.5 | OK |
| Pog to NB | 0.0mm | 3.8 | OK |
| Pog to i-NB | 0.0mm | -1.3 | OK |
| I to NA ° | 22.0° | 18.3 | -1.7 |
| i to NB ° | 25.0° | 16.7 | -6.3 |
| I to i ° | 131.0° | 144.2 | 11.2 |
| Occl to SN | 14.0° | 17.1 | 1.1 |

b

Figure 44

a, b: Teleradiograph with Steiner lines and end-of-treatment cephalometry; ablation, Oct. 2010, 15y 9m.



a

| Analyse de Tweed : | | | |
|--------------------|--------|-------|------|
| Angle FMA | 25.0° | 26.6 | OK |
| Angle FMIA | 68.0° | 72.0 | 1.0 |
| Angle IMPA | 87.0° | 81.5 | -0.5 |
| Angle SNA | 82.0° | 79.0 | -1.0 |
| Angle SNB | 80.0° | 78.3 | OK |
| Angle ANB | 2.0° | 0.8 | OK |
| AO-BO | 0.0mm | -3.2 | -1.2 |
| Occlusal - SN | 14.0° | 17.1 | 1.1 |
| Occlusal - FH | 10.0° | 6.6 | -1.4 |
| Inter-incisif | 135.0° | 144.2 | 6.2 |
| total chin | 11.0mm | 16.2 | 0.2 |
| upper lip | 13.0mm | 13.0 | OK |
| Angle Z | 78.0° | 83.8 | 2.8 |
| Nasion - ENA | 56.6mm | 51.8 | OK |
| Menton - ENA | 65.7mm | 75.3 | OK |
| HFP | 45.0mm | 44.7 | OK |
| HFA | 65.0mm | 72.6 | OK |
| HFP / HFA | 0.7 | 0.6 | OK |

b

Figure 45

a, b: Teleradiograph with Tweed lines and end-of-treatment cephalometry; ablation, Oct. 2010, 15y 9m.

Tweed analysis

Interincisor

Chin

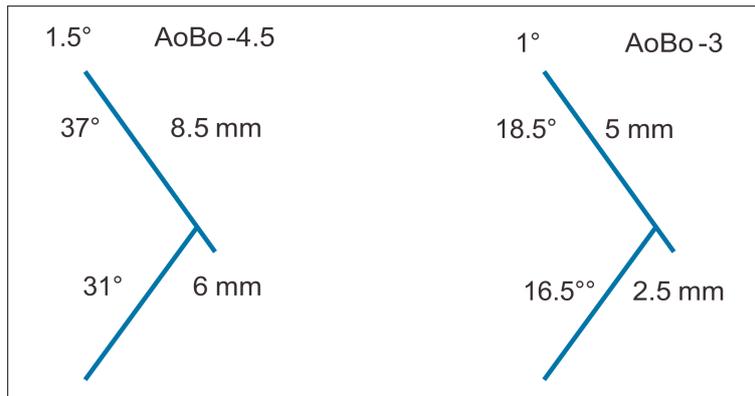


Figure 46
Control of anterior dentition.



a b c
Figure 47
a, b, c: Lateral, smile and frontal views: 3 years post-treatment: Oct. 2013, 18y 9m.



a b c
Figure 48
a, b, c: Right, frontal and left vestibular intra-oral views: 3 years post-treatment: Oct. 2013, 18y 9m.



Figure 49
Panoramic view after extraction of 18-28-38-48. 3 years post-treatment: Oct. 2013, 18y 9m.

CASE 3

Diagnosis

Audrey, born January 1998, consulted in May 2011, aged 13 years 4 months. Above all, her smile was impaired by crowding in both arcades (figs 50 and 51). Facial examination

found vertical excess and difficult labial contact. Teleradiography confirmed insufficient occlusal contact, with slight anterior gap; cephalometry found hyperdivergent class I (figs 53 and 54).

