



## Use of resorbable bicortical screws as an alternative in mandibular orthognatic surgery. Presentation of two cases and literature review

### *Uso de tornillos bicorticales reabsorbibles como alternativa en cirugía ortognática de mandíbula: presentación de 2 casos y revisión de la literatura*

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#### ABSTRACT

The use of plates and resorbable screws of polylactic and polyglycolic acid allows that these osteosynthesis materials be used as substitution of traditional materials like titanium, in pediatric as well as in adult cases. When compared to titanium, they still show some disadvantages like discomfort during use and financial cost, many studies show they are a valid alternative to osteosynthesis with titanium in most clinical situations. In this report two clinical cases are described where resorbable materials like maxillofacial osteosynthesis, and advantages and disadvantages are assessed as well as characteristics of these materials. Advantages and disadvantages are also assessed with respect to two cases where this material was used. Present indications of resorbable osteosynthesis according to literature are also documented.

**Key words:** Orthognatic surgery, resorbable screws.

**Palabras clave:** Cirugía ortognática, tornillos reabsorbibles.

#### RESUMEN

La utilización de placas y tornillos reabsorbibles de ácidos poliláctico y poliglicólico permite que cada vez sea más común el uso de estos materiales de osteosíntesis en sustitución de los materiales tradicionales de titanio, no sólo en su aplicación pediátrica, sino también en adultos. Aunque todavía presentan algunas desventajas en relación con el titanio, como la mayor incomodidad de uso y el costo económico, muchos estudios demuestran que es una alternativa válida a la osteosíntesis con titanio en la mayoría de las situaciones clínicas. En este artículo se describen dos casos clínicos que utilizan materiales reabsorbibles como osteosíntesis maxilofacial, y se revisan las ventajas y desventajas así como las características de estos materiales. Así mismo, sus ventajas y desventajas conforme a la experiencia en 2 casos donde se utilizó este material y se documentan las indicaciones actuales de la osteosíntesis reabsorbible conforme con la literatura.

#### INTRODUCTION

In modern maxillofacial surgery, rigid osteosynthesis has become one of the major breakthroughs. For 25 years now, titanium has shown its excellent qualities.<sup>1</sup> Nevertheless, the onset and popularity of the combination of polylactic and polyglycolic acids has shown these new materials are in much use. There is no doubt left about the usefulness in pediatric applications, but there is still controversy on its use in maxillofacial surgery of adult patients.<sup>2</sup> When using titanium materials, sometimes it is necessary to perform a second operation for the removal of these screws. All the disadvantages inherent to metallic materials such as palpation, sensitivity, migration, obstruction in the X-ray, possible bone resorption, allergies, and

growth delays in children have led to the development of resorbable materials.<sup>3</sup> These biodegradable materials cause inflammation, it is then necessary to allow for a phase that will enable resorption without causing toxic reactions. Resorbable bicortical screws have

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been used in craniofacial surgeries, and several studies prove the security and effectiveness reached when using these materials in mandibular osteotomies.<sup>4</sup>

# CASE REPORT

Two cases of mandibular orthognatic surgery are presented. In them internal fixation was provided by bicortical screws manufactured with resorbable materials.

## CASE 1

17 year old male patient with no family history relevant to his condition. Personal pathological history of hepatitis at 7 years of age. Sent from the department of orthodontics of the Technological University of Mexico. He reports the onset of his condition during his growth stages. It became apparent during his adolescence, for this reason he sought orthodontic treatment. When performing intraoral examination, the following was observed: jaws devoid of pathological data, left mandibular laterognatia, posterior crossbite and -7 mm anterior overbite and lateral deviation of 3 mm (*Figure 1*).

The most relevant cephalometric data are condensed in *table I*. Based on cephalometric and clinical diagnoses, a prognathism reduction surgery with 10 mm mandibular retraction and 3 mm right rotation was programmed.

