Surgery – First approach with 3D customized passive self-ligating brackets and 3D surgical planning. Case Report

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It is possible to unify 3-dimensional customized orthodontic techniques and 3-dimensional surgical technology. In this case report, it is introduced a treatment scheme consisting of passive self-ligation customized brackets and virtual surgical planning combined with the orthognathic surgery-first approach in a Class III malocclusion patient. Excellent facial and occlusal outcomes were obtained in a reduced treatment time of 5 months.

Keywords: **Má oclusão Classe III de Angle. Cirurgia Ortognática, Ortodontia. Imagem Tridimensional.**

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» Patients displayed in this article previously approved the use of their facial and intraoral photographs.

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INTRODUCTION

Accuratesurgical treatment starts with precise diagnosis by evaluating all dimensions and determining the nature of deformity because it might be a combination of hard and soft tissue components.[1]

The main limitation of conventional surgical planning is its 2-dimensional approach that involves clinical examination, extraoral and intraoral photographs, lateral and posteroanterior cephalograms, and plaster dental models.[2,3] To overcome those deficiencies, cone-beam computed tomography (CBCT) for imaging the craniofacial region heralds a true paradigm shift from a 2-dimensional to a 3-dimensional (3D) approach.[4]

Computer aided surgical simulation (CASS) utilizing 3-dimensional images obtained from multi-slice computer tomography (MSCT)/cone beam computer tomography (CBCT) has been successfully performed previously to plan craniofacial surgery.[5-8] Also, CASS has been combined with the surgery-first approach (SFA) to demonstrate two useful and practical methods for planning these cases.[9]

Furthermore, the patient can be virtually visualized by generatinga fusion model with digital dental casts, a CBCT reconstructed bony volume and textured facial soft tissue image.[10,11] Additionally, with this fusion model the clinicians canaccuratelycreate surgical splints using the computer-aided design/computer-aided manufacturing (CAD/CAM) systemfor successful surgical treatments.[11,12]

Recently, significant technological advancements have been made in computer-aided orthodontic treatment. In the Insignia system (Ormco Corporation, Orange County, CA), PVS impressions are digitized with computed tomography to produce highly detailed digital models or an intraoral dental scanner (Lythos, Ormco Corporation, Orange County, CA) is used to generate 3D digital models. The orthodontist adjusts the digital setup using a real-time 3D interface, while referring to the patient's intra and extraoral photographs and radiographs for consideration of esthetic treatment goals. After the clinician approves the final setup, the customized brackets, tubes, and arch-wires are fabricated and bracket-positioning jigs are provided for accurate indirect transfer.[13]

In this case report, 3D virtual customizedbracket design (Insignia, Ormco Corporation, Orange County, CA) is integrated with 3D virtual surgical planning along with fabrication of digital surgical splints using a CAD/CAM technique. This article aims to report how the use of 3D digital technology, self-ligation and the SFA can drastically reduce the treatment time.

CASE REPORT

A 21-year-old Hispanic male reported to the orthodontist office with the primary complaint of not feeling comfortable with the bite and chin projection (Fig 1). A subsequent clinical examination showed that the profile had worsened since a previous orthodontic treatment.

Systemically, he referred controlled Diabetes Mellitus Type I. The extraoral examination showed concave facial profile, with a slight maxillary hypoplasia, significant chin projection, upper lipretrusion and adequate nasolabial angle (Fig 1). Dentally, the patient presented a Class III malocclusion with proclined upper incisors and retroclined lower incisors, edge to edge bite, lower proper alignment and spacing of 2mm in the upper arch (Fig 1; Fig 2, Fig 3A). The panoramic x-ray showed mild different ramus lengths. (Fig 3B). Skeletally, h Class III pattern with mandibular prognathism and macrognathism were observed (Fig 3A, 3C).

The treatment objectives were to correct the Class III skeletal pattern, to improve profile, to increase overjet and to improve facial aesthetics. The treatment options presented were presurgical orthodontic treatment followed by mandibular setback and SFA, or mandibular setback followed by fixed appliances to align, level and stabilize the occlusion. Considering that the patient's chief concern was his facial esthetics, it was decided to proceed with SFA, because the patient wanted immediate facial change. This approach would avoid deterioration in his profile and malocclusion during presurgical orthodontics and would also take advantage of the biological potential of the RAP.

