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Technical Note

Pre-prosthetic Schuchardt Osteotomy: The contribution of computer-assisted surgical planning

Mickaël Samama[1,2,3,4], Julia Masliah[5,*]

[1] Stomatologist and Oral Surgeon, 5 rue Dupont des Loges, Paris 75007, France
[2] Clinique Saint Jean de Dieu Paris 7, Paris, France
[3] Department of Maxillo-facial Surgery, Hôpital Pitié-Salpêtrière, Medecine Sorbonne Université, 47–83 Boulevard de l'Hôpital, Paris 75013, France
[4] Department of Head and Neck ENT Surgery, Gustave Roussy Institute in Paris, Paris, France
[5] Department of Oral Surgery Division, University of Reims, CHU Reims, 51100 Reims, France

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Abstract – : Premature loss of teeth leads to an inevitable egression of opposing teeth. Schuchardt osteotomy is a quick and efficient alternative to create a prosthetic space compatible with prosthetic rehabilitation. Its planning and execution are now facilitated by the rise of digital technology and specialized softwares. Through virtual simulation of the osteotomy and the creation of surgical guides, they offer enhanced safety and predictability. Communication between the practitioner and the laboratory, as well as between the practitioner and the patient, is strengthened. In this clinical case, we will detail the key steps in digital planning, and the surgical protocol for a segmental Schuchardt osteotomy for preprosthetic purposes.

Introduction

Anticipatory tooth loss can lead to the egression of antagonist teeth due to the masticatory compensation phenomenon. This primarily occurs within the first year after dental organ loss and can potentially compromise future prosthetic rehabilitation by causing a loss of prosthetic space and tilting of the occlusal plane.

In the literature, various solutions have been proposed to restore usable prosthetic space, depending on the space required and the therapeutic gradient. These solutions include ameloplasty (1–2 mm), orthodontic ingression (2–4 mm), prosthetic rehabilitation (6 mm) or extraction [1].

In cases of severe egressions (>6 mm) in the posterior region of the maxilla, a conservative surgical approach may be considered: the segmental Schuchardt osteotomy. This technique was initially described by Schuchardt in 1957 in Germany for correcting anterior gaps using a two-stage protocol [2]. Kufner (1970) later modified the technique by introducing a one-stage posterior maxillary osteotomy, cutting through the palate and maxillary sinus [1,3,4]. The initial orthodontic indication of this osteotomy is expanding, thus finding its applications for pre-prosthetic purposes, with quick and efficient result. Traditionally, a setup is performed using physical models, with the simulation of maxillary osteotomy directly on the model. Today, thanks to software, we can digitally simulate the wax-up of the antagonistic teeth as well as the maxillary teeth ingressions. The fabrication of a custom repositioning guide and a palatal retention plate is also made easier.

Through a clinical case of Schuchardt's segmental osteotomy for pre-prosthetic purpose, its computer-assisted surgical planning and its surgical protocol will be detailed.

Technical note

Diagnosis and treatment planning

A 44-year-old patient without any systemic diseases visited the office, referred by his dentist for maxillary molars ingression in sector 2.

Upon clinical examination, he presented with uncompensated edentulous areas in teeth 36, 37, and 47, leading to severe egression of the alveolar-dental block of 26–27.

Complementary examinations were conducted, including: dental panoramic X-ray, CBCT (Cone Beam Computed Tomography), and physical impressions for study models, mounted on an articulator, for preliminary study of the case (Fig. 1). An optical impression of these models was taken and sent to the laboratory for simulation on the software.