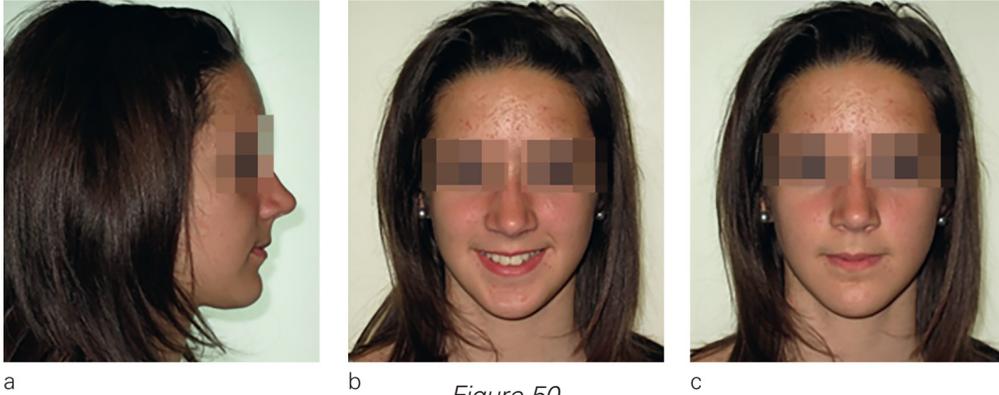


Figure 50
a, b, c: Lateral, smile and frontal views. 1st documents, May 2011 (13y 4m).



Figure 51
a, b, c: Right, frontal and left intra-oral views. 1st documents, May 2011 (13y 4m).



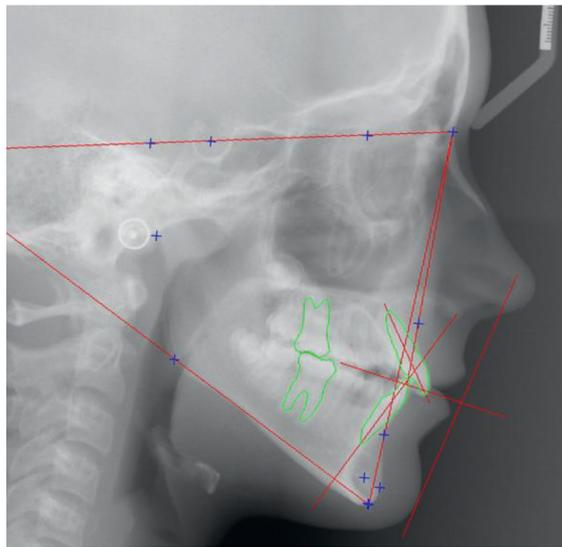
Figure 52
Panoramic view. 1st documents, May 2011 (13y 4m).

Intra-oral examination found superior protrusion with overjet, confirmed on cephalometry (figs 53 and 54).

Posterior DMD was moderate (figs 52 and 56).

Treatment plan

An anterior alignment-advancement plan was abandoned, mainly due to the vertical problem: anterior balance would have been precarious.



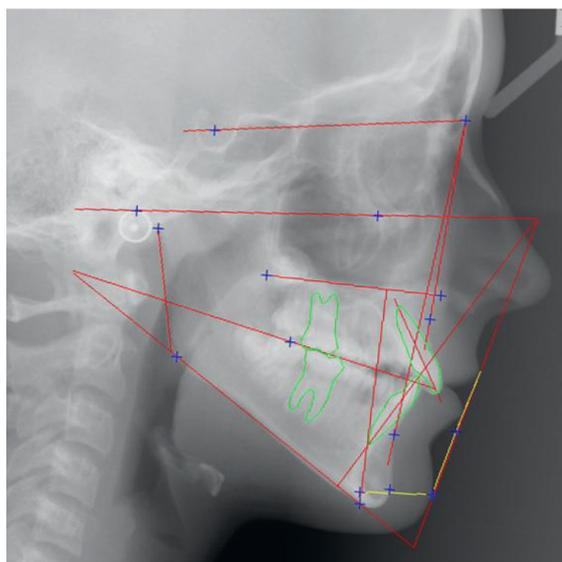
| | | | |
|-------------|--------|-------|------|
| SNA | 82.0° | 77.8 | -2.2 |
| SNB | 80.0° | 75.2 | -2.8 |
| ANB | 2.0° | 2.5 | OK |
| SND | 76.0° | 73.7 | -0.3 |
| SL | 51.0mm | 52.4 | OK |
| SE | 22.0mm | 20.0 | OK |
| GoGn to SN | 32.0° | 39.2 | 5.2 |
| I to NA mm | 4.0mm | 7.6 | 1.6 |
| i to NB mm | 4.0mm | 4.7 | OK |
| Pog to NB | 0.0mm | 2.5 | OK |
| Pog to i-NB | 0.0mm | 2.2 | OK |
| I to NA ° | 22.0° | 34.1 | 10.1 |
| i to NB ° | 25.0° | 23.7 | OK |
| I to i ° | 131.0° | 119.7 | -9.3 |
| Occl to SN | 14.0° | 20.2 | 4.2 |