A Computed Tomography (TC) (Bright Speed Elite, General Electric, and Fairfield, Connecticut, USA) was taken for the construction of a model of the skull[8] with PROPLAN CMF (Materialise,

Figure 1 - Pre-treatment photographs showing skeletal and dental Class III malocclusion.

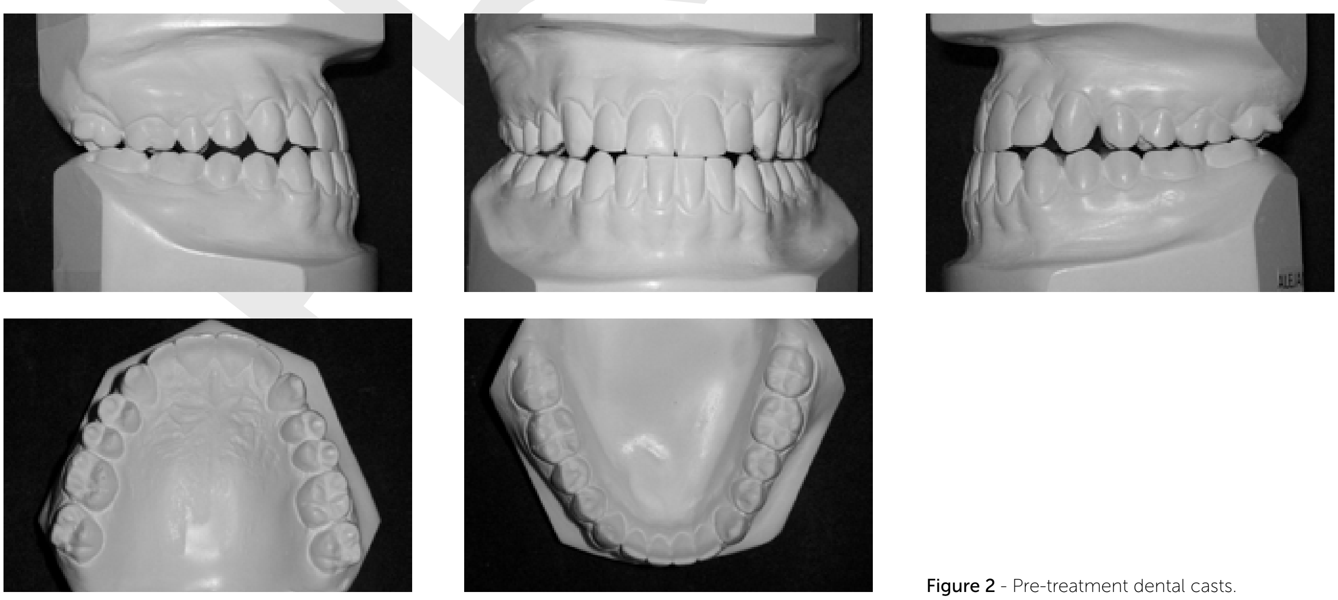

Figure 2 - Pre-treatment dental casts.