* Correspondence: juju.masliah@hotmail.fr

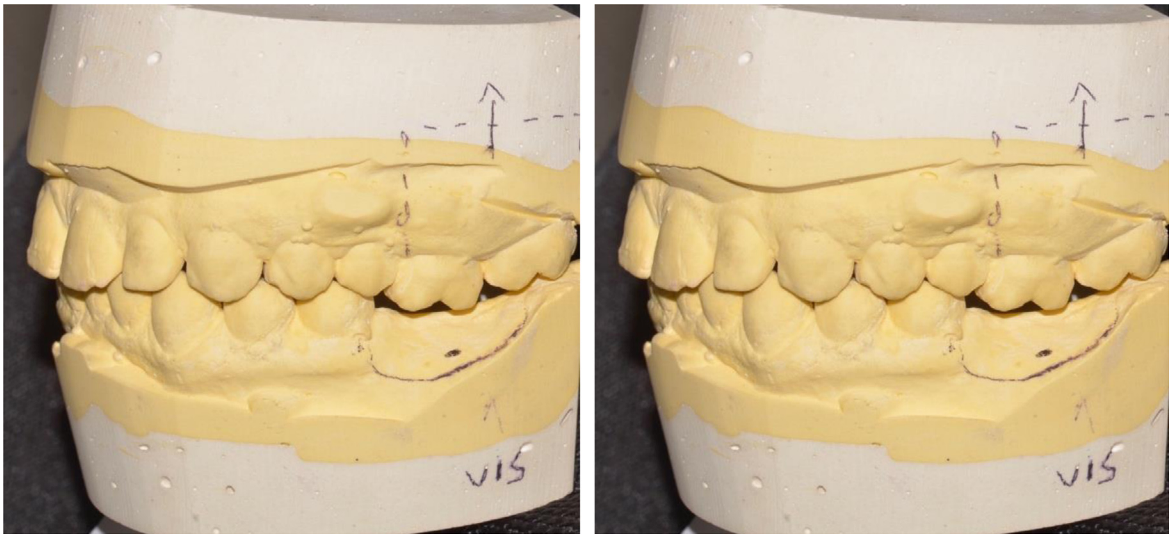

Fig. 1. Initial situation: study models in occlusion.

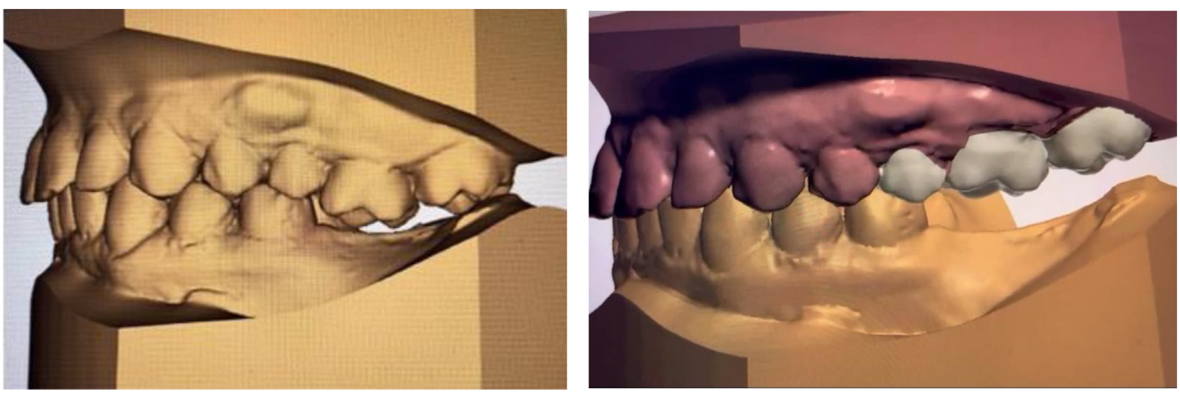

Fig. 2. Digital simulation of Schuchardt osteotomy with correction of prosthetic space and occlusal plane.

After delivering a consent to the patient, including a clear and fair information about advantages and disadvantages of several solutions, it was decided to proceed with a segmental Schuchardt osteotomy in sector 2. During the same procedure, tooth 28 would be extracted along with the other wisdom teeth. Additionally, implants would be placed for teeth 36 and 37.

Before the surgery, a periodontal clean-up was conducted to ensure optimal oral health.

Surgical planning

Virtual planning results from close collaboration between the surgeon, who contributes his clinical and medical knowledge, and the engineer, responsible for designing.