a

b

Figure 53

a and b: Lateral telerradiograph with Steiner lines and Steiner cephalometry. 1st documents, May 2011 (13y 4m).



| Analyse de Tweed : | | | |
|--------------------|--------|-------|-------|
| Angle FMA | 25.0° | 38.1 | 8.1 |
| Angle FMIA | 68.0° | 54.8 | -10.2 |
| Angle IMPA | 87.0° | 87.1 | OK |
| Angle SNA | 82.0° | 77.8 | -2.2 |
| Angle SNB | 80.0° | 75.2 | -2.8 |
| Angle ANB | 2.0° | 2.5 | OK |
| AO-BO | 0.0mm | -0.8 | OK |
| Occlusal - SN | 14.0° | 20.2 | 4.2 |
| Occlusal - FH | 10.0° | 17.0 | 5.0 |
| Inter - incisif | 135.0° | 119.7 | -12.3 |
| total chin | 11.0mm | 16.6 | 0.6 |
| upper lip | 13.0mm | 12.7 | OK |
| Angle Z | 78.0° | 70.6 | -4.4 |
| Nasion - ENA | 54.9mm | 57.1 | OK |
| Menton - ENA | 65.7mm | 72.2 | OK |
| HFP | 45.0mm | 40.5 | OK |
| HFA | 65.0mm | 70.5 | OK |
| HFP / HFA | 0.7 | 0.6 | OK |

a

b

Figure 54

a and b: Lateral telerradiograph with Tweed lines and Tweed cephalometry. 1st documents, May 2011 (13y 4m).
Tweed analysis

A second-premolar extraction strategy avoided strong incisor retraction, while balancing the anterior box; the

permitted anchorage loss should be of good prognosis for 3rd molar "salvage" (fig. 55 and 56).