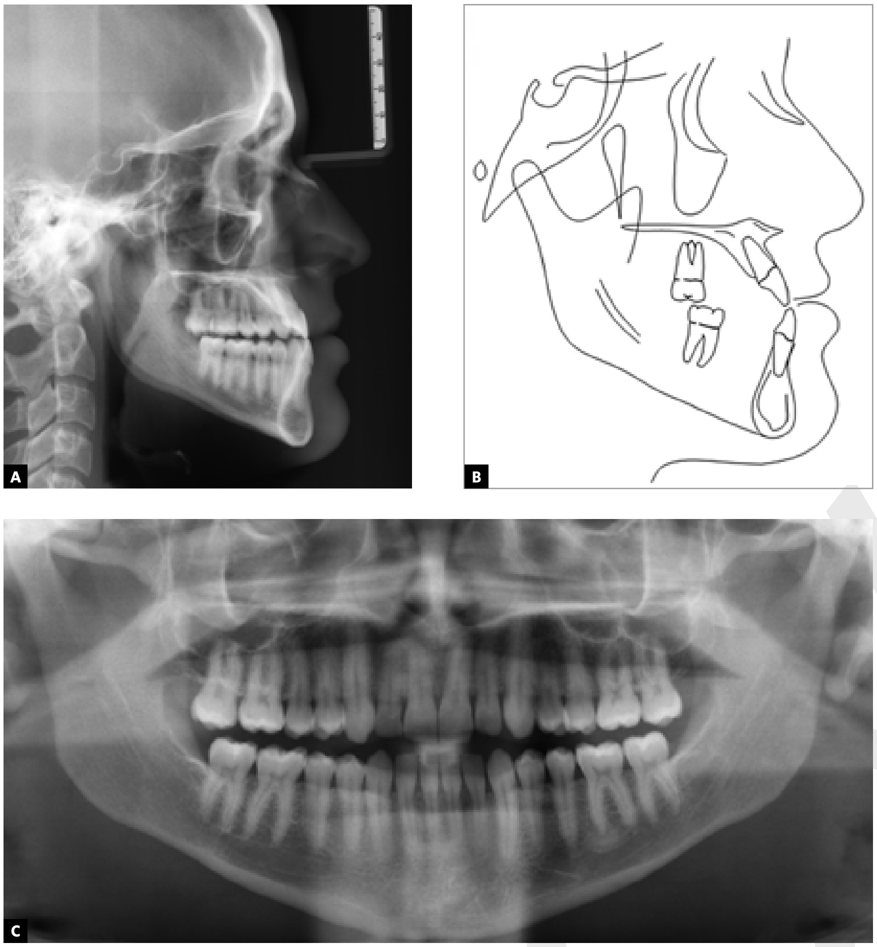

Figure 3 - A) Pre-treatment lateral cephalometric radiograph; B) Pre-treatment panoramic radiograph. C) Pre-treatment lateral head film tracing.

Plymouth, MIs). The surgical planwasmandibular setback (Fig 4). The virtual design was transferred to the CAD/CAM software for production of surgical splints. The intermediate and final splints, were physically generated by a 3D printer (Fortus 250mc, Stratasys, Eden Prairie, MN, USA) with hybrid epoxy-acrylate polymer.

The first step in the Insignia system (Ormco Corporation, Orange, CA) for custom-designed orthodontics is to send precise polyvinyl siloxane impressions as well as photographic and radiographic information to the manufacturer. The brackets chosen were Insignia self-ligating (SL) brackets, whichare the customized version of Damon Q SL brackets (Ormco Corporation, Orange, CA).[14] The final set-up for the patient was approved with an overcorrection of lower incisors torque, ensuring optimal expression of the lower incisors decompensation exploiting the massive RAP after orthognathic surgery. (Fig 5) The wire sequence selected was Cooper NiTi 0,014 inch, Cooper NiTi 0,014 x 0,025 inch, Cooper NiTi 0,018x0, 025 inch, TMA 0,019x0, 025 inchand stainless steel 0,019x0, 025 inch (Ormco Corporation, Orange, CA). The brackets were bonded 3 days before surgery and no archwire was placed.

In the day of the surgery, immediately before intubation assisted by a fiber optic probe, Copper NiTi0.014 inch (Ormco Corporation, Orange, CA) archwires were placed (Fig 6). After mandibular setback surgery by sagittal osteotomy, under brain activity monitoring and once a suitable rigid fixation and postoperative occlusion were established, ¼ 3.5 ozintermaxillary elastics were applied with Class III vector.

After 15 days1/8 3.5 ozintermaxillary elastics were used (Fig 7) and the archwires were changed to 0,014x0,025 Cooper Ni-Ti (Ormco Corporation, Orange, CA). One month after surgery .018x.025

