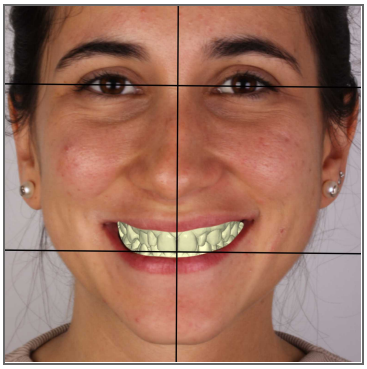

OCT 04, 2023

OPEN ACCESS

DOI:
dx.doi.org/10.17504/protocols.io.8epv5x9q6g1b/v1

Protocol Citation: Rupert HG Kelley BSc, Álvaro Ferrando Cascales DDS,PhD, Raúl Ferrando Cascales DDS,MSc,PhD 2023. Protocol for Facially Guided Digital Diagnosis in Orthodontics. **protocols.io** https://dx.doi.org/10.17504/protocols.io.8epv5x9q6g1b/v1

Protocol status: Working
We use this protocol and it's working

Protocol for Facially Guided Digital Diagnosis in Orthodontics

Rupert HG Kelley BSc[1], Álvaro Ferrando Cascales DDS,PhD[1], Raúl Ferrando Cascales DDS,MSc,PhD[1]

[1]Faculty of Medicine. UCAM. Universidad Católica de Murcia. Campus de los Jerónimos 135 Guadalupe, 30107 Murcia. Spain

DIGITAL DIAGNOSTIC PROTOCOL FACIALLY GENERETED

Rupert HG Kelley
Universidad Católica San Antonio de Murcia (UCAM)

Created: Jul 31, 2023

Last Modified: Oct 04, 2023

PROTOCOL integer ID: 85705

Keywords: orthodontics, diagnosis, facially guided protocol, digital dentistry

ABSTRACT

As the digital age of dentistry continues to flourish, it has never been more important to have protocols to guide dentists through the planning and performance of treatments using the latest technology and software. This is especially true in the field of orthodontics, where the use of technology has revolutionised treatment outcomes. During the first stages of this protocol, extensive records are collected which are then used throughout the treatment. After that, a shift occurs from two dimensions to three dimensions, and movement of the maxillary teeth begins. Then, the mandibular teeth are moved, and the case is completed. The final step is to check the results and ensure that our outcome matches what was planned before the commencement of treatment. This protocol aims to guide orthodontists in the treatment of their patients no matter the type of treatment that is planned, whether orthodontic, restorative or surgical. At any stage of the treatment, the orthodontist can refer back to the protocol to stay on the path towards a successful outcome for the patient.

CITATION

Coachman C, Sesma N, Blatz MB (2021). The complete digital workflow in interdisciplinary dentistry..

LINK

https://doi.org/

CITATION

Coachman C, Georg R, Bohner L, Rigo LC, Sesma N (2020). Chairside 3D digital design and trial restoration workflow..

LINK

https://doi.org/10.1016/j.prosdent.2019.10.015

Treatment Planning

1 Records: NHP pictures, STL and DICOM files

1.1 This first essential step forms the basis of the protocol and provides digital records that

can be used in the subsequent steps. A full series of facial photographs is taken, ensuring that the patient's head is in its natural position. The orthodontist uses their judgement to find this position, ensuring that the patient is in a relaxed position and looking into the distance at a point located at the same level as their eyes. A complete series of intraoral photographs is also taken.

