

## Horizontal augmentation of the atrophic ridge: Split crest technique

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### ABSTRACT

Therapy with osseointegrated implants has been shown over the years to be the best choice in the rehabilitation of edentulous jaws. The challenge of modern implant dentistry is to solve clinical situations found in most edentulous edges that hindered or prevented the replacement of teeth with osseointegrated implants. It is known that the success of osseointegrated implant therapy lies in adequate bone volume and remaining height. To solve these defects, mainly, the horizontal defect techniques have been developed that allow the return of the pre-tooth loss socket dimension: distraction osteogenesis; guided bone regeneration (RGO); interpositional and split crest osteotomies. Split Crest (RSP), also called lateral expansion of the crest, increases the width of the edentulous ridge through osteotomies in the region of the buccal wall and thus moving away from the lingual wall to gain in the horizontal dimension, creating conditions for the correct positioning of the dental implant.

**Keywords:** Horizontal augmentation, Implant, Bone expansion.

### INTRODUCTION

Therapy with osseointegrated implants has been shown over the years to be the best choice in the rehabilitation of edentulous jaws.<sup>1,2</sup>

There are several causes of the non-presence of dental units (dental trauma; periodontal diseases; congenital factors, etc.), which can alter the size and shape of the jaws.<sup>3,4</sup>

Implantology began its studies based on the principle that in order to be successful there should be bone height and thickness remaining.<sup>5,6,7</sup> Currently, studies have shown that implant therapy tends to solve clinical situations that were previously considered critical or contraindicated its use in the rehabilitation of these edentulous ridges.<sup>4,8,9</sup>

After the loss of the dental unit, either for the reasons mentioned above, there is a physiological change (as can also be caused by the prolonged use of mucus-supported prostheses) in the size and width of the alveoli and this atrophic condition of the jaws hinders or prevents the placement of implants of adequate diameter, as well as their correct positioning and restoration.<sup>5,10,11</sup> Reestablishing its function and aesthetic harmony of the natural dentition<sup>3</sup>.

To solve these defects, mainly, the horizontal defect techniques have been developed that allow the return of the pre-tooth loss socket dimension: distraction osteogenesis; guided bone regeneration (RGO); interpositional and split crest osteotomies.<sup>12,13,14</sup> *Split Crest* (RSP), also called lateral expansion of the

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crest, increases the width of the edentulous ridge through osteotomies in the region of the buccal wall and thus moving away from the lingual wall to gain in the horizontal dimension, creating conditions for the correct positioning of the dental implant.<sup>4,11,15</sup>

The objective of this review is to detail the concept; the various ways of being carried out; indications and contraindications of the Horizontal Ridge Augmentation (Split Crest) technique.

## **METHOD**

Through the search in databases such as PUBMED and COCHRANE, a search was carried out with the keywords related to the theme. This search was carried out with a time cut of 6 years (2010 to 2015), with the exception of one article that was found in all the references found. After reading the abstracts, 38 articles were selected for reading in full and of these, 23 were selected for their relevance to the theme.

## **LITERATURE REVIEW**

The challenge of modern implantology is to solve clinical situations found in most edentulous edges that hindered or prevented the replacement of teeth with osseointegrated implants.<sup>16,17</sup> It is known that the success of osseointegrated implant therapy lies in adequate bone volume and remaining height.<sup>5,10</sup>

The atrophic condition of the bone in the jaws makes it difficult to position it correctly, as well as to use the appropriate diameter for oral rehabilitation. This atrophy can occur after the loss of the dental unit, which can be caused by periodontal disease; pathological lesions; dento-alveolar trauma or congenital factors, even sinus pneumatization or the use of muco-supported prostheses for a prolonged time; which modify the height and, mainly, the horizontal dimension.<sup>4,8,11,14</sup>

Most alveolar volumetric defects occur in the anterior region of the maxilla and posterior mandible, occurring in 25% of cases in the first year, reaching 40 to 60% in the three years following tooth loss.<sup>3,9,18</sup> Regarding the oral wall, the remodeling is 56% and the palatine 30%<sup>14</sup>.