Data acquisition

The first step was to obtain a digital scan of the patient's mouth, thanks to intraoral scanners or optical impressions of study models; digitized into STL files. It recorded the arches' anatomy separately and then captures the occlusion between them.

Simultaneously, the DICOM data (Digital Imaging and Communications in Medicine) from the CBCT was extracted.

Virtual planning

Following data matching, specialized virtual planning software 3Shape Appliance Designer®, Autodesk Mexhmixer® or Exocad® were used to create a virtual model of the patient's dentition. The engineer identified the prosthetic space and the occlusal plane, considering the occlusal curves of Spee and Wilson, and then created a digital wax-up of the mandibular teeth.

Afterward, he could perform a virtual simulation of maxillary teeth ingressions by 8 mm (Fig. 2).

With the Schuchardt osteotomy simulated, the surgeon could ensure the feasibility of the surgery, and adjust the position of the maxilla to achieve the desired correction of the prosthetic space and occlusal plane. This helps in planning the precise movements required during the actual surgical procedure.

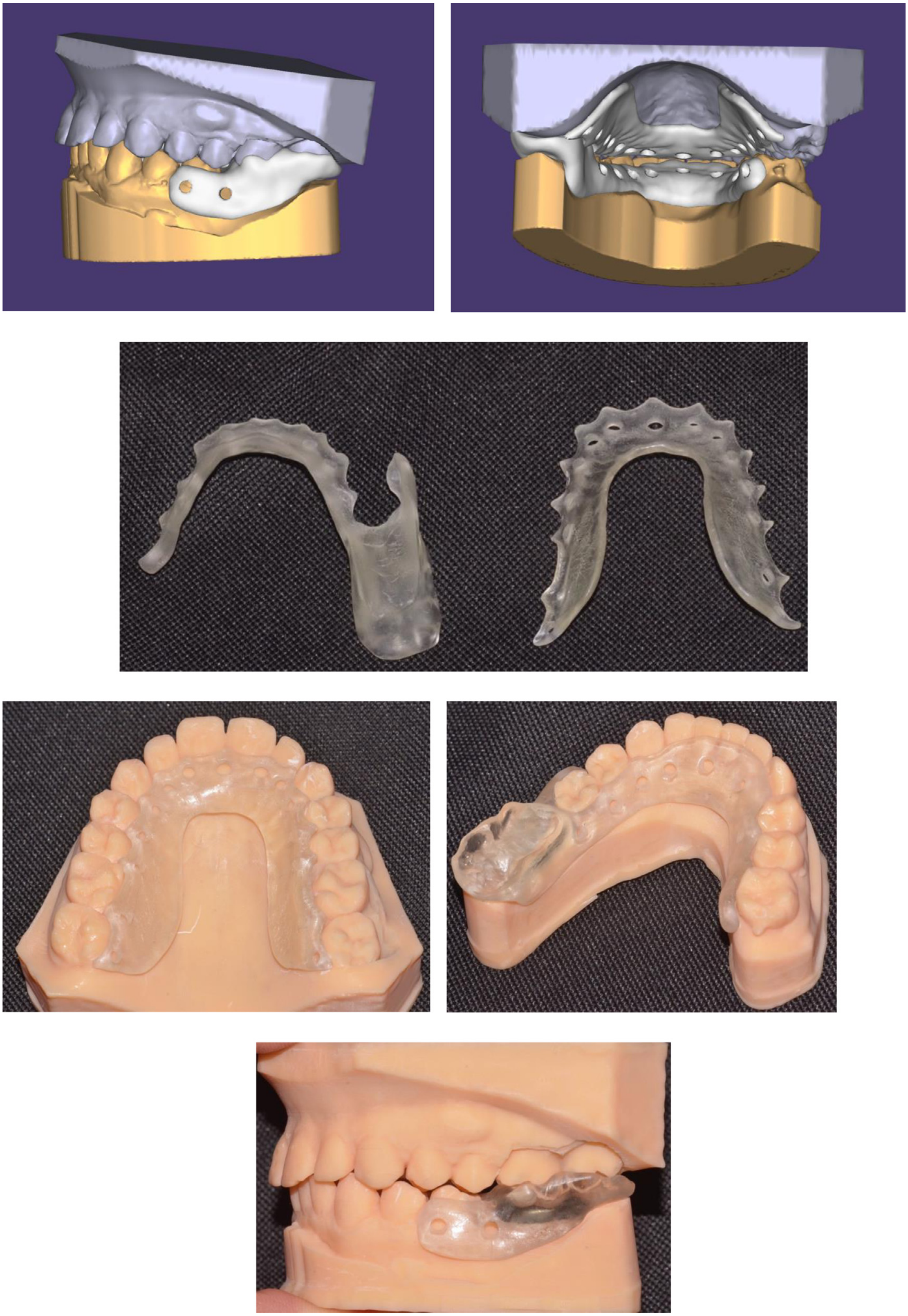

Fig. 3. Manufacturing of mandibular repositioning splint and palatal retainer. Holes allowing the passage of steel wires are noticeable.