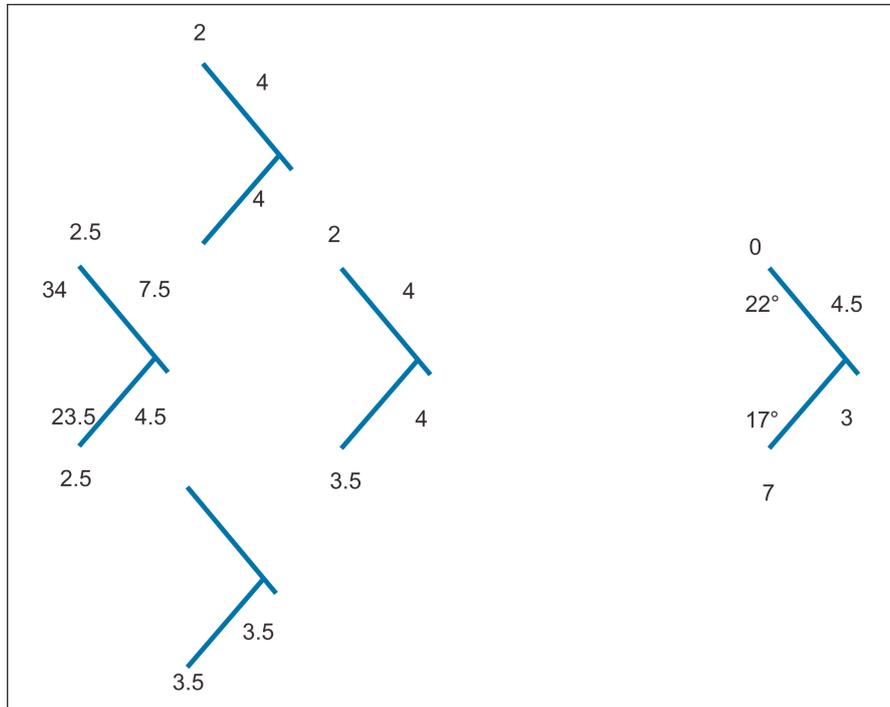


Figure 55
Steiner chevrons. 1st documents, May 2011 (13y 4m).

| | | |
|------------------|--------------|------------|
| Discrepancy | -4.5 | |
| Spee curve | -1 | |
| Relocation i | -1 | |
| Extraction (4x5) | -8 | +15 |
| IMT II | | |
| Relocation 6 | | |
| Total | -14.5 | +15 |

| | |
|-------------------------|--------------|
| Free space | 0 |
| Diameter of 8s | -21 |
| Present deficit | -21 |
| Residual growth* | +13.48 |
| Anchorage loss | +8 |
| Expected deficit | +1.48 |

• According to: $Space\ gain = 33 - 1.722 \times age\ (girl)$

Figure 56
Steiner "box" and posterior space "box"

**Treatment and finishing: April 2012
(14 years 3 months) - November
2014 (16 years 10 months)**

The patient was fitted with straight arch brackets with Roth prescription and built-in -10° and -15° mandibular molar tip-back for better anchorage

control (passive self-ligating brackets).

Multibracket treatment was begun in April 2012 (14 years 3 months) and finishing in March 2014 (16 years 2 months) (figs 57 and 60), with mainly 2nd order interventions. Multibracket treatment was completed in November 2014 (16 years 10 months).



Figure 57

a, b, c: Right, frontal and left vestibular intra-oral views. Start of finishing, March 2014 (16y 2m): superior incisor intrusion steps to avoid contact with inferior brackets and facilitate superior incisor retraction (transient closed bite).



Figure 58

a, b, c: Right, frontal and left vestibular intra-oral views. Finishing, August 2014 (16y 7m): suppression of incisor intrusion steps (retraction terminated), correction of 21, intrusion of 15, extrusion of 46.



Figure 59

a, b, c: Right, frontal and left vestibular intra-oral views. Finishing, August 2014 (16y 7m): vertical interarcade traction and renewed intermaxillary traction II (insufficient class II correction).

The photographs of the terminal arches show the finishing results (figs 61-65): mainly 2nd order interventions (step, Spee curve, accentuated in maxilla and inverted in mandible, tip-

forward on 21, intrusion step-down molar groups with a slight gauge excess etc.) but also 3rd order (reduction of superior incisor torque).



Figure 60

a, b, c: Right, frontal and left vestibular intra-oral views. End of finishing, Nov. 2014 (16y 10m).

