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Original Research Article **Oral Implantology**

Ridge Expansion in Two Surgical Stages Using the Transitional Implant Technique. Case Series with 8-Year Follow-Up

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Abstract

Extremely wide bony ridges require surgical procedures in order to insert dental implants. When less than 3 mm is present, different procedures are available, with ridge splitting being one of the most commonly used. The main limitation of this procedure is the angulation of the inserted implant. The two-stage split with transitional implants was created to overcome this drawback and achieve greater bone volume in the intervention area. This case series shows patients treated with this novel procedure. ***Material and Method*:** We retrospectively analysed patients who had undergone two-stage ridge expansion (using transitional implants) with at least 9 years of follow-up from the loading of the definitive implant, both in the maxilla and mandible. Data collection was performed by two independent examiners (different from those performing the prosthetic or surgical phase). All data were entered into a database which was managed by computer for the subsequent statistical analysis. The implant was the unit of analysis for descriptive statistics in terms of location, implant dimensions, and radiographic measurements. The primary variable was implant survival and as secondary variables mesial and distal bone loss and final bone crest width achieved after transitional implant integration, before replacement, were recorded. ***Results*:** Thirteen patients were recruited, and 30 transitional implants were inserted for width expansion in two surgical stages. These transitional implants were subsequently replaced by definitive implants at 5 months in the maxilla and at 3 months in the mandible. The mean initial ridge width of all two-stage split sites was 2.65 mm (+/- 0.63), range 1.32 to 3.70 mm. After placement of the transitional implants and bone healing, the final mean width of the specimen was 7.60 mm (+/- 0.26), range 4.31 to 12.20 mm. The mean mesial bone loss after loading of the final implant was 0.80 mm (+/- 0.26) and the mean distal bone loss was 0.85 mm (+/- 0.25). ***Conclusion*:** The two-stage split technique to achieve a gain in width of the residual bone crest is minimally invasive, predictable and the implants placed in the final (definitive) stage have a high survival rate, as we have seen in the present study with 9 years of follow-up.

Keywords: split crest, transitional implant, bone expansion.

INTRODUCTION

Extreme bone atrophies (3 mm in width or less) in the horizontal direction in both the mandible and maxilla are complex cases that must be approached with a careful treatment protocol that allows us to generate sufficient residual bone volume for the successful insertion of implants [1-4]. This can be done using different regenerative techniques, with the difference in the decision tree being the presence or absence of the vestibular table, which is key in this type of problem [5, 6]. When both plates, the vestibular and lingual tables are present, one of the best options is to perform a ridge split, leaving guided bone regeneration and bone block grafting for situations where the bone volume in width is less than 3 mm or one of the cortices is missing [5, 6]. This technique consists of the mechanical separation of both cortices, generating a space in the trabecular bone between the two slabs, which is subsequently displaced for the insertion of an implant in this area [7-13]. Once the implant has been inserted, the resulting gap or space between the slabs that is not occupied by the titanium of the implant can be filled with different osteoinductive or conductive materials, generally in order to achieve new bone formation in this area [7-13]. One of the main problems when rehabilitating implants inserted by means of ridge splitting is the angulation that they usually have, which is usually protrusive, and the fact that the implant is not very well placed. This can be corrected today with angulation change techniques (Cad-Cam), but there are clinical situations where this angulation, despite the solutions available to us, can be limiting, such as in the aesthetic sector. To solve this main drawback, our study group has developed a two-stage surgical ridge expansion technique. In 2011 [14, 15], we described this technique for the first time, using transitional implants or expanders that would occupy the space between the cortices and which could subsequently be removed atraumatically in a second surgical stage without generating any type of bone loss in the bed where they were embedded. Once the transitional implants have been removed, we can place larger diameter implants and even expand or over-correct them again if necessary.

Since its publication, we have carried out numerous studies in which we have used this procedure successfully [14-19]. Using this technique, a controlled expansion can be generated with better guarantees while at the same time providing a ridge for the second implant where the definitive implant can be inserted in a more favorable axis for subsequent prosthetic rehabilitation. In the present work, we show a series of clinical cases rehabilitated using this procedure, with a long-term follow-up of the definitive implants placed in the regenerated bed, analyzing the bone volume gained with the subsequent behavior of the implant (crestal bone loss and survival).