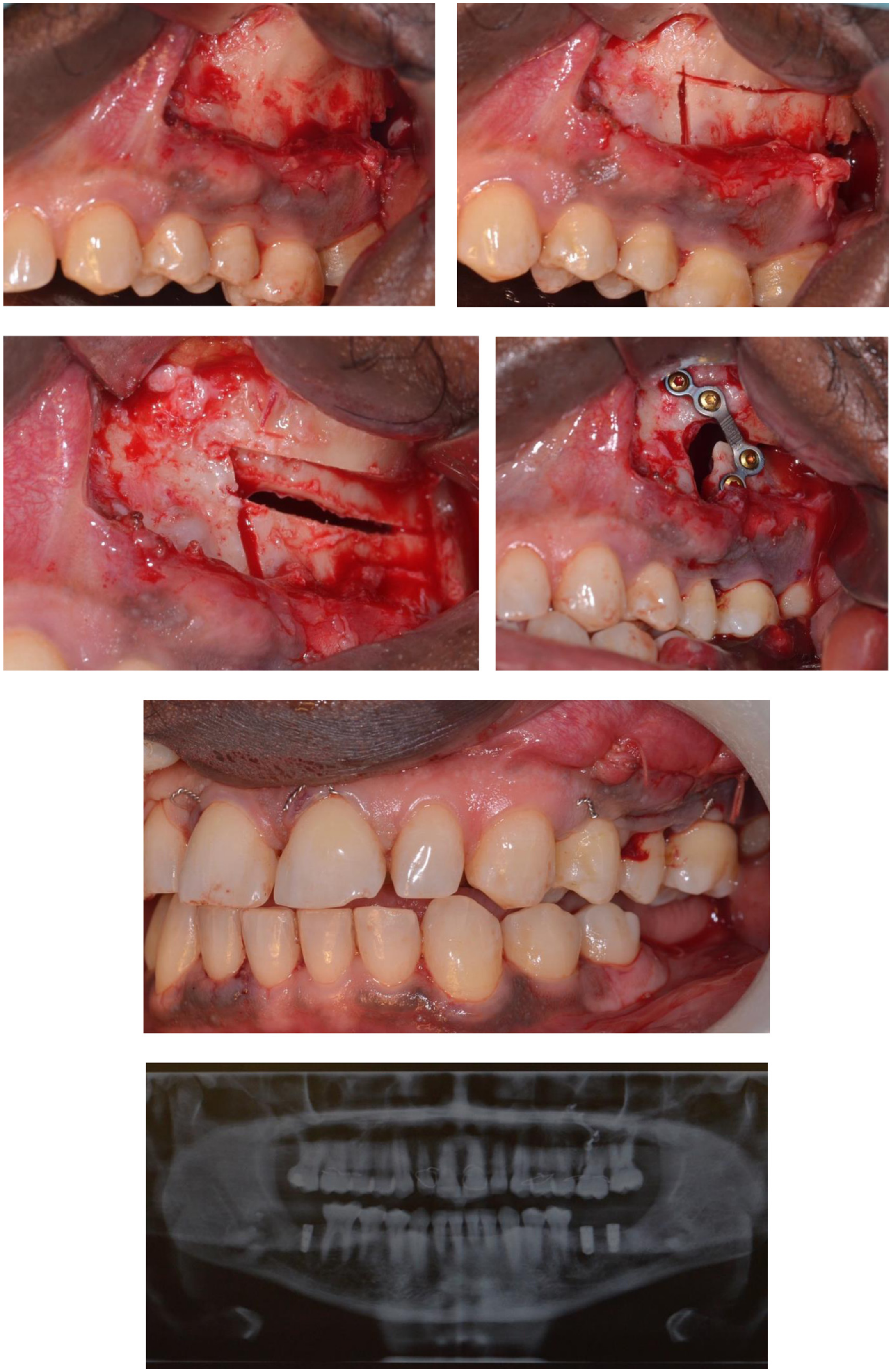

Fig. 4. Operative time and orthopanthomogram control.

Fig. 5. Situation at 3 months: removal of palatal plate and placement of healing screws for mandibular implants.

Traditional simulation on an articulator for the prosthodontic treatment plan, was not longer necessary, using a wax-up or a guiding setup, followed by the osteotomy performed with a plaster saw and fixed using laboratory wax until achieving a stable occlusion.

Repositioning splint and palatal retainer design

Based on virtual simulation, biocompatible resin surgical guides could be 3D-printed, with FormLabs 2® and Stratasys J3 printers® (Fig. 3). This consisted in a mandibular repositioning guide and a palatal retainer.

These guides aid the surgeon during the actual osteotomy, ensuring precise and accurate execution of the planned movements, and providing stability of the alveolar block.

Surgical procedure

The surgery was conducted under general anesthesia, with naso-tracheal intubation. Facial asepsis is achieved using chlorhexidine. For local infiltration, 1 cc of naropeïne® 7.5 mg was administered to initiate tissue detachment, assist in haemostasis, and anticipate post-operative analgesia.

We started by extracting the wisdom teeth #28 following a standard protocol, and placing mandibular implants.

A vestibular approach was performed with a horizontal linear incision slightly above the muco-gingival line, extending from tooth 24 to the maxillary tuberosity. Special attention was given to the cleavage plane and osteotomy lines (Fig. 4).