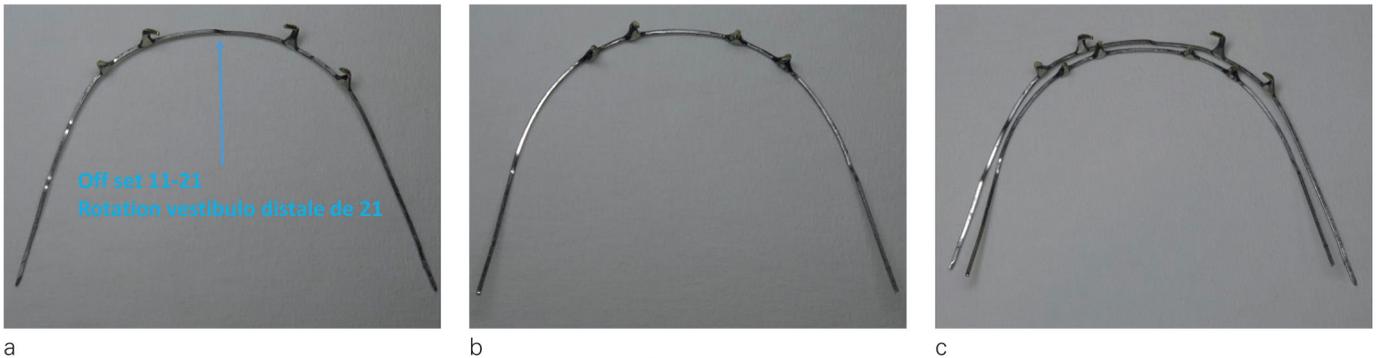


Figure 61

a, b, c: Occlusal views of terminal arches: maxillary, mandibular (upside-down) and coordination. November 2014 (16 years 10 months). Distal vestibular rotation of 21



Figure 62

a, b, c: Maxillary terminal arch: right, frontal and left views. November 2014 (16 years 10 months).



Figure 63

a, b, c: Mandibular terminal arch (upside-down): right (left side), frontal and left (right side) views. November 2014 (16 years 10 months).

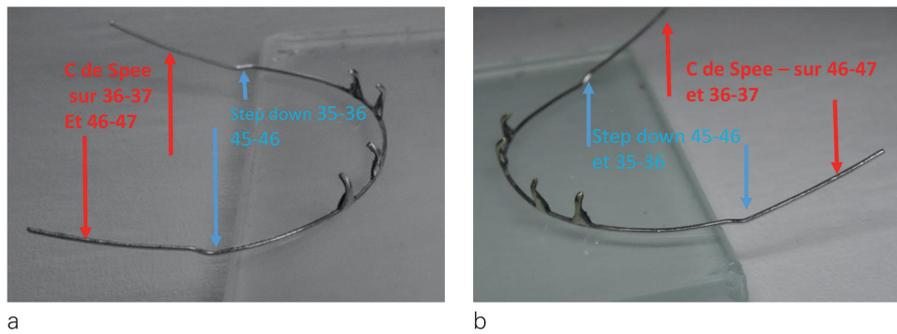


Figure 64

a, b: Mandibular terminal arch (upside-down) on glass plate: right (left side), frontal and left (right side) views: evidence of 2nd order. November 2014 (16 years 10 months).

(a) Spee curve on 36-37 and 46-47 / Step-down and step-up on 35-36 and 45-46
 (b) Spee curve on 46-47 and 36-37 / Step-up and step-down on 45-46 and 36-37