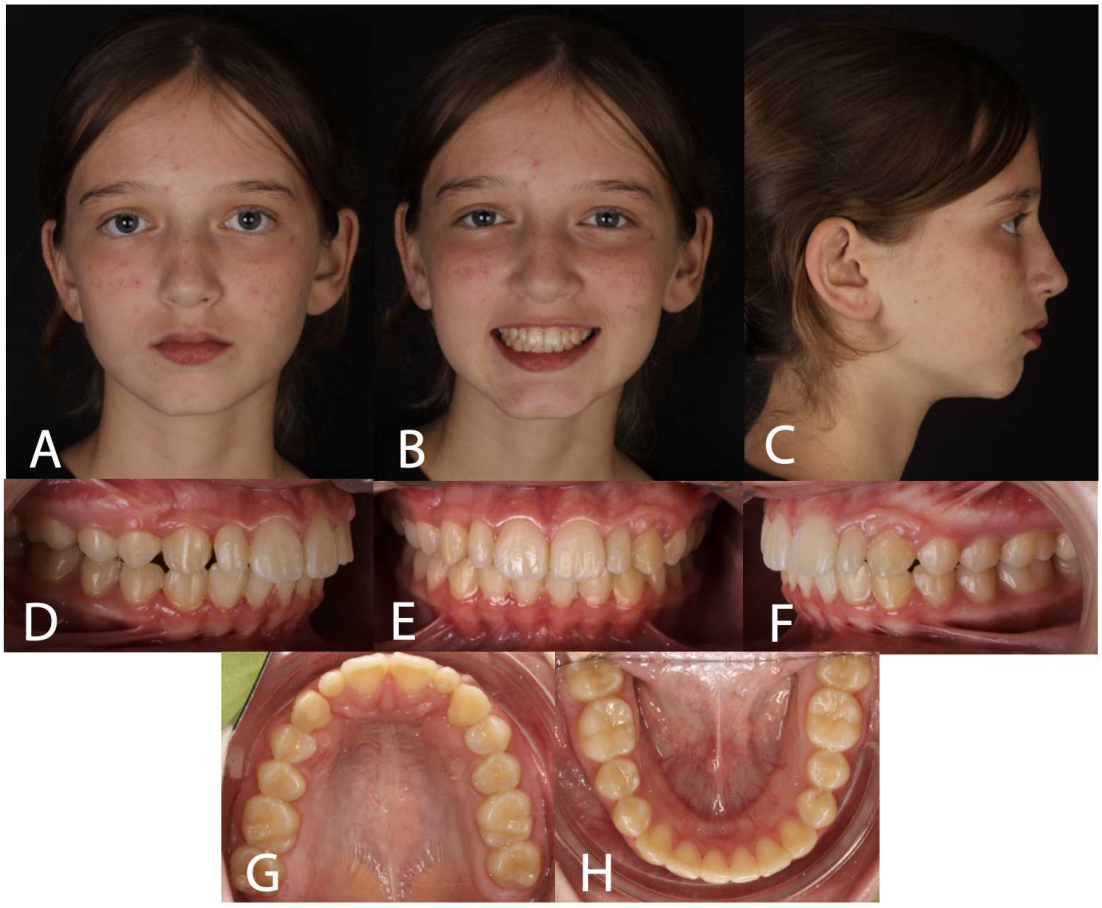

Figure 1 – (A-C) Examples of facial photographs taken with the patient's head in its natural position. (D-H) Intraoral photo series.

1.2 In addition to photographic records, digital impressions are taken of the upper and lower arches, giving rise to STL files. Depending on the age of the patient, a CBCT scan can also be performed, providing DICOM files.

2 Orientation and alignment of STL and DICOM files with photographs

Once all the records have been obtained, the digital impressions (STLs) can be superimposed onto the natural head position photographs using a software package such as NemoCeph (Nemotec SL, Madrid, Spain). If a CBCT was taken, then the DICOM file can be superimposed

onto the photographs using the same software. The key in this stage is to obtain the precise orientation of the STL and DICOM files based on natural head position. Correct orientation of the digital records facilitates accurate determination of the movements that are desired. Incorrect angulation could result in failure to reach the objectives at the end of the treatment.