MATERIAL AND METHODS

We retrospectively analyzed patients who had undergone two-stage ridge expansion (using transitional implants) with at least 9 years of follow-up from the loading of the definitive implant, both in the maxilla and mandible. All patients were studied prior to implant insertion by means of diagnostic models, intraoral exploration and dental CT (Cone-beam) subsequently analyzed using specific software (BTI-Scan III). Prior to implant insertion, antibiotic pre-medication consisted of amoxicillin 2g orally one hour before surgery and paracetamol 1g orally (as an analgesic). Subsequently, patients were treated with amoxicillin 500-750 mg orally every 8 hours (according to weight) for 5 days. The surgical technique was the same for all patients, consisting of: Anesthesia, elevation of the mucoperiosteal flap to full thickness, starting drill at high revolutions with irrigation for marking the area where the implant insertion will be performed and subsequent joining of the initial points with ultrasound (piezoelectric surgery). Subsequently, expansion is carried out to separate the ridges (vestibular and lingual) with motorized expanders (Biotechnology Institute - BTI). This creates sufficient space for the insertion of the transitional implant. Finally, the gap between the boards is filled with freshly activated PRGF-Endoret fraction 2 (clot) and we can perform a vestibular overcorrection with autologous bone obtained from the drilling if available or obtain it with a bone scraper (obtained mainly from the horizontal branch), embedded in PRGF-Endoret. When the transitional implant and the overcorrection are placed, everything is covered with activated and retracted PRGF-Endoret fraction 1 fibrin membranes. Once the integration time has elapsed, the transitional implant is removed, and the definitive implant is placed in the same bed and with angulation correction (figure 1).

Data collection was performed by two independent examiners (different from those performing the prosthetic or surgical phase). All data were entered into a database which was managed by computer for the subsequent statistical analysis.

The implant was the unit of analysis for descriptive statistics in terms of location, implant dimensions, and radiographic measurements. The patient was the unit of measurement for the analysis of age, sex and medical history. The principal variable was implant survival and as secondary variables mesial and distal bone loss and final bone crest width achieved after transitional implant integration, before replacement, were recorded. For this purpose, the initial ridge was measured in a dental Cone-Beam performed in the planning phase and another one in the final expansion phase, in the planning Cone-Beam of the final implant. The marginal bone loss was measured on the last periapical radiograph taken with the follow-up positioner. Once the X-ray was obtained in digital format, it was calibrated using specific software (Digora for Windows, SOREDEX Digital Imaging systems) through a known length in the X-ray, such as the dental implant. Once the calibration measurement is entered, the software performs a calculation based on this measurement to eliminate the magnification, allowing linear measurements to be made free of this error. The crestal bone loss was measured at two points: mesial and distal to each implant.

A Shapiro-Wilk test was performed on the data obtained to verify the normal distribution of the sample. For the analysis of the difference between the initial and final measurements, a t-student test for paired samples was performed. The significance level was set at $p<0.05$. Implant survival was calculated using the Kaplan-Meier method. Data were analysed with SPSS v15.0 for windows (SPSS Inc., Chicago, IL, USA).

RESULTS

Thirteen patients were recruited and 30 transitional implants were inserted for width expansion in two surgical stages. These transitional implants were subsequently replaced by definitive implants at 5 months in the maxilla and at 3 months in the mandible. The mean age of the patients was 65 +/- 9.7 years and 7 patients were female. The most frequent site for transitional implant placement was position 11 with 16.7 % of cases, followed by position 13 with 13.3 % of cases. The remaining positions are shown in figure 2.

The mean initial ridge width of all two-stage split sites was 2.65 mm (+/- 0.63), range 1.32 to 3.70 mm. After placement of the transitional implants and bone healing, the final mean width of the specimen was 7.60 mm (+/- 0.26), range 4.31 to 12.20 mm. The initial and final width of each of the quantified points in the expansion zone and transitional implant placement are shown in figure 3. Most expansions were performed in the maxilla (22 cases), and except for 3 cases (single implants), all expansions were of more than one implant.

The mean mesial bone loss after loading of the final implant was 0.80 mm (+/- 0.26) and the mean distal bone loss was 0.85 mm (+/- 0.25). The mean follow-up time of the final implant after loading was 120 months (+/- 4.5) and during this time (9 years) no implant failures were observed in the implants studied, so that the survival rate can be set at 100%.

Figures 4 - 18 show one of the cases included in the study.

