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EDITORIAL

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Director *Científica Dental*

Dra. Isabel Leco Berrocal
Subdirector *Científica Dental*

Dear colleagues and readers of *Científica Dental*,

This is the seventh year that *Científica Dental* has offered this special supplement in English. It includes the best papers published over 2020 in the categories of best scientific article, best case study and best publication by a new author. A total of six papers are presented, which are the finalists of the aforementioned categories.

The subject matter of the papers is up-to-date and varied, with research papers and clinical case studies on bone regeneration and implantology, as well as original articles on the diagnosis of retained maxillary canines and the relationship between craniocervical position and occlusion. Our readers can freely access this issue at the website www.cientificadental.es

Finally, we would once again like to thank our authors for the high quality of the papers they submit, and also the copy editors and proofreaders, whose work is essential for the production of each issue of this journal, and of course our readers, for whom we offer this issue with the most significant papers published in 2020, a year that will be difficult to forget.

We hope that you enjoy your long-awaited holidays. We wish you a happy summer.

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Original article

Radiographic diagnosis of impacted maxillary canines: Comparison between two and three dimensions

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ABSTRACT

Introduction: An impacted canine is a very common condition and raises several clinical complications. Early and exact diagnosis is important in order to minimise the risks and subsequent complications. The objective of this study is to analyse the effectiveness of two dimensions in the volumetric diagnosis for impacted maxillary canines, using the lines proposed by Alqerban as a reference.

Methods: An orthodontic study of the maxilla using orthopantomography with cone beam computed tomography (CBCT) at the Madrid European University Clinic was performed on 27 patients selected with 36 maxillary impacted canines. Three reference lines were drawn based on the distance from the cusp of the canine to the occlusal plane (L1), to the midline (L2) and to its ideal eruption site (L3), in both the orthopanthomography and the CBCT. As ideal reference values, we selected a control group of 36 erupted maxillary canines.

Results: The results were compared in 2 and 3 dimensions using the Student's t test, after verifying their normal distribution using the Anderson-Darling contrast test. Statistical significance ($p > 0.05$) was not obtained for any of the variables studied.

Conclusions: The use of CBCT is vital to ensure good diagnosis of the canine position and its relationship with adjacent structures and thus establish an adequate treatment plan. However, orthopantomography provides sufficient information for initial planning.

KEYWORDS

Impacted maxillary canines; Impacted tooth; Dental inclusion; Cone beam computed tomography; Orthopantomography.

INTRODUCTION

Canines are of vital importance in facial and oral aesthetics, as well as in the functionality and development of occlusion. Both Andrews[1] with his six keys to occlusion and the latest articles by Clark[2] demonstrate the importance of the canine in occlusion. There is no doubt that the canine is one of the pillars in the ideal occlusion scheme proposed by nature. If it is in an aberrant position, it can cause alterations in the entire occlusion system. Due to its anatomy, the maxillary canine guides mandibular movements and supports the forces of occlusion, with a large crown compared to the size of the mandibular tooth itself, and is the tooth with the greatest stability. Its roots are the longest and widest, so these teeth have a firm anchorage in the alveolar bone. Clinically, canines are the teeth that should be lost last. Due to their strategic location in the mouth, they are the cornerstones of the dental arch[3].

The maxillary canine is the permanent tooth with the longest eruption path. It begins forming with a mesial tilt and rapid growth, then slows down as it straightens or even shows a slightly distal diversion.[4] This change in speed and inclination corresponds to the contact of the canine with the distal area of the lateral incisor, at approximately 9 years of age. Hence the important role played by the upper lateral incisor in the eruption of the canine. The prevalence and incidence of an impacted maxillary canine is widely reported in the literature. The earliest articles we found in this regard were by Cramer in 1929[5] and Mead in 1930[6]. These describe an incidence of 1.4% and 1.57%, respectively, after selecting a sample of American white males. Other authors expand and modify the sample, and obtain prevalences of 0.92% (Dachi[7]), 1.8% (Thilander and Jakobsson[8]), 2.2% (Thilander and Myberg[9]), 3.61% (Aitasa- lo[10]) and 2.8% (Ericson and Kurol[4,11-13]).

For the interarch position, the classification refers to maxillary canines impacted by the palatal or vestibular. According to this classification[14], Jacoby found that 92.31% of patients (a ratio of 12:1) had a palatal impaction, on later expansion of the sample, a ratio of 6.6:1, palatal vs vestibular, was found. Other authors, such as Gaulis and Joho[15] obtained a ratio lower than 2:1. The international consensus is for a ratio of 3:1. The current classification, proposed by authors such as Stivaros and Mandall[16], reduces the percentage of palatal inclusions to 61%, while vestibular inclusions appear in 5% of patients. For these authors, 34% of canines would be positioned at an intermediate point in the arch. For Rimes et al,[17] the proportion of canines impacted palatally is 44%, while those displaced in the vestibular position is 38%. Syrynska[18], however, reported 60.3% for palatal canines and 20.6% for vestibular; while 19.2% were in an intermediate position in the alveolus.

The literature suggests impaction occurs more in women than men. Dachi[7] reports 78.57%, Gashi[19] 77.10% and Bishara[20] suggests a ratio of 2:1 for maxillary canine impaction in women over men, which is confirmed by Cooke[21].

Regarding bilaterality, 8% of patients have a bilateral impaction according to Dachi[7], Bishara[20], Manne[22] and Yadav[23]. Shirazi[24], however, found no association in gender for unilateral or bilateral impaction in maxillary canines.

Most authors associate palatal inclusion with the Caucasian race, at 5.9%, while vestibular inclusion is associated with Asians, 1.7%[25-27]. The impaction ratio of Caucasian patients to African or Asian patients is 2:1, according to Peck and Peck[28]. Etiological factors associated with impacted canines are shown in Table 1.

MATERIAL AND METHODS

A total of 148 patients (76 men and 72 women) with one or both maxillary canines impacted were selected from those who underwent orthodontic studies during the Master's of Orthodontics at the University Clinic between 2009 and 2016.

The inclusion criteria were as follows: patients with impacted upper uni- or bilateral canines; over 10 years old of either sex; with a diagnostic CBCT and

Table 1. Factors associated with impacted maxillary canines[28].

LOCAL FACTORS	SYSTÉMIC FACTORS	OTHER ASSOCIATED FACTORS
• Tooth size in relation to arch size • Failure to reabsorb the root of the temporal canine • Premature loss of the temporal canine • Cysts • Root dilaceration • Absence of lateral incisor • Anatomical changes in lateral incisor size • Iatrogenic or idiopathic factors • Changes in the formation time of the lateral incisor root	• Endocrine deficiencies • Febrile illnesses • Ionising radiation	• Hereditary • Palatal cleft • Malposition of the dental germ

orthopantomography of the maxilla. The following were excluded: those with previous completed orthodontic treatment; those with agenesis or absence of one