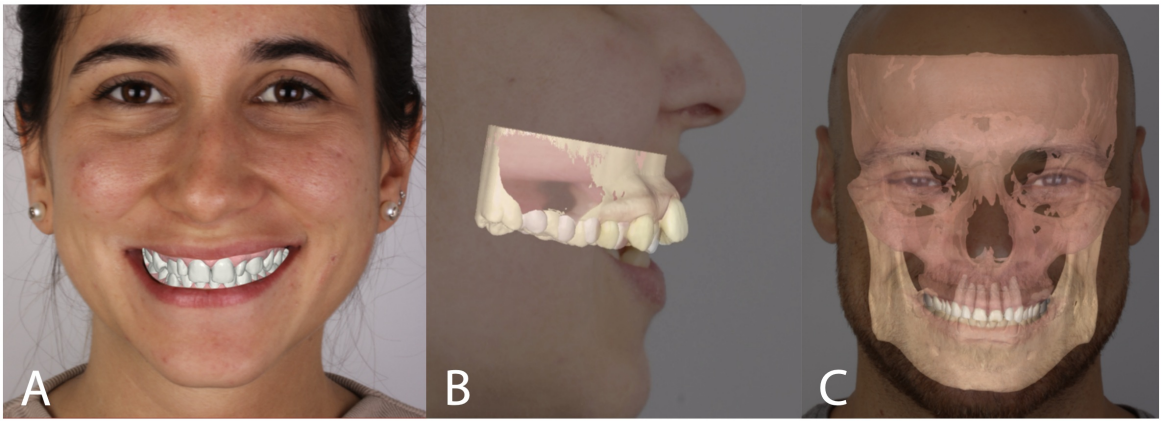

Figure 2 – (A, B) STL digital scans orientated, aligned and superimposed onto natural head position photographs. (C) A CBCT DICOM file and an STL digital scan superimposed onto a frontal natural head position photograph.

3 Occlusal analysis: Crowding and virtual articulator

3.1 Analysis of the presence of crowding or diastemas in the upper and lower arches forms part of the next step of the protocol. The presence or absence of crowding in the upper arch guides the first stages of the treatment. Based on this measurement, it may be determined that treatments such as extractions or expansion are required.

3.2 Next, we can observe the occlusal relationship using the virtual articulator. This includes the initial contact in centric relationship, interferences and the occlusal contacts present during protrusive and lateral movements. Furthermore, the curves of Wilson and Spee can be measured to determine whether flattening of the curves is required, and the space required to do this.

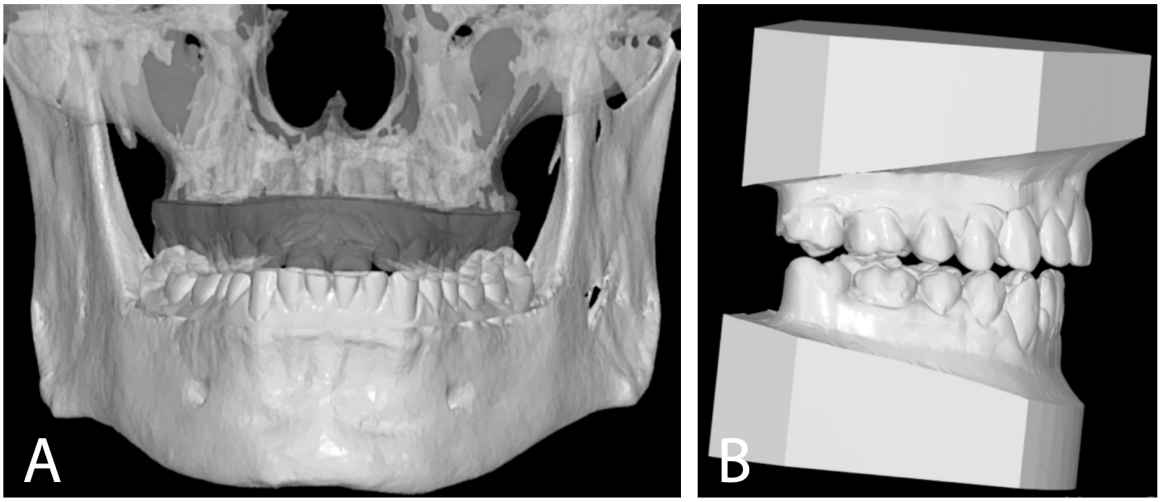

Figure 3 – (A) A CBCT DICOM file with maxillary and mandibular STL digital scans orientated and aligned and in occlusion in a virtual articulator. (B) Maxillary and mandibular digital casts.

4 2D cephalometric analysis and 2D VTO/STO

4.1 A 2D cephalometric analysis is carried out to determine the current situation of the patient and to establish the measurements that are outside of the normal ranges. First, an analysis of the hard tissues is performed in order to determine the facial pattern of the patient and their skeletal class. This could be a Ricketts analysis or that of Steiner or McNamara [1]. Following this, a further analysis is performed to provide information on the soft tissue structures and their projection to the true vertical line. An Arnett or Ayala analysis is preferred [2]. The key in this step of the protocol is to determine the desired position of the upper central incisors, as these are the teeth that will be moved first. Their vertical position regarding the upper lip is a crucial measurement. Arnett described that there should be 3.9mm of upper incisor exposure at rest in males and 4.7mm in females [2]. According to Arnett, it is also acceptable to show 2mm of gingival tissue above the maxillary anterior teeth when smiling.