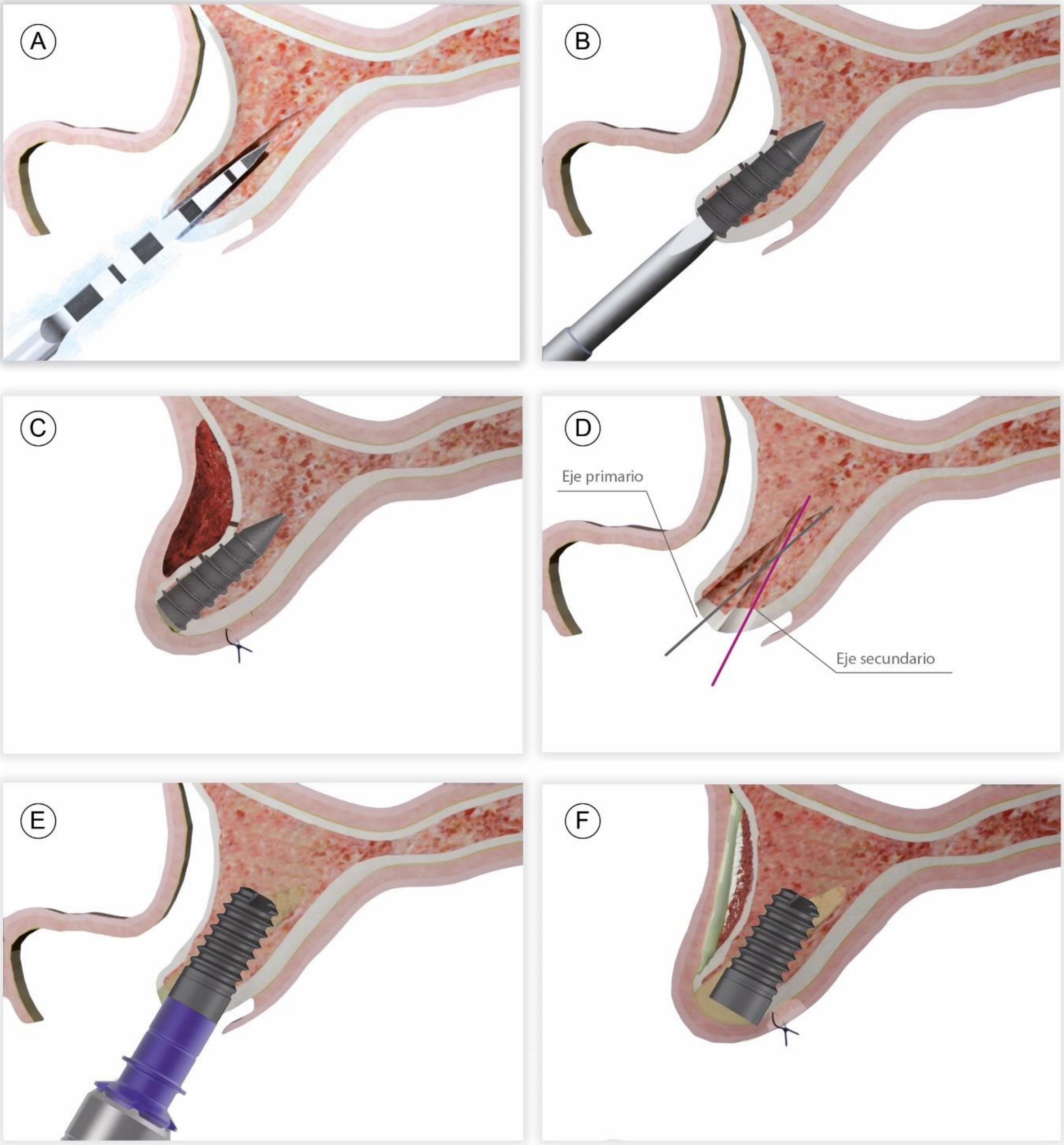


Figure 1: Two-stage split technique for ridge expansion with extreme horizontal resorption. A) Marking with a high speed drill with irrigation. B) Placement of the transitional implant after expansion with motorised expanders. C) Vestibular overcorrection with autologous bone obtained from drilling or by scraping adjacent areas D) Removal of the transitional implant and correction of the insertion axis of the new implant E) placement of the new implant in the appropriate axis. F) New vestibular over-correction with autologous bone and biomaterial embedded and compacted in PRGF-Endoret covered with autologous fibrin membranes