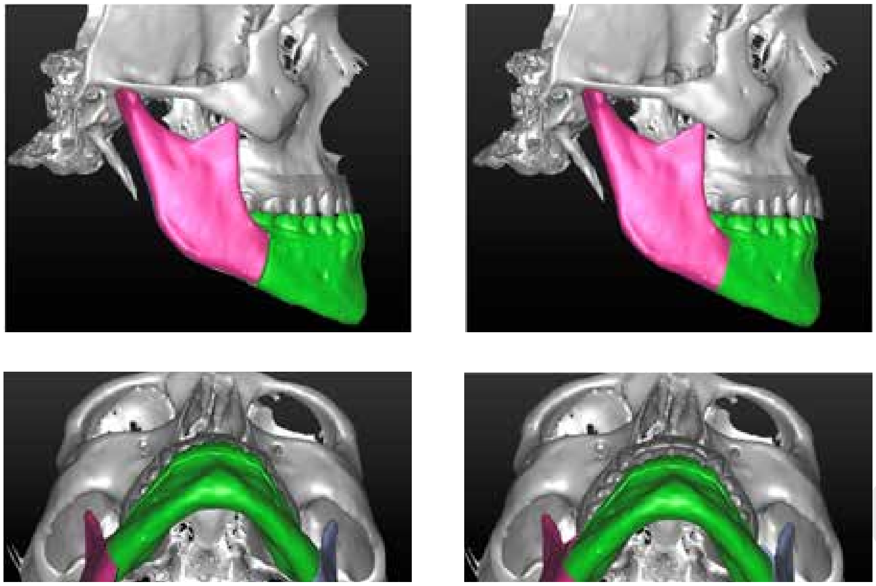

Figure 4 - Surgical planning of mandibular set-back.

Figure 5 - Custom designed orthodontics with Insignia.

Figure 6 - First archwire placed during the surgery.

inch CopperNiTi arch wires (Ormco Corporation, Orange, CA) were placed and Class III intermaxillary elastics were continued. TMA arches of 0.019 x 0.025 inch (Ormco Corporation, Orange, CA) were placed 6 weeks later.

The orthodontic treatment was completed 5 months after mandibular setback, showing great improvements in facial profile, Class I occlusion with ideal overjet and overbite (Fig 8, Fig 9, Fig 10A, 10B, 10C, 10D). The 24-month posttreatment photographs show excellent stability of the treatment results (Fig 11).

Figure 7 - Class III intermaxillary elastics.

Figure 8 - Post-treatment photographs.

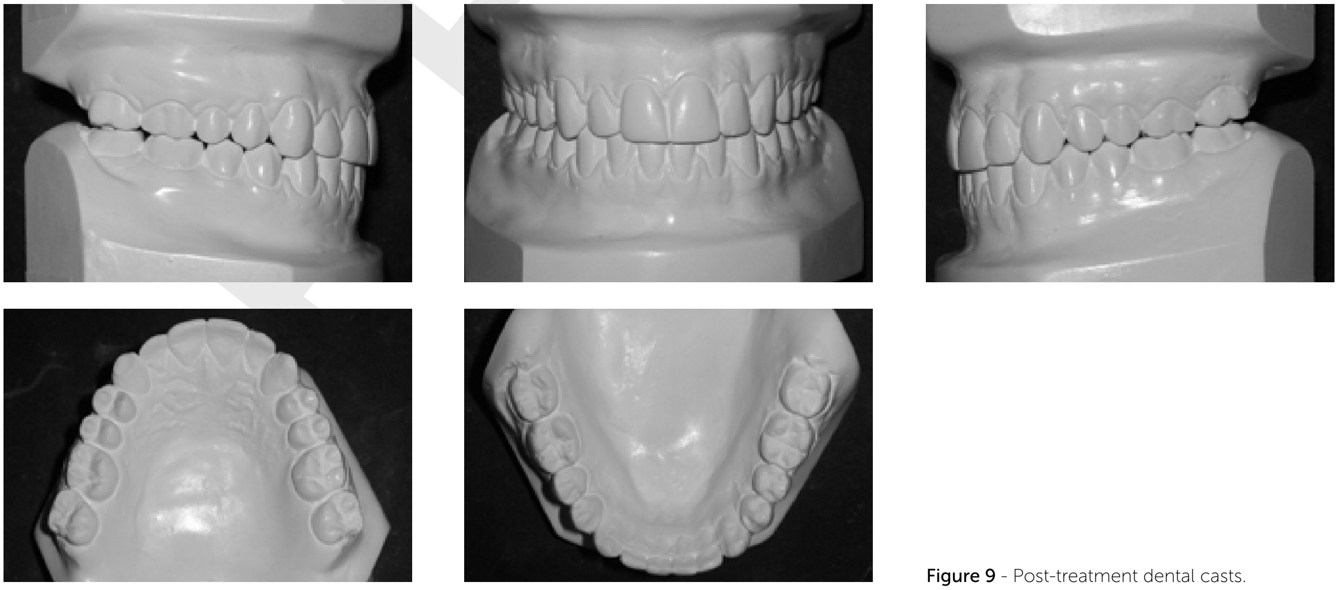

Figure 9 - Post-treatment dental casts.