4.2 After the cephalometric analysis, a VTO is performed with attention to crowding and cephalometric discrepancy. The desired projection of the maxillary central incisor can be visualised and the interincisal angle can be corrected. In case surgical correction is planned for a patient, an STO can be performed.

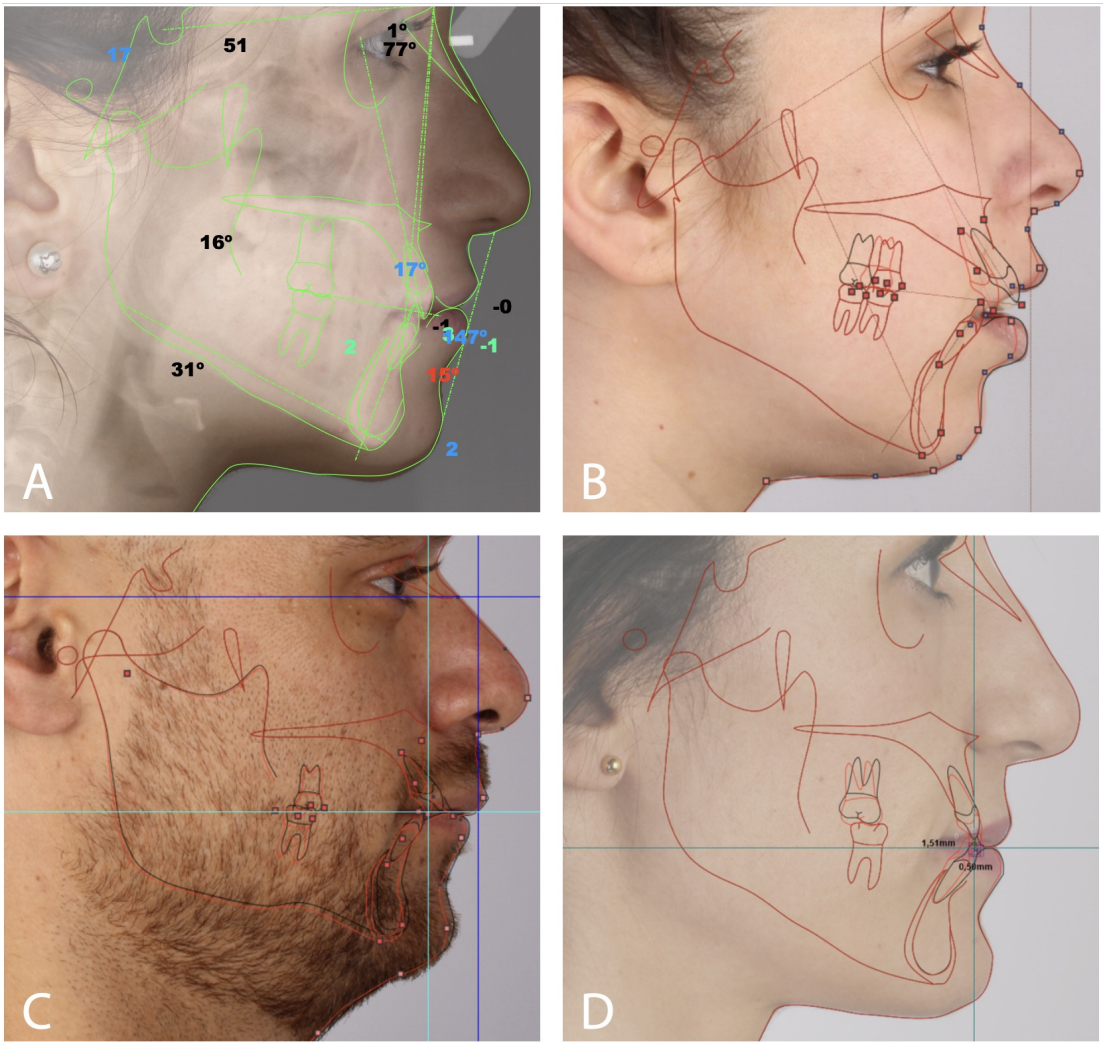

Figure 4 – VTO analysis of a class I patient (A), class II patients (B,C) and a class III patient (D), showing the versatility of the protocol.