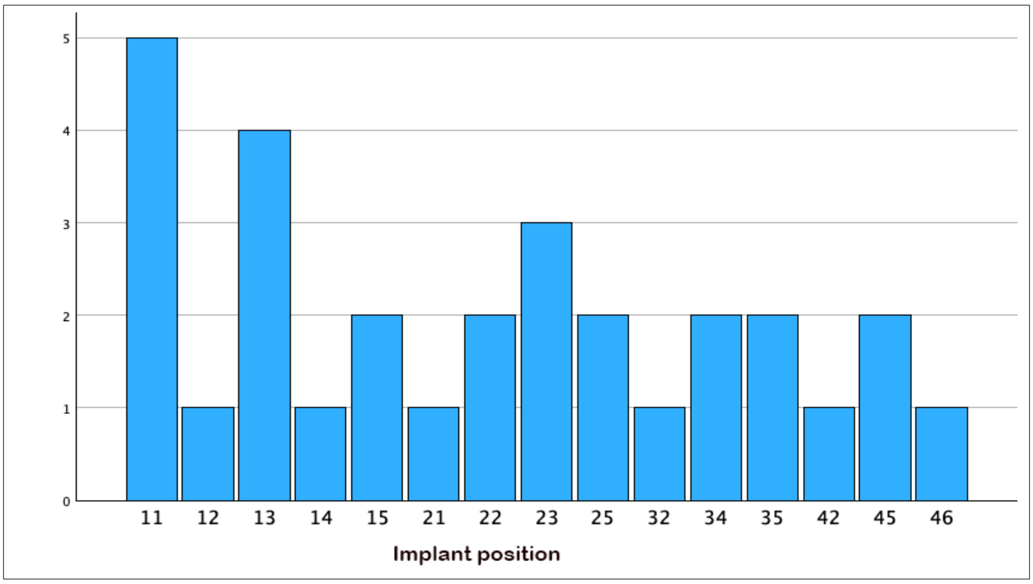


Figure 2: Placement positions of transitional implants

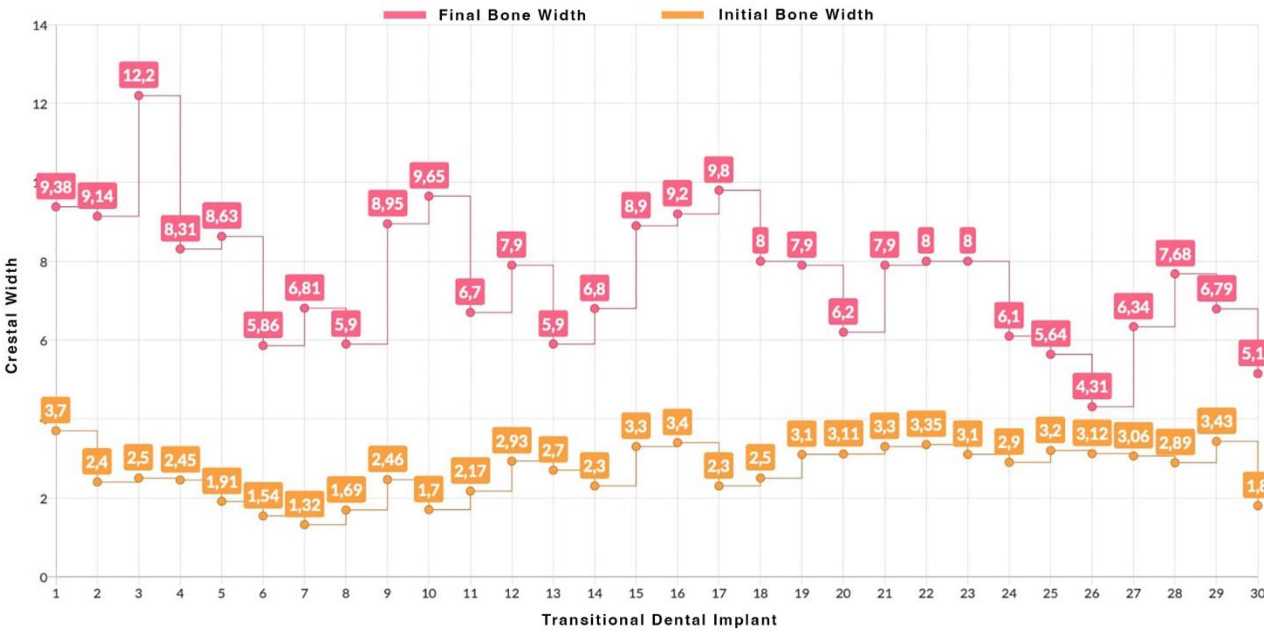


Figure 3: Initial and final widths in each of the cases included in the study

Figures 4-5: Initial images of the patient showing complete upper edentulism and a thin mucosa covering the bony ridge, suggesting that the patient is in atrophic bone