Next, a full-thickness mucoperiosteal detachment was performed to expose the zygomatico-maxillary console, and a malleable blade was inserted for distal protection. Caution was taken to detach the lower edge of the vestibular incision without disinserting it from the tooth neck.

At this stage, a 26–27 alveolar block frame osteotomy could be traced using a piezotome and ice-cold serum. A first osteotomy was performed opposite tooth 28, which was then extracted.

The horizontal supra-apical osteotomy should be performed at least 3–5 mm above the dental apices, below the pyramidal process of the infra-temporal surface. It should end in contact with the lateral blade of the pterygoid process behind the tuberosity, allowing for the resection of a 8 mm vestibular strip for impaction.

For the anterior osteotomy, it is essential to perform it away from the teeth and as deeply as possible without damaging the periosteum on the palatal side.

A curved osteotome was used to create the posterior pterygomaxillary disjunction. Strict bone contact must be maintained along the posterior part of the tuberosity.

Before proceeding with the palatal osteotomy, the alveolar block is passively mobilized using a Tessier disjoncteur, tilting medially.

The palatal bone wall was cleaved by means of a greenstick fracture, providing direct trans-sinusal access to the palatal wall [5]. On the palate, the osteotomy was continued using a long insert piezotome® and a fine round bur, employing a trans-sinus approach.