Movement of Teeth

5 Transfer sagittal values from VTO/STO to SETUP based on NHP pictures

5.1 In the previous step, the projection of the upper central incisor was determined. Now, this position in VTO/STO (2D) is transferred to SETUP (3D) using the most incisal point of this tooth. At this stage, work continues to take place from the lateral view of the patient. Therefore, the antero-posterior and vertical position of the central incisors is the critical measurement. Now, movement of the upper central incisors can begin, followed by movement of the other maxillary teeth in the sequence:

Central incisors -> Lateral incisors -> Canines -> Premolars -> Molars

5.2 The maxillary central incisor that is the most unfavourable position is selected to be moved first, followed by the contralateral central incisor. Starting movement of the upper arch with the central incisors and then moving distally enables the orthodontist to achieve a harmonic arch shape. Once the correct antero-posterior and vertical position of the maxillary teeth has be achieved, rotations can be performed.

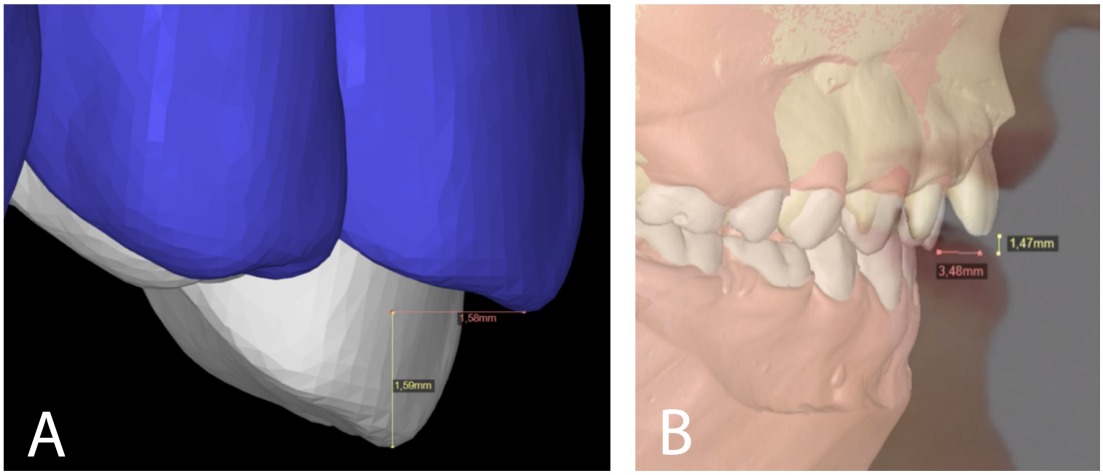

Figure 5 – (A,B) Determination and quantification of the desired movement of the upper central incisor.

6 Frontal analysis with with NHP and STL pictures

6.1 At the start of this step, attention shifts from the lateral view of the patient to the frontal view, whereby a frontal facial analysis is performed. This takes place once movement of the maxillary teeth has been completed. There are three keys in this step: transverse dimension of the maxilla, transverse angulation of the occlusal plane (canting) and symmetry of the midlines.

6.2 First, the midline is corrected, then canting and finally the transverse dimension of the maxilla. During this stage, techniques such as maxillary expansion, SARPE, miniscrews etc. may be used to achieve a desired result in the maxilla. Before moving to the next stage, it should also be checked that the arch contour is parallel to the smile line.