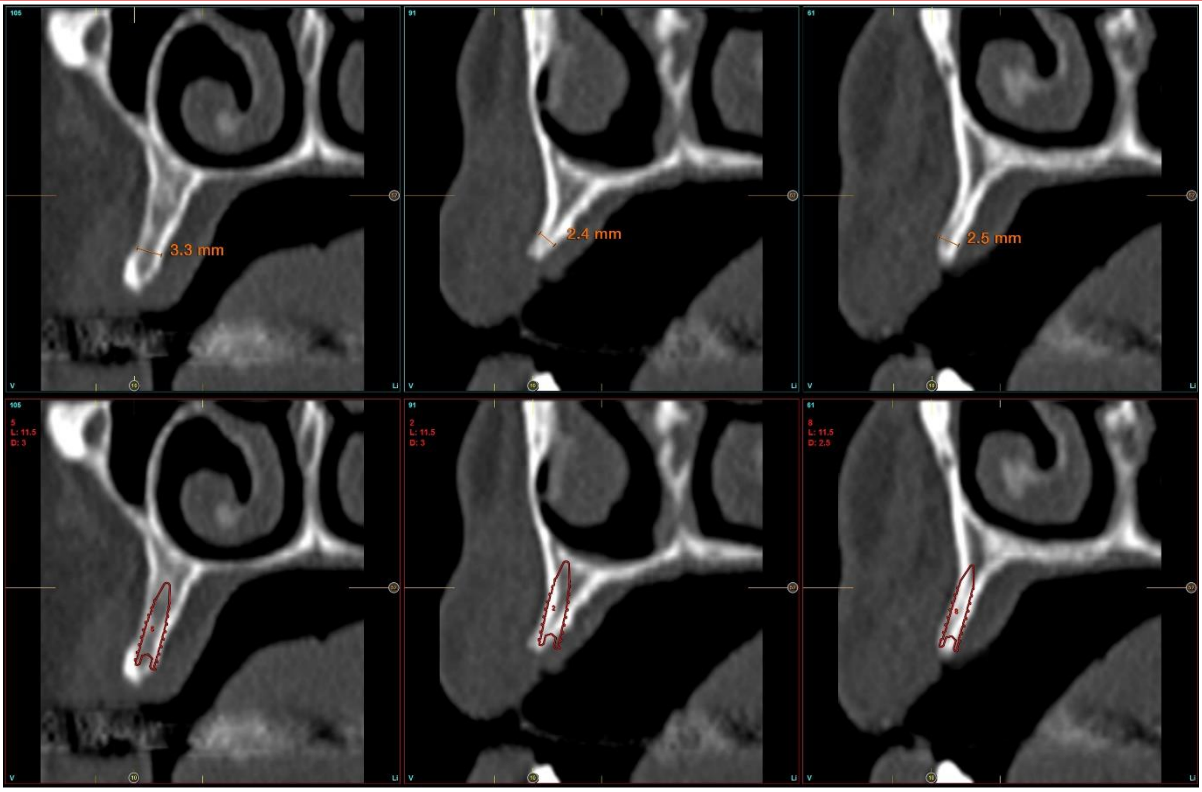
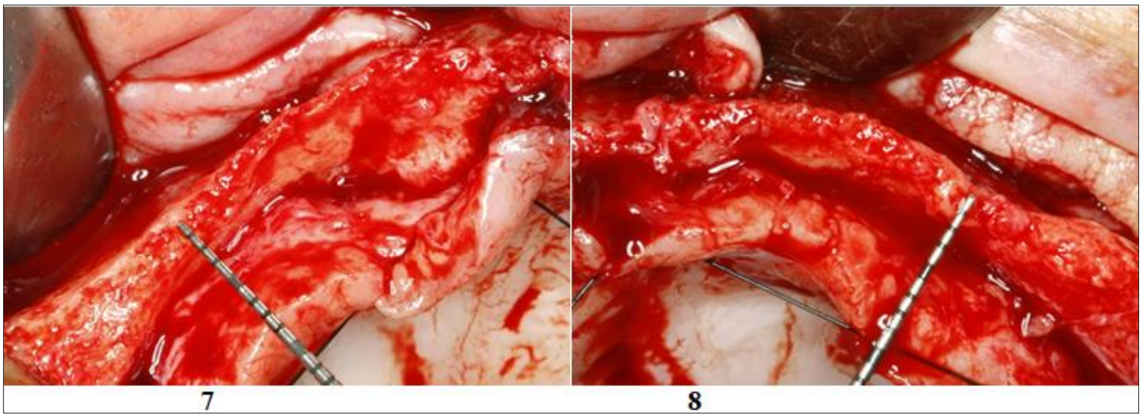
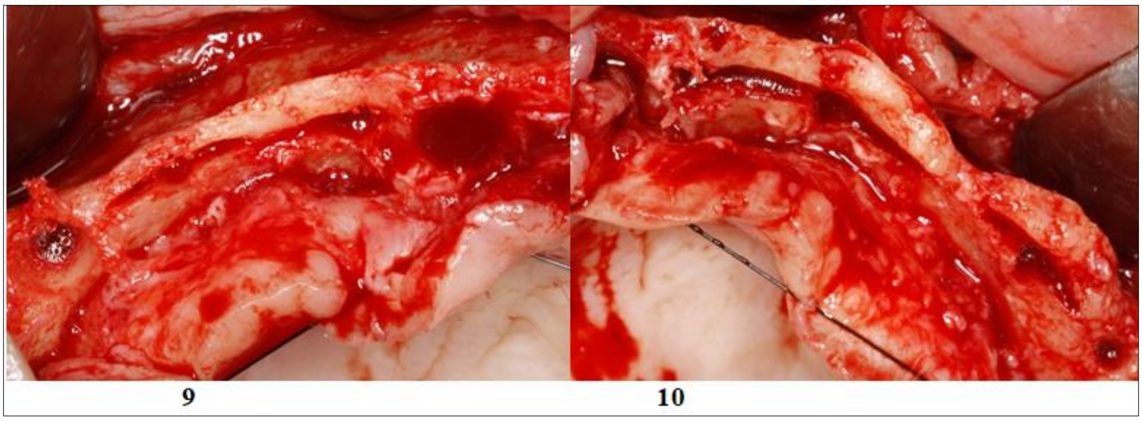