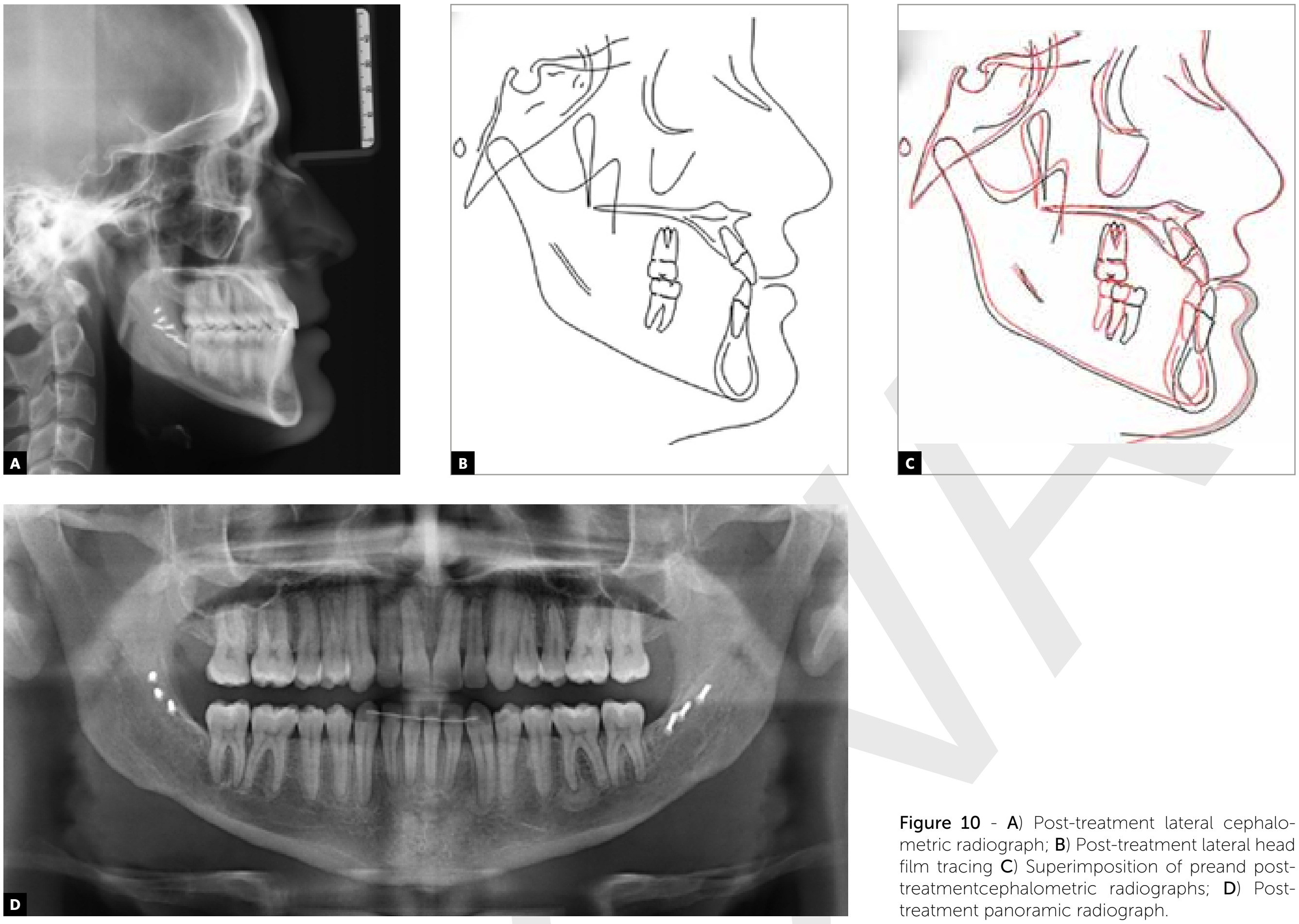

Figure 10 - **A**) Post-treatment lateral cephalometric radiograph; **B**) Post-treatment lateral head film tracing **C**) Superimposition of preand post-treatmentcephalometric radiographs; **D**) Post-treatment panoramic radiograph.