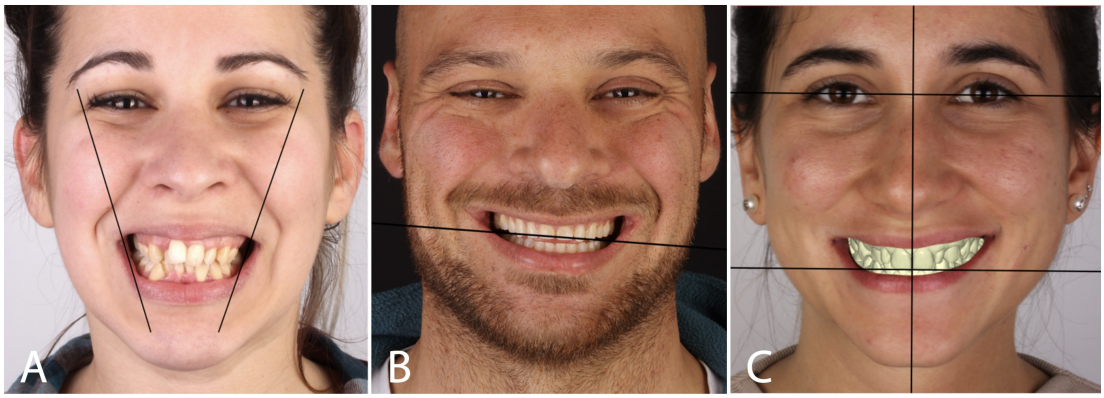

Figure 6 – The three keys of step 6 – Transverse dimension of the maxilla (A), transverse angulation of the occlusal plane (B) and symmetry of the midlines (C).

7 Establish precise teeth movements (SETUP)

7.1 Now that movement in the upper arch has been completed, the focus of the orthodontist moves to the lower arch. Once again, the first teeth to be moved are the lower central incisors, which are placed in a correct overbite and overjet with the upper central incisors. Then, the rest of the mandibular teeth are moved in the sequence:

Central incisors -> Lateral incisors -> Canines -> Premolars -> Molars

7.2 Just like with the upper arch, once the correct antero-posterior positions have been achieved, the rotation of each tooth is corrected to give the desired arch shape. At the end of the stage of the protocol, a functional occlusion should have been established. A Bolton analysis is performed to determine that there is a correct relationship between the upper and lower teeth. If this relationship is incorrect, alterations can be made such as interproximal reduction or composite build-ups.

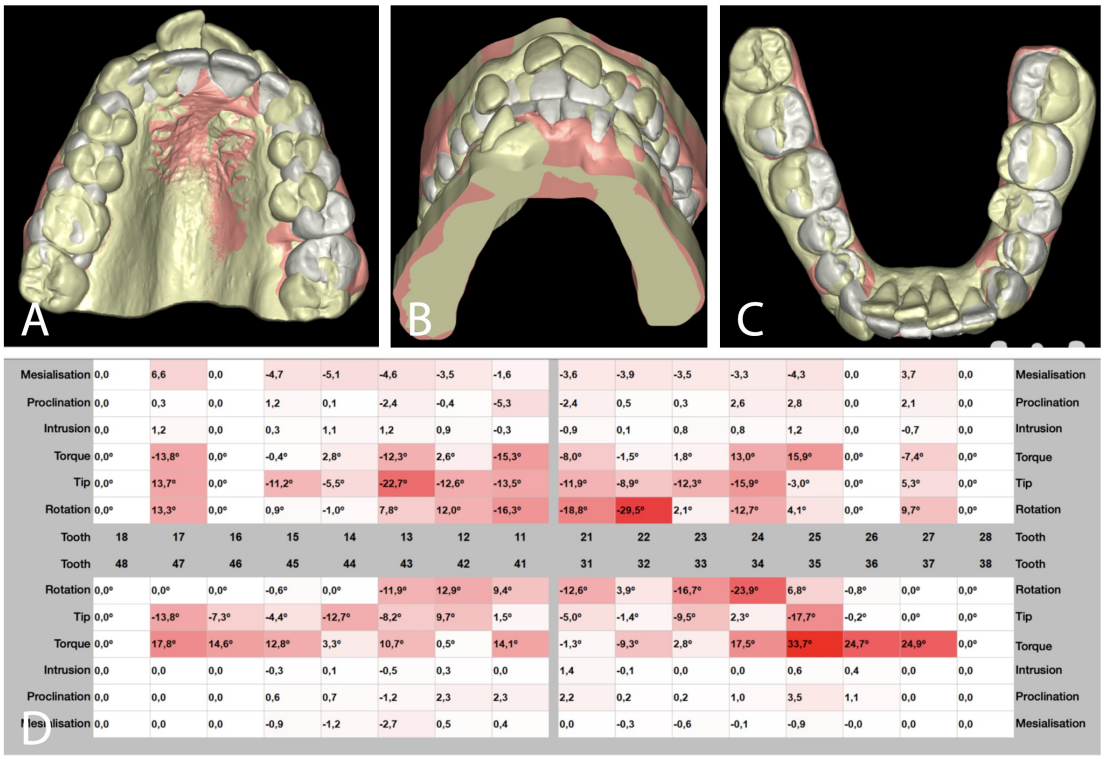

Figure 7 – (A-C) Visualisation of tooth movements using superimposition of STL scans. (D) An example table of values displaying the desired movements of each tooth in a patient.