Figure 6: Sectional cuts before performing the first phase of expansion and planning of the transitional implants in position 25, 23 and 13 respectively



Figures 7-8: Intraoral images of the ridge showing the extreme horizontal atrophy of the patient



Figures 9-10: Ridge expansion performed with ultrasound and motorised expanders prior to placement of transitional implants

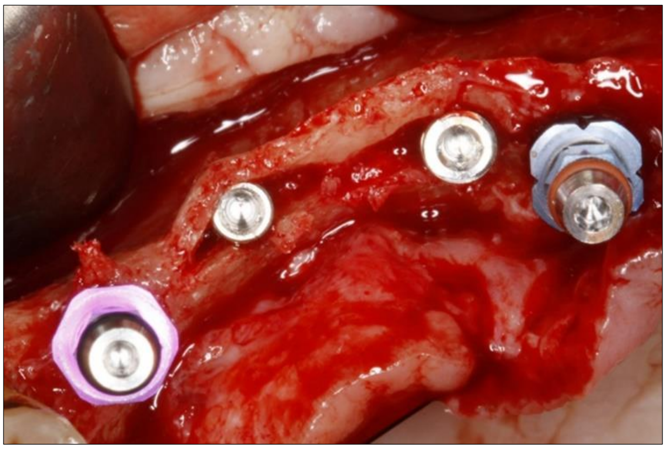


Figure 11: First quadrant transitional implants together with definitive implants, which are placed in the same surgical phase