In the operating theatre, with the patient under nasotracheal intubation, a retromolar approach was performed, with exposition of the ascending ramus and sagittal osteotomy. Once the procedure was performed on both sides, after previous consultation with the orthodontist, a new occlusal position was achieved with an acrylic surgical splint and a one step elastic chain.

Proximal excess was removed, and the segments were fixated in the mandibular angle zone with three 2.8 x 16 mm resorbable bicortical screws (CPS System, Inion®) (*Figure 2*).



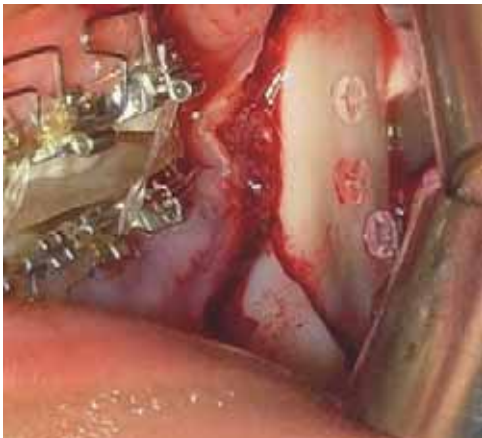
**Figure 1.** Patient number 1. Malocclusion view.

Intraoral wounds were sutured with resorbable material (vicryl 3-0) and skin wounds were sutured with non resorbable material (nylon 5-0).

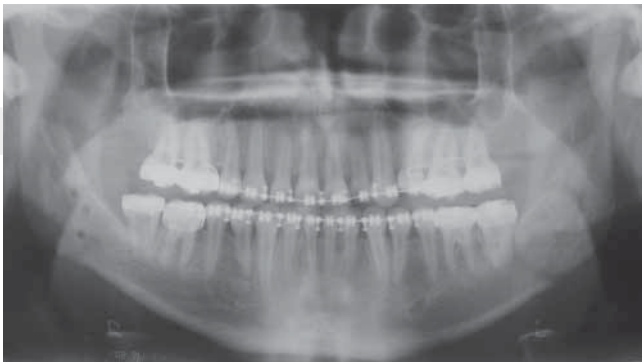
The postoperative period was uneventful with conventional course of antibiotics and analgesics. The material cannot be discerned in the radiographic im-

**Table I.** Significant cephalometric data. Patient No.1.

NA-FH	90°	90°
1-PMx	109°	115°
1-FH	110°	114°
NB-FH	88°	93°
< ANB	-2°	+4°
G-SN:SN-Me	1:1	79/89
Sn-Ls	0 mm	2 mm
Sn-Pog´	-4 mm	+3 mm
CHIN-labial	124°	126°



**Figure 2.** 2.8 x 16 mm resorbable screws in surgical procedure number 1.



**Figure 3.** Postoperative orthopantomography of patient number 1.

age, only the sites perforated for the placement of the screws can be seen (*Figure 3*). Intermaxillary fixation was progressively removed from the 4<sup>th</sup> up to the 8<sup>th</sup> week after the operation. After this period, the patient was once again sent to us for management of postoperative orthodontia.

From the immediate postoperative moment, and up to three control years, the patient has not shown any complication.

## CASE 2

18 year old female patient, showing no relevant history for her condition. She reports untreated mandibular growth during her teen age years. (adolescence). She does report treatment for the 18 months previous to her attendance to the Mexico Technological University. No previous medical history contraindicated orthognatic surgery. In clinical studies a 6 mm discrepancy of the horizontal bite was observed.

Based on clinical and cephalometric studies an 8mm mandibular retraction was programmed. *Table II* shows the most relevant cephalometric data.