8 Decision of mechanics and/or technique to be used

Now that the movement of the upper and lower arches has been completed, the position of each tooth can be analysed and compared to the treatment objectives. Based on the results of this analysis, further treatment may be required to reach the objectives. The choice of mechanics or technique is guided by the expertise and experience of the orthodontist and by the magnitude of the movement that is required. For example, if a molar intrusion of 1mm is required, this can be performed orthodontically, but if 3mm of intrusion is required, skeletal anchorage would be required. It may also be found during this stage that the relationship between the arches does not meet the objectives. In this situation, further techniques such as expansion or class II/III traction may be required.

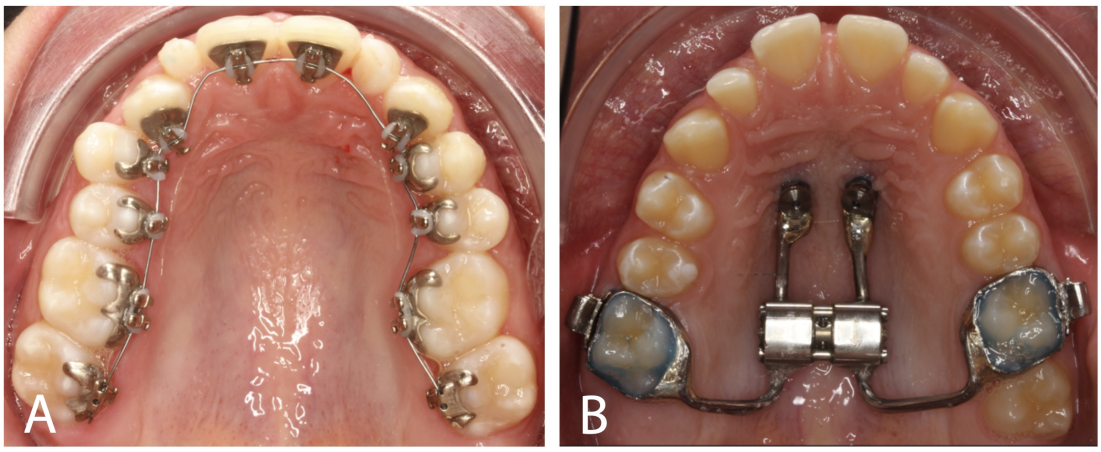

Figure 8 – Example of two techniques that can be used to reach treatment objectives. (A) Incognito bracket system. (B) A MARPE (miniscrew assisted rapid palatal expansion) hybrid expander.

Verification of Results

9 Verification of results. 3D superimposition

9.1 During this step, an analysis of the results is performed. If the objectives have been met, then the treatment has been successful. If not, then the reasons for the failure should be found and further treatment should be carried out as described in the previous step of the protocol.

2D superimpositions such as of a pre- and post-treatment cephalometric analysis can provide useful information regarding the success of the treatment, but not exact quantitative values. In order to quantify the results and provide exact numerical discrepancies, a 3D superimposition can be performed using a pre-treatment and post-treatment STL files using a stable anatomical reference. DICOM files can also be superimposed to verify treatment results. The superimposition of STL files is useful for tracking the results of dental movement. Superimposition of DICOM files has value in tracking growth and the result of surgical treatment, whereby the cranial base can be aligned and certain points such as the anterior nasal spine can tracked.

9.2 Finally, it must be mentioned that photography is a very powerful tool that allows orthodontists to verify the results of their treatment. Given that this protocol is facially-guided, the final result must be aesthetically acceptable in the face of the patient.

Figure 9 – Verification of treatment results using different methods. (A,B) Superimposition of pre-treatment and post-treatment STL files. (C,D) Facial photographs of a patient pre-treatment (C) and post-treatment (D) showing the aesthetic result especially with regards to the face and smile of the patient.