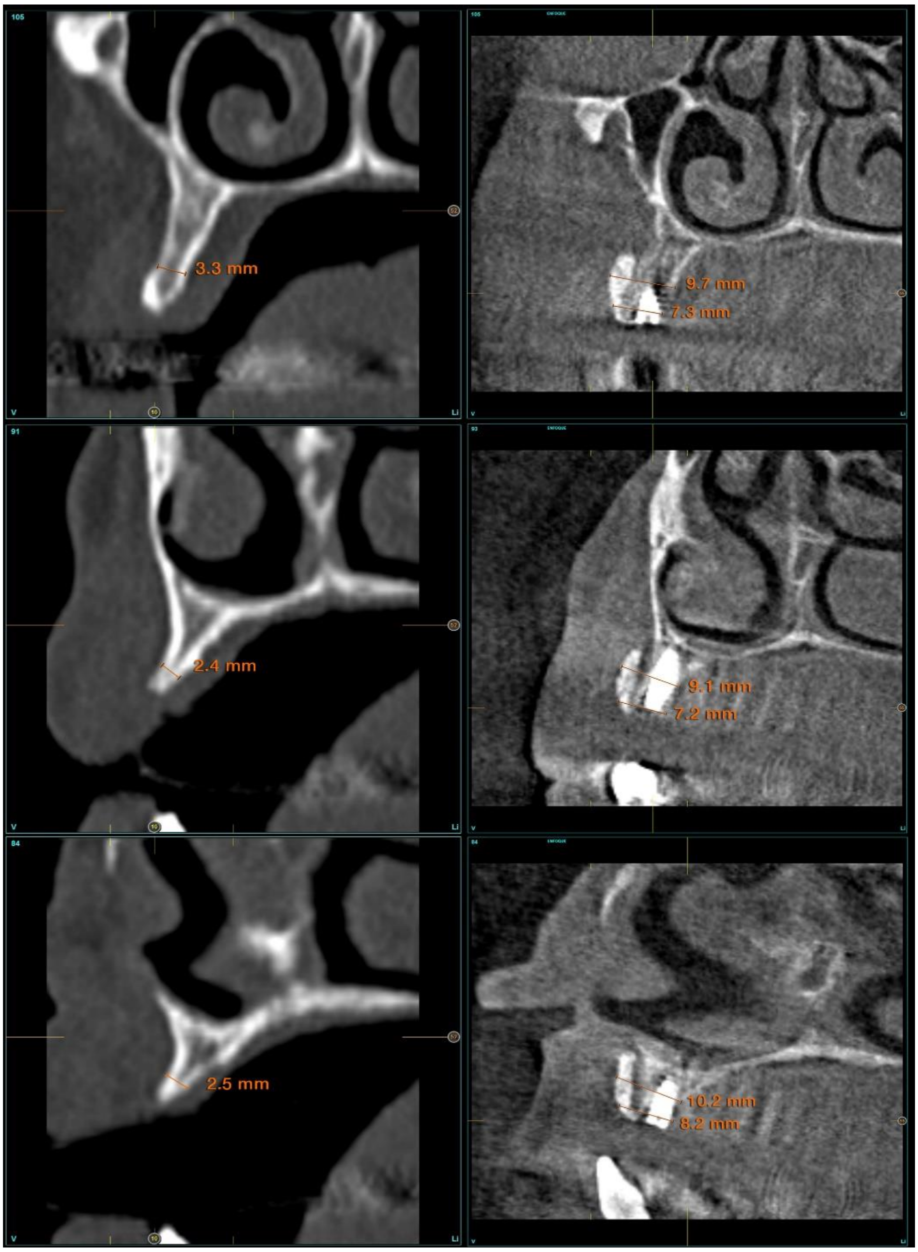
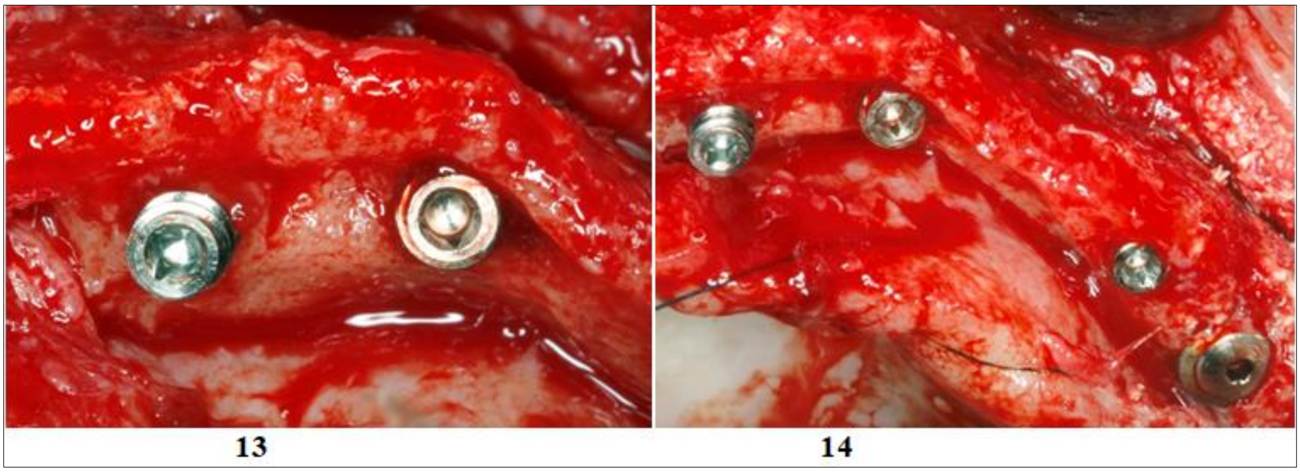


Figure 12: Comparison of the initial and final cross-section showing the gain achieved with the two-stage expansion before replacing the transitional implant



Figures 13-14: Intraoperative images of the expansion area where we directly observe the width achieved by the transitional implants, as shown in the previous cone-beam sectional cuts