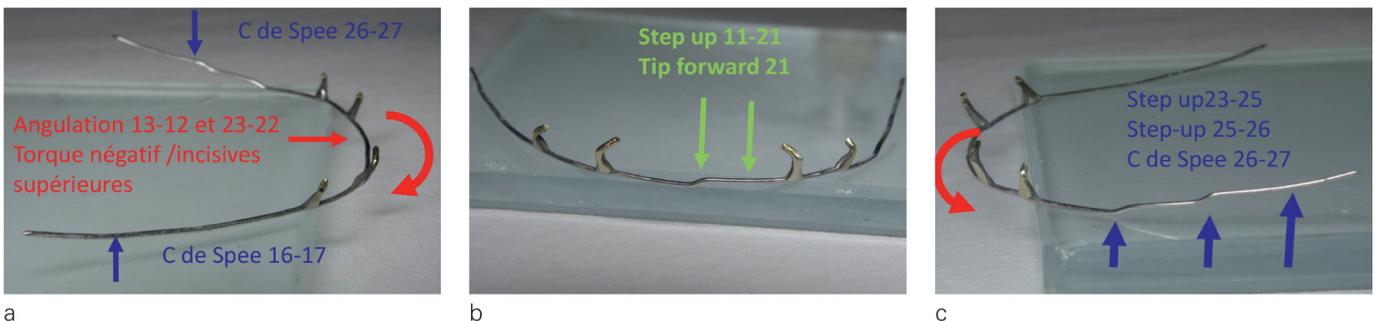


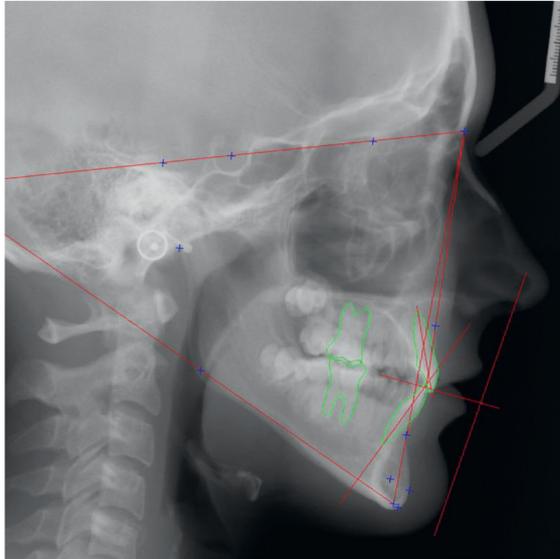
Figure 65

a, b, c: Maxillary terminal arch on glass plate: right, frontal and left views: evidence of 2nd order. November 2014 (16 years 10 months).

Spee curve 16-17 and 26-27 / Angulation 13-12 and 23-22 / Negative torque on superior incisors / Step up 23-25 and 25-26.

End of multibracket treatment documents show over-compensation of linear and angular superior protrusion, guaranteeing stability

(from 7.5 mm/34° to 2.5 mm/18.5°) (figs 66 and 67). Rigorous intercuspatation, and beaming smile (figs 68, 69 and 70).



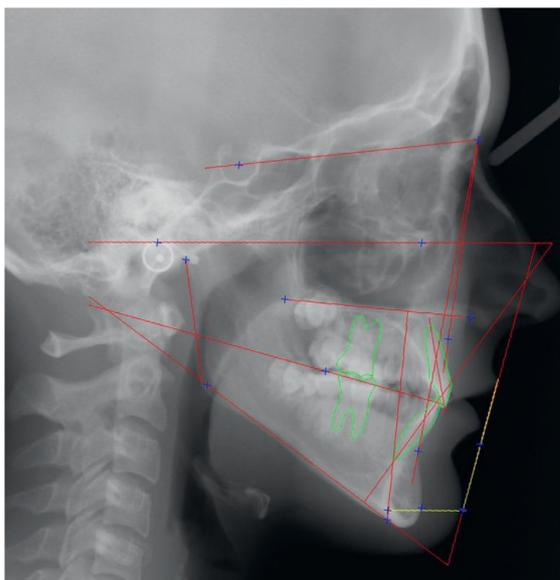
| | | | | |
|-------------|--------|--------|-------|------|
| SNA | 82.0° | ±2.0 | 75.6 | -4.4 |
| SNB | 80.0° | ±2.0 | 73.3 | -4.7 |
| ANB | 2.0° | ±2.0 | 2.3 | OK |
| SND | 76.0° | ±2.0 | 72.0 | -2.0 |
| SL | 51.0mm | ±3.0 | 42.8 | -5.2 |
| SE | 22.0mm | ±3.0 | 20.7 | OK |
| GoGn to SN | 32.0° | ±2.0 | 40.9 | 6.9 |
| I to NA mm | 4.0mm | ±2.0 | 2.6 | OK |
| i to NB mm | 4.0mm | ±2.0 | 3.0 | OK |
| Pog to NB | 0.0mm | ±100.0 | 4.0 | OK |
| Pog to i-NB | 0.0mm | ±100.0 | -1.0 | OK |
| I to NA ° | 22.0° | ±2.0 | 18.3 | -1.7 |
| i to NB ° | 25.0° | ±2.0 | 25.0 | OK |
| I to i ° | 131.0° | ±2.0 | 134.4 | 1.4 |
| Occl to SN | 14.0° | ±2.0 | 21.8 | 5.8 |

a

b

Figure 66

a, b: Teleradiograph with Steiner lines and Steiner cephalometry. November 2014 (16 years 10 months).