Rehabilitation with implants in atrophic edges is currently a trend, due to the emergence of bone regeneration techniques that enable volume recovery such as distraction osteogenesis; RGO (block or particulate) and *Split Crest*.<sup>5,6,19</sup>

Distraction osteogenesis is indicated for increase in volume, i.e., increase in height and width, being a pre-implantation surgery, but due to its complexity in the technique and high cost, it does not make it a routine technique of choice.<sup>2,14</sup>

The en bloc graft is also a pre-implantation surgery, used to recover the horizontal dimension of the ridge, which can be from intraoral (chin and ramus) or extraoral (skullcap; tibia and iliac crest) donor areas. However, this technique has some disadvantages such as failures between 8.5% and 10%; infection;



inadequate contour of the block and secondary fracture after the placement of the fixation screw; morbidity of the donor site; membrane exposure and graft resorption.<sup>9,13,16,20</sup>

The alternative to perform horizontal augmentation and implant insertion at the same surgical time is the Split Crest technique<sup>6</sup>.

### *SPLIT CREST*

Its introduction as a solution for horizontal ridge regeneration took place in the 70's with Dr. Hilt Tatun, presenting itself as a technique that not only enables this increase but also makes a bone space for implant placement<sup>12,15</sup>. It consists of the separation of the buccal and palate/lingual walls of the alveolar ridge through an osteotomy on the ridge of this ridge and one or two lateral osteotomies on the buccal wall causing a "green stick" fracture.<sup>4,6,17,21</sup>

Past *Split Crest* the technique receives several denominations depending on what we are related to; if a more specific aspect we have the following nomenclatures: Split Crest Osteotomy; Alveolar Split Osteotomy, Alveolar Split Grafting; when we relate it to the result, the technique is called Lateral Bone Augmentation, Lateral Crest Expansion, Bone Lateral Augmentation and Edentulous Crest Expansion.<sup>12,14,20</sup>

In the 90s, scholars such as Scipione, Bruschi and Calesini made some modifications to the technique in order to facilitate or improve its purpose.<sup>3,5</sup>

The concept of the Split Crest technique is to make a longitudinal cut on the crest of the atrophic ridge allowing a division into two parts, that is, separating the buccal and palate/lingual walls; opening space in the buco lingual sense, increasing the thickness and enabling the installation of osseointegrated implants. To assist the lateral expansion of the buccal wall, one or two lateral osteotomies can be performed, especially in the mandible region, whose bone composition is denser.<sup>6,8,10</sup>

This longitudinal cut can be made with diamond discs or drills, and after osteotomies, osteotomes/chisels and hammers are introduced, although some patients are resistant to the use of these instruments, so that the oral wall can be displaced, providing the necessary space for the implant to be installed.<sup>14,17</sup> Some scientific reports add to the technique the use of micro saws or piezoelectric to facilitate the performance of osteotomies and articulated motors and arms; or even screws, for the expansion of the mouth wall in a controlled manner.<sup>2,9,12,13</sup>

The use of piezoelectric improves the technique, making it faster and enabling a lower post-surgical inflammatory process. Together with the use of instruments that can perform a progressive and controlled expansion, avoiding the complete fracture of the oral wall; since RSP is a technique that requires control of the operator's strength, that is, a tactile sense in moving away from these corticals.<sup>2,10,13,14</sup>



Bone density is also a variable to be analyzed during the planning of lateral expansion, bones with little or no medullary bone contraindicate the use of the technique, as fracture of the vestibular wall can occur more easily; summarizing for the realization of the *Split Crest* there must be presence of medullary bone below the narrow bone crest. This medullary bone will also be responsible for the blood supply in the newly formed space, so type III or IV bone are the choices most found in the literature; as well as defects of at least 02 to 03mm between the walls.<sup>6,8,11,12,18</sup>

Comparing the two maxillae with the bone density requirement, we noticed that the maxilla presents better results for the lateral expansion technique of the buccal wall than the mandible. Due to the low elasticity of the mandibular bone, the occurrence of a bad fracture in the "green stick" becomes a complicating factor in the future installation of osseointegrated implants; Even so, the technique has a success rate of 86 to 97% compared to the conventional implant placement technique.<sup>1,3,10,12,15</sup>

To avoid this complicating factor, in 2006 Chiapasco et al.<sup>13</sup> reported on the Extension Crest (Bio SRL, Milan Italy), which is a device with two surgical steel arms articulated apical x transverse and a screw that performs the progressive activation of 0.5 mm each turn, thus managing to move the buccal and palatal walls away in a controlled manner, avoiding the mouth wall. Brugnamì et al.<sup>10</sup> In his study, he mentions the use of expander screws for better control during axial insertion and pressure during bone expansion. Rodrigues-Martinez<sup>2</sup> talks about the use of surgical motors with expanders are also a good alternative.