Figure 11 - Follow-up photographs (24 months).

DISCUSSION

SFA was first proposed by Nagasaka and colleagues in 2009[15] With the orthognathic surgery performed before the orthodontic correction, total treatment time could be reduced to even less than the average period for presurgical orthodontics.[16-19] Considering the number of patients who want orthognathic surgery mainly for esthetic reasons and would appreciate a shorter treatment time, SFA offers an attractive alternative for managing skeletal malocclusions while improving patients' self-esteem and function at the beginning of treatment.[20,21]

The authors described several advantages offered by the surgery-first approach: (1) Improvement in patient's facial esthetics and dental function in early treatment, rather than following a possible period of years, (2) improvement in patient's swallowing and speech functions after surgery, (3) the proceeding of orthodontic tooth movement at a much faster pace following surgery, thus reducing the overall treatment time, (4) improved cooperation of the patient during orthodontic treatment, (5) easier orthodontic tooth movement following restoration of the normal functional and anatomic relationships of the bony skeleton and surrounding soft tissues and (6) stability of results equal to, or in some cases superior to, those achieved using the traditional orthodontics-first approach.[22]

Most articles recommended that orthodontic appliances should be fitted prior to surgery, even when using a surgery-first approach. Studies reported bonding the orthodontic brackets immediately before,[15,23] 1 week before,[24-26] 1 month before[27-29] or 1-2 months before[30] surgery. Only one of the papers reported the total elimination of preoperative orthodontic treatment and the fitting of orthodontic brackets 10-14 days after surgery[20] Studies described that active orthodontic force can be applied before[26-29] or shortly after[15,23-25,30] surgery. Preoperative orthodontic preparation can, therefore, be started immediately before or approximately 1-2 months before surgery. Occasionally, it might be completely eliminated.

The shortest reported treatment time for postoperative orthodontic treatment was 4 months for correction of a skeletal Class III malocclusion with anterior open bite and dental crowding[26] and 4.5 months in the management of unilateral condylar hyperplasia,[11] similar to this case report with total treatment time of 5 months. Most studies described completing postoperative orthodontic treatment within approximately 1 year[15,27,28,30] or in 6-9 months.[20,23,25] Treatment time was approximately 6-12 months shorter using a SFA, compared to using a conventional orthodontics-first approach. Only one study described similar treatment time (approximately 1.5 years) for both approaches.[29]

There is no doubt that SFA requires precise and accurate diagnosis and planning. Post-surgical orthodontic movements must be carefully executed according to the surgical plan, which implies constant communication between orthodontist and oral surgeon.

To expedite post-surgical orthodontics, Insignia System (Ormco Corporation, Orange, CA) is an important tool for offering customized backets and archwires, alsodiminishingerrors from appliance positioning.Customizeddevices in orthodontics have been reported before. Subjects treated with SureSmile (OraMetrix, Richardson, Tex)were compared with those undergoing conventional orthodontic treatment, concluding that treatment time was 7 months shorter in patients treated with SureSmile.[31] Saxe[32] obtained comparable results. However, SureSmile technology (OraMetrix, Richardson, Tex) customizes only the archwires using robotically assisted archwire bending technology.[32,33] Insignia (Ormco Corporation, Orange County, CA) customizes bracket prescription, bonding and archwires.[14] Besides,the light forces produced by the passive self-ligating system with high-tech archwires will control the transverse dimension in coordination with post-surgical sagittal changes.[19]

With 2-dimensional (2D) imaging, the most usual problems are landmark identification , image distortion and magnification.[34,35] However 2D imaging remains as the gold standard for the craniofacial region.The 3D computer-assisted surgical planning benefits the specialists because it can predict surgical movements including translations in anteroposterior, lateral, and vertical directions, and rotations around the x-, y-, and z-axes, the so-called pitch, roll, and yaw rotations[36] and this is an undisputed advantage in determining the best treatment option.

CONCLUSIONS

1. The 3D diagnostics, digital surgical planning and CAD/CAM customized bracket systems with passive self-ligation offer a more accurate alternative to improve the efficiency of orthodontic-surgical treatment.
2. SFA helps to reduce treatment time, delivering aesthetic results from the beginning,which generates greater acceptance in surgical patients.

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