This was followed by a right osteotome under digital control, to complete the posterior impaction. Indeed, the palatal periosteum is the only source of blood supply to the osteotomy block, and must be preserved to avoid bone necrosis. A palatal retainer was stabilized by 6 trans-prosthetic steel wires, to control the correct transverse positioning of the block. It will be left in place for a period of 45 days, corresponding to bone healing time [6]. The retention splint must conform to the following characteristics: providing relief at the level of the palatal mucosa to preserve vascular supply, being transparent for monitoring possible hematoma, ischemia, or necrosis, being made of non-porous resin to reduce plaque retention, and having fixation holes for interdental ligatures. Then, the mandibular prosthetic guide was placed using 6 steel wires, to restore and control the prosthetic space.

Maxillo-mandibular blocking was performed to ensure proper engagement of the mandibular gutter. The upper alveolar block must be positioned in the desired position, with impaction and internal rotation. The adherence to the occlusal plane was checked. The osteosynthesis was carried out using a micro L-plate, consisting of a 5 mm bridge, and fixed with 4 screws, each 1.5 mm in diameter and 6 mm in length. Once the blocking was removed, the occlusion was again carefully checked to restore a good prosthetic space.

The surgical wound was closed with overlock sutures using 3.0 absorbable thread.

The patient underwent controls at 2 days, 7 days, 2 weeks, and 1 month after the procedure, and didn't describe any complications. A clinical and radiological evaluation was conducted, including panoramic X-ray and CT scans. The post-operative Scan was compared with the virtual simulation to ensure the desired corrections were achieved. The periodontal status (dehiscence and pocket), mobility, pulpal vitality, absence of pain, signs of inflammation, mucosal necrosis or infection, and the status of the implants were assessed.

After a three-month period, the palatal plate was removed, marking the beginning of the prosthetic phase for the mandibular implants (Fig. 5 and Fig. 6).