In the operating theatre, with patient under general nasotracheal anaesthesia, a sagittal osteotomy of the bilateral ascending ramus was performed. With this procedure, a mandibular retraction and right rotation were achieved. The new occlusal position was brought about with a surgical splint. After removing proximal excess, the segments were fixated with three 2.8 x 16 mm bicortical screws (CPS System, Inion®) percutaneously placed on each side (*Figure 4*). Intraoral wounds were sutured with resorbable material (vicryl 3-0) and skin wounds were sutured with non resorbable material (nylon 5-0).

The patient experienced an uneventful postoperative period with conventional administration of analgesics and antibiotics. At the 4<sup>th</sup> postoperative week, intermaxillary fixation was gradually removed. 7 weeks after the operation the patient was sent for postoperative orthodontic treatment.

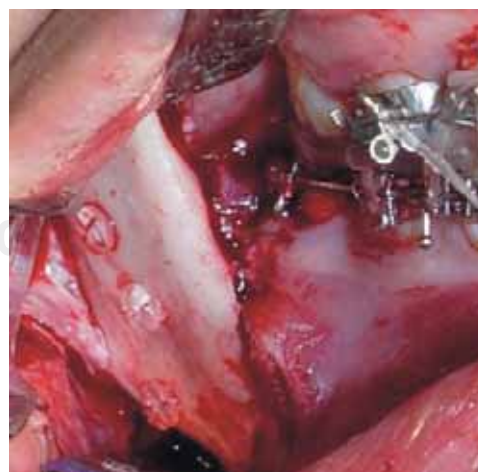
## DISCUSSION

Rigid internal fixation with metallic materials is a standard technique, in use for the last 30 years and performed to align bone segments during healing periods.<sup>5</sup> The first bioresorbable materials were used in membranes for guided tissue regeneration as well as sutures. The first clinical reports of resorbable plates were published around 1980.<sup>6</sup> Metal screws used in maxillofacial surgery sometimes require secondary removal, due to migration, unacceptable palpation, growth restriction in pediatric patients and interferences in imaging diagnoses which include radiation.<sup>7</sup> Bioresorbable materials most used in maxillofacial surgery are high molecular weight poly-alpha-hydroxyl acids, polylactic acid (PLA), polyglycolic acid (PGA), polydioxanone (PDS) as well as their co-polymers. The material used is a mixture of rigid and elastic polymers selected for their strength, malleability, and degradation properties. In Inion CPS system, polymers are: L-lactic D, L-lactic glycolic and trimethylene carbonate.<sup>8</sup>

These acids degrade through simple hydrolysis in the aqueous system of live tissues. First they dissolve into small fragments which are phagocytosed by macrophages and giant cells. The resulting products of PLA (polylactic acid) and PGA (polyglycolic

**Table II.** Relevant cephalometric data, patient No. 2.

NA-FH	90°	87°
1-PMx	109°	106°
1-FH	110°	108°
Is-FH	56 mm	56 mm
NB-FH	88°	88°
1-PMn	91°	88°
< Go	125°	132°
Sn-Sts	20 mm	20 mm
Sn-Stm-Me	1:2	20/55
Sn-Li-Me	1:1	34/43
Sn-Ls	0 mm	3 mm
Sn-Pog	-4 mm	0
< Chin cervical	107°	135°



**Figure 4.** 2.8 x 16 mm screws used in surgical procedure patient number 2.

acid) are metabolized in carbon dioxide and water, and are eliminated through respiration.<sup>9,10</sup> Turvey has published his experience in 70 patients subject of bi-maxilar orthognatic surgery with a short term follow up (6-24 months). Three patients experimented some problems with loss of screws, but stability and occlusion were adequate in all patients.<sup>11</sup>

One of the advantages of resorbable material is that it is adequate to support bone fragments during the healing period, besides becoming totally resorbed when the bone has been consolidated, with no fear that the resulting metabolites cause any local or general alteration. Matthews & al, have studied the stability of SR-PLLA (Inion®) resorbable screws in osteosynthesis of sagittal mandibular advancement osteotomy in 11 patients. They compared these results with those of 11 patients subject to a similar osteotomy fixed with titanium. They did not find significant differences between both groups when comparing cephalometric stability, in a one year follow-up period. These characteristics provide indubitable advantages, especially since they do not require a second procedure to remove materials used in the first operation.<sup>12</sup>