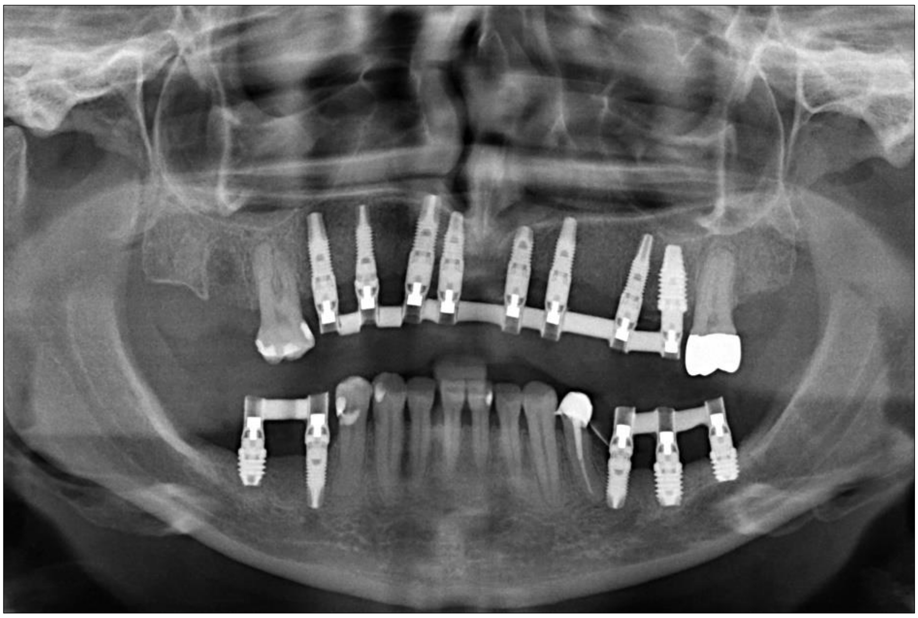


Figure 15: X-ray with the immediately loaded provisional prosthesis of the implants placed after the replacement of the transitional implants

Figures 16-17: Initial image and at 9 years. We can see how the increase in thickness of the bone crest is accompanied by an increase in the volume of the soft tissues as well

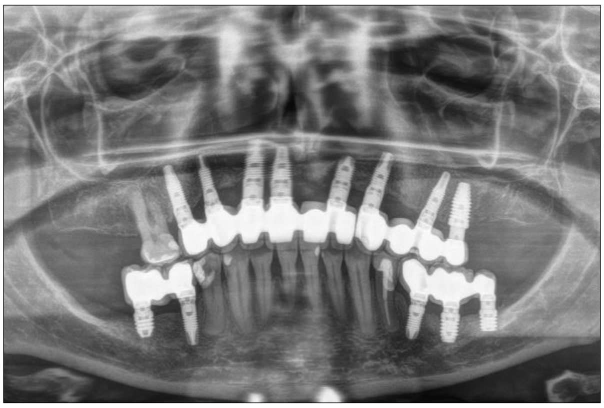


Figure 18: Panoramic X-ray at 9 years with full treatment stability and no associated bone loss in the implants placed in the two-stage expansion zones

DISCUSSION

The main advantage of the two-stage split technique shown in the present study is the correction of the angulation of the implant placed second, allowing a more predictable aesthetic restoration and the approach to more complex cases that could not be treated with the conventional split technique and a gain in width in many cases that is superior to the single-stage split [14-19]. When we focus on the quantification of the possible regeneration in the horizontal direction, achieved with all available techniques, the international literature shows a gain in width for the different techniques of 3.6 mm on average, being somewhat greater when resorbable membranes are used to cover the expansion (4.2 mm) than when non-resorbable membranes are used (2.9 mm) [20-22]. For conventional ridge expansion by splitting, the international literature reports an average bone gain of 3.61 mm for conventional surgical procedures (discs, chisels and hammers) and 3.69 mm for those cases where ultrasound was used [23]. In the work published by our study group for the two-stage split technique with transitional implants, the width of the osseous ridge was measured and the initial and final values were compared on the final computed tomography (CT) scan of the patients. The mean initial ridge width was 3.35 mm apical (+/- 1.14, range 2.68 to 5.06) and 2.74 mm occlusal (+/- 0.24, range 2.48 to 3.06 mm), while the final measurements after double ridge expansion were 10.46 mm apical (+/- 0.6, range 9.9 to 11.11 mm) and 11.23 mm occlusal (+/- 2.02, range 8.77 to 13.22 mm). Therefore, we can consider the mean ridge expansion with two-stage expansion to be 8.49 mm (+/- 1.8) and 7.10 mm (+/- 0.80) apically and occlusally, respectively [14-19]. In this study, the average gain was 5 mm, including extreme cases below 3 mm in width and some mandibular cases in posterior sectors, so we can affirm that the results obtained were satisfactory. Furthermore, the absence of failures during the follow-up period, in this case 9 years, indicates that the two-stage split is a predictable technique that can be used in cases of extreme horizontal resorption, even in the mandible and posterior sector, such as some of the cases included in the study, which may a priori be considered the most complex.

CONCLUSION

The two-stage split technique to achieve a gain in width of the residual bone crest is minimally invasive, predictable and the implants placed in the final (definitive) stage have a high survival rate, as we have seen in the present study with 9 years of follow-up.

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