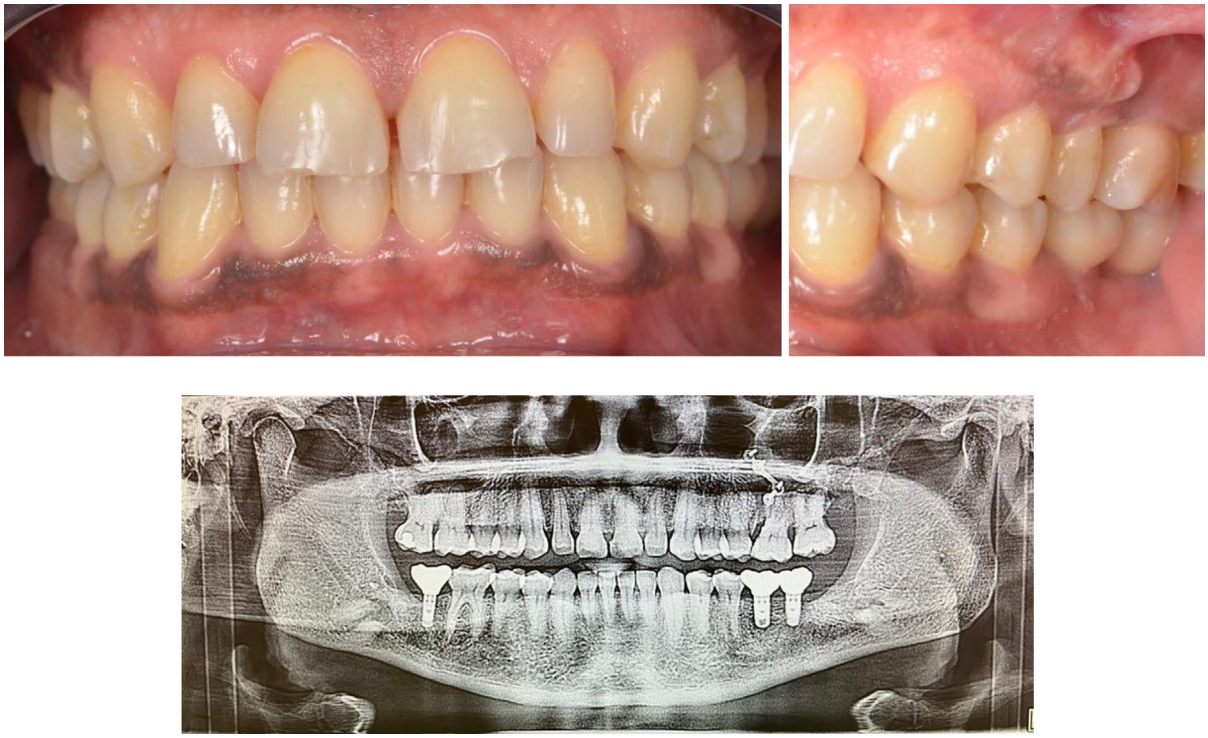

Fig. 6. Final situation, with crowns placed on teeth 36 and 37.

Discussion

The Schuchardt osteotomy was initially indicated for orthognathic correction of anterior open bite [2,4]. Its indication for pre-prosthetic purposes is not extensively described in the literature, as it is reserved for extreme cases and allows for:

– A vertical reduction of excessive alveolar bone in edentulous areas to obtain adequate interarch space for prosthetic restoration. This procedure, unlike conventional bone regularization, avoids cortical bone loss, widening of the edentulous ridge, and mobilization of the keratinized mucosa, which could disrupt the subsequent placement of implants and prosthetic rehabilitation [7].
– An impaction of the posterior dentate maxillary sector for implant rehabilitation of the opposing sector [3,8–10].
– A vertical augmentation of the atrophied posterior maxilla before rehabilitation with a fixed implant-supported prosthesis, as an alternative to other methods of vertical bone augmentation [8].
– The treatment of the palatal impacted canine by the simultaneous advancement of the posterior segment and extraction of the tooth [1].

The technique of using posterior maxillary segmental osteotomy to surgically intrude over-erupted posterior maxillary segments for the restoration of edentulous mandibular segments was first documented by West and Burk [9], and later by Alexander and Sickels [3,11]. However, the following complications have been described: dental vitality loss (2%), periodontal defects, infection, and necrosis of the residual alveolar block if the soft tissue incisions are not properly designed, leading to an inadequate blood supply to perfuse the segment [3]. Additionally, nerve injuries, root sectioning, aesthetic alterations, and pseudoarthrosis (lack of bone consolidation) can occur.

This technique, therefore, requires a sufficient level of experience and skill from the practitioner. In order to facilitate its execution, precise preoperative planning is essential. While frequently used in maxillofacial surgery [12], digital planning now finds its application in oral surgery as well. It provides greater safety and comfort for the practitioner, reducing the risk of complications and undesirable events. The results become more predictable, the surgical time is reduced, and postoperative recovery is improved [12]. Indeed, it enhances and facilitates communication with the laboratory. Through close collaboration with an engineer, the practitioner can digitally simulate the osteotomy, control and assess its feasibility, and anticipate the risk concerning neighboring vital structures such as the greater palatine artery or dental roots. He can visualize the surgical procedure before it is performed on the patient.

Similarly, digital assistance can help control the surgical procedure during osteotomy design by creating cutting guides and ensuring the accurate positioning of bone segments using custom plates [12]. This incurs an additional cost for the patient, who must be informed about it. However, Shuchardt's osteotomy cannot be entirely guided due to the palatal cut. There is no guide available to assist its execution.

The development of computer-aided design (CAD)/computer-aided manufacturing (CAM) and 3D printing technologies and materials contribute to the creation of precise, rigid, and biocompatible repositioning splints and retention plates. Patient adherence is also made easier. The reduced working time in the laboratory accelerates the patient's rehabilitation, and the digital simulation is a valuable tool for patient communication. The practitioner shows the patient the prosthetic project, discuss the expected outcomes, and address concerns before proceeding with the surgery.

Digital assistance is, therefore, flourishing in oral surgery, and its applications are constantly expanding. It offers a wide range of possibilities for practitioners to enhance and secure their practice, leading to improved patient outcomes and satisfaction.

The future of the oral surgery appears to be intricately linked with that of digital technology.

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Conflicts of Interest

The autors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability statement

The data can be shared upon request.

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