Fuente del Campo in a study of several Centres, has reported his experience with maxillofacial osteosynthesis with PLLA (poly-L-lactic acid) resorbable material in 208 cases, of which 142 cases corresponded to orthognatic surgery. These cases had a maximum follow up period of 8 years. This author has observed a 7.9% complication rate: 2 cases of maxillary instability due to poor technique, 6 cases of granuloma, 4 cases of plate exposition and 4 cases of plate displacement. Most of these complications are attributed to the technique rather than the material used.<sup>13</sup> Handling of these screws is difficult when comparing them to the more common titanium screws, therefore, initially, surgical time will be extended by 10 or 15 additional minutes. This is due to the process of forming the thread for the orifice required in most systems. The development of hand devices to introduce the screw into the orifice without using a mallet has enabled the surgeon to decrease surgical operating time without causing a problem to its mechanical properties.<sup>14</sup>

Another possible disadvantage of resorbable materials is their radiolucent appearance in radiographic examination. This makes them invisible with only the orifice being seen. This can hinder diagnosis in cases where there are consolidation problems<sup>15</sup> (Figure 5). Stability of resorbable screws in sagittal osteotomies has been studied in different articles as well as clinical and radiographic evaluation of skeletal stability and bone healing.<sup>16</sup> Kohn conducted some biomechanical studies in the mandible of human corpses where

displacement with resorbable PLLA/PGA screws and bicortical titanium screws were studied. Screws were subject to force exerted on a board; this exercise showed that there is no significant difference between both types of screws.<sup>17</sup> Two screws placed over the neurovascular bundle can be sufficient to provide satisfactory fixation in the bone segments. If a third screw were to be needed, the best place to place it is under the neurovascular bundle close to the inferior border of the mandible.<sup>18</sup> A 10 year follow-up study mentions that problems that might arise are rare and similar to those encountered when using titanium screws, therefore, complications can be considered as less important. The only difference is the possibility of encountering granulation tissue, which will not require surgery unless the material becomes palpable in the area.<sup>19</sup> It becomes then clear, that in mandibular orthognatic surgery, resorbable material is a valid alternative for titanium. It is probable, that in the future, resorbable materials will be the only ones used, and replace titanium the same way that titanium once replaced steel.<sup>20</sup>

## CONCLUSIONS

In most clinical situations, the use of resorbable screws and plates for maxillofacial osteosynthesis used nowadays, is a valid alternative to titanium osteosynthesis. Presently, resorbable materials still present some disadvantages in comparison with titanium, like discomfort of use and higher cost. If we exclude fractures with small comminuted fragments as well as other specific situations where there is an excessive muscular traction force, resorbable materials can be used just as well as titanium to achieve maxillary osteosynthesis.

Mechanical properties of resorbable screws used in orthognatic surgery fixation are comparable to metal fixation systems. These materials fulfil all expectations



**Figure 5.** Case No. 2 postoperative orthopantomography.



of immobilization, fixation and stabilization. Skeletal stability is sufficient for the required bone healing period.

For years, resorbable materials have shown good results in situations where they are not subject to muscular traction. Based on experience derived from these cases, we can conclude that biodegradable screws have the potential to successfully fixate sagittal mandibular osteotomies, when placing bicortical screws of the right thickness. We did so in the cases here presented which represent a situation where there is great muscular traction, and not just in tension free cases as was the habitual procedure up to a few years ago.

Literature review has shown the excellent results obtained when using resorbable rigid internal fixation in the middle third. Now begins the experience of mandibular resorbable internal fixation. In the long run, we will be able to reassess results, and we would not be surprised, in a few years, to see the use of titanium restricted to reconstruction cases where a higher profile material is required.

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