| Analyse de Tweed : | | | | |
|--------------------|--------|-------|-------|-------|
| Angle FMA | 25.0° | ±5.0 | 36.9 | 6.9 |
| Angle FMIA | 68.0° | ±3.0 | 54.4 | -10.6 |
| Angle IMPA | 87.0° | ±5.0 | 88.7 | OK |
| Angle SNA | 82.0° | ±2.0 | 75.6 | -4.4 |
| Angle SNB | 80.0° | ±2.0 | 73.3 | -4.7 |
| Angle ANB | 2.0° | ±2.0 | 2.3 | OK |
| AO-BO | 0.0mm | ±2.0 | -0.6 | OK |
| Occlusal - SN | 14.0° | ±2.0 | 21.8 | 5.8 |
| Occlusal - FH | 10.0° | ±2.0 | 15.7 | 3.7 |
| Inter - incisif | 135.0° | ±3.0 | 134.4 | OK |
| total chin | 11.0mm | ±5.0 | 16.0 | 0.0 |
| upper lip | 13.0mm | ±5.0 | 13.4 | OK |
| Angle Z | 78.0° | ±3.0 | 75.0 | 0.0 |
| Nasion - ENA | 56.6mm | ±10.0 | 51.5 | OK |
| Menton - ENA | 65.7mm | ±10.0 | 64.0 | OK |
| HFP | 45.0mm | ±10.0 | 36.2 | OK |
| HFA | 65.0mm | ±10.0 | 62.1 | OK |
| HFP / HFA | 0.7 | ±0.2 | 0.6 | OK |

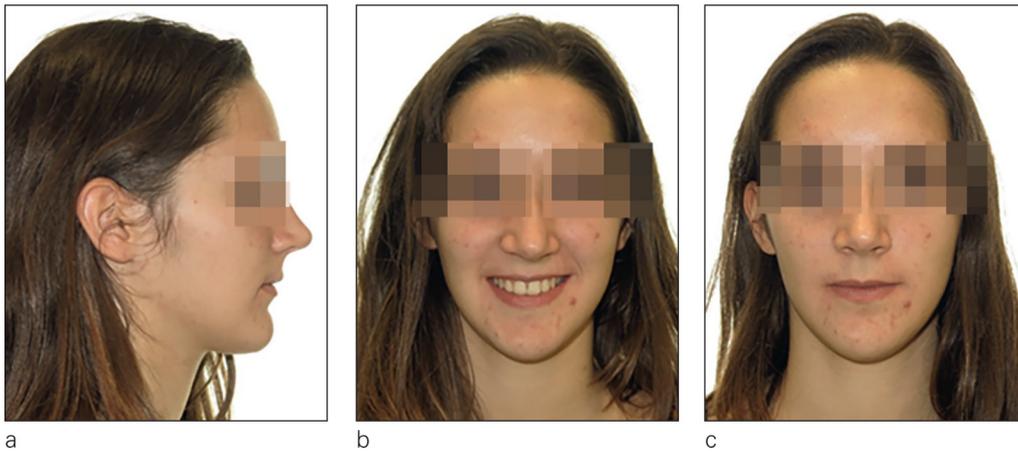
a

b

Figure 67

a, b: Teleradiograph with Tweed lines and Tweed cephalometry. November 2014 (16 years 10 months).

Tweed analysis
Interincisor
Chin



a

b

c

Figure 68

a, b, c: Lateral, smile and frontal views. Ablation. November 2014 (16 years 10 months).



Figure 69

End-of-treatment smile.



a

b

c

Figure 70

a, b, c: Right, frontal and left vestibular intra-oral views. Ablation. November 2014 (16 years 10 months).

Third-molar progression will be followed up (fig. 71).

Retention comprises a transparent maxillary splint and a metal wire glued to the mandibular ar-

cade from 33 to 43 (figs 72 and 73).

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



Figure 71
Panoramic end-of-treatment view. November 2014 (16 years 10 months).



a b c
Figure 72
a, b, c: Right, frontal and left vestibular intra-oral views with retention. November 2014 (16 years 10 months).



a b
Figure 73
a, b: Intra-oral occlusion views, with retention. November 2014 (16 years 10 months).

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