In the literature we find the technique of *Split Crest* performed in two stages for those denser bones or defects smaller than 3.5 mm, promoting more safety in their use and in the installation of future implants. The first surgery is performed the longitudinal and horizontal osteotomies, consequently, lateral expansion begins with the placement of allogeneic or xenogenous material or transient implants to maintain the space created; the second surgery causes a divergence among researchers without reaching any consensus on when it will be performed, some authors argue that it should be in a few weeks; others prefer three to four months.<sup>1,3,6,12, 17,19</sup>

The design and type of flap also influence the technique of lateral expansion of the alveolus. Full-thickness flaps are contraindicated, as they do not allow the preservation of the periosteum, so perfusion to the buccal wall is interrupted, causing its resorption and causing failure in the *Split Crest*.<sup>4,5,15,16</sup>

The space created between the buccal and palatal walls after horizontal bone expansion and implant insertion can be filled with autogenous particulate bone, xenogenous, or a mixture of both, up to platelet-rich plasma.<sup>11</sup> Urban et al.<sup>21</sup> state that there are no differences between filling this space with autogenous or a mixture of both; in addition to having demonstrated that the use of absorbable membranes for graft protection.



Pelican<sup>5</sup> reports in his work that there is bone formation, even without the placement of any type of graft. In his study, Tair<sup>1</sup> used small blocks of autogenous bone only to maintain the space created after the use of the technique.

Some characteristics should be observed in the implant to be inserted after the *Split Crest*, these should have a shape similar to the roots of the teeth, thus obtaining higher success rates; Because the technique allows greater contact between the walls and the implant surface, however, short implants in extensive interocclusal spaces may be the source of osseointegration failure. The Switching platform and the Morse taper connection hinder the formation of peri-implantitis and bone resorption, due to the maintenance of the biological space maintaining the inflammatory cells, reducing microgaps and the decrease in peri-implant bone stress.<sup>5,8,11,22</sup>

In addition, there is a need for bone remainder of 3 to 4 mm below the apex of the implant, thus achieving good primary stability; although density after lateral bone expansion is impaired.<sup>6,10</sup>

In the literature, the RSP presents a significant horizontal gain, this gain is equal to the initial thickness; Reflecting a volumetric increase necessary for the success of implant dentistry therapy, it recommends that implants have bone mass around them of at least 1mm in thickness. The sagittal osteotomies technique reduces morbidity, that is, it reduces the risk of infection; Although it is a minimally invasive procedure, complete fracture of the buccal wall can occur and consequently its resorption.<sup>7,13,17,20</sup>

Cedrum<sup>22</sup> states that several osteotomy techniques have not been successful in the installation and preservation of the implant. The technique does not prevent bone resorption or peri-implantitis, as studies have shown that even after positioning and placing it in function, this resorption occurs and there are no differences in implants placed at the tissue or bone level.<sup>8,11,16</sup>

Ozzer et al.<sup>23</sup> cite in their studies the use of *Split Crest* to move teeth and thus close edentulous spaces, which were prevented by the decrease in the vestibulolingual dimension.

Tolstunov<sup>14</sup> reports that in his research the most common complications in the development of the *Split Crest* were: lack of operator experience; several other techniques that reduce surgical time; presence of fracture of the lingual wall and presence of local infection. Thus, he believed that the success of the technique is based on five principles: 1) care to maintain vascularization as a whole; 2) the use of particulate bone; 3) immobilization of the vestibular wall; 4) the presence, quality, and quantity of bone density, and 5) care during osteocondensation.



## DISCUSSION

Rehabilitation in atrophic ridge is a trend in implant dentistry clinic, we are increasingly faced with situations that hinder or prevent implant therapy. To this end, several procedures are suggested for the correction of these anomalies.

Pelican<sup>5</sup> Tolstunov,<sup>14</sup> Shibuya et al.,<sup>15</sup> report that there are distraction procedures En bloc grafts and the technique of *Split Crest*.

Yoon et al.<sup>16</sup>, points out the disadvantages of the use of en bloc grafts, due to possible resorption and morbidity of the donor site; in addition to needing a second surgery for the placement of the implant. Distraction, on the other hand, is the area necessary for the realization and the high cost.

The technique of *Split Crest* or Lateral Ridge Expansion has a great advantage of performing horizontal augmentation and inserting the implant in the same session. The technique consists of opening a flap that is not full-thickness, sagittal osteotomies on the marginal crest and two horizontal osteotomies on the buccal wall, and the use of chisels and hammers for the separation of the walls and bone condensation.<sup>4</sup> Garcez Filho et al.,<sup>6</sup> Brugnami et al.,<sup>10</sup> Demetriades et al.,<sup>12</sup> Shybuya.<sup>15</sup>

The importance of not performing a full-thickness flap is to preserve the blood supply to the buccal wall and not to reabsorb it. Corroborating Pellicano's work,<sup>5</sup> Yoon et al.<sup>16</sup>

RSP solves problems of ridge atrophy with its etiology in periodontal diseases; tooth extraction; trauma; congenital factors and even the prolonged use of mucus-supported prostheses, however, there must be spongy bone between the bone walls, which will contribute to the primary stabilization of the implant, as well as the blood supply in the intercortical region. According to the studies of Mechery et al.,<sup>3</sup> Gonzales-Garcia et al.,<sup>8</sup> Basseti et al.<sup>18</sup>

Ozzer et al.<sup>23</sup> used the *Split Crest* to orthodontically close a space with ridge atrophy.

Abu-Tair,<sup>1</sup> Mechery et al.,<sup>3</sup> Chiapasco et al.,<sup>13</sup> Tolstunov,<sup>14</sup> Anitua et al.,<sup>19</sup> Urban et al.<sup>21</sup> argue in their research that the Horizontal Expansion of the Atrophic Ridge can be performed in two phases as long as they find widths of less than 3.5 mm or that the maxilla to be performed the technique has a bone with little elasticity, making it difficult to move the oral wall. Between the first and second phase, autogenous or xenogenous bone graft should be used to maintain the newly created space.

Samartino et al.<sup>11</sup> used platelet-rich plasma in their study to improve the healing process of soft and hard tissues.

As an alternative to the use of chisels and hammers, which some patients have resistance, and because it is a technique that requires control of force and precision: Brugnami et al.<sup>10</sup> presented the use of screws to perform this movement, with greater control, while Chiapasco et al.<sup>13</sup> presented the *Extension Crest*, Rodrigues-Martinez et al.<sup>2</sup> reported the use of expanders connected to surgical motors.



It is believed that the shape of the implant and that of the future restoration help to preserve bone height, also avoiding peri-implantitis, consequently, the survival and success of implant therapy. Root implants with platform *Switching*, along with the morse taper connection and positioning at the tissue or bone level are the most cited in the literature by Pozzer et al.,<sup>4</sup> Samartino et al.,<sup>11</sup> Shybuya et al.,<sup>15</sup> Yoon et al.<sup>16</sup> and in the systematic reviews by Garcez Filho et al.<sup>6</sup> e Basseti et al.<sup>17</sup>

The main complications that can be found in this technique are: Infection, loss of oral wall vascularization, complete fracture of the buccal wall, fracture of the lingual wall and lack of experience of the operator. Corroborating Pellicano's work,<sup>5</sup> Wassdorp et al.,<sup>9</sup> Demetriades et al.,<sup>12</sup> Shybuya et al.,<sup>15</sup> Basseti et al.,<sup>18</sup> Avvanzo et al.<sup>20</sup> e Cedrum.<sup>22</sup>

For the success of this technique, making it safe, the vascularization of the oral wall becomes an important step to be verified during and after the technique, the use of bone graft; immobilization of both the wall and the inserted implant; the quality of bone density; the performance of controlled and efficient osteocondensation and less traumatic methods of osteotomies, corroborating the work of Toltunov<sup>14</sup>.

## CONCLUSION

The technique of *Split Crest* It has become a good alternative for the recovery of the horizontal dimension and implant installation in the same session.

Some prerequisites must be considered for the realization of the expansion and therefore more research should be carried out on the subject, for better elucidation and application of the *Split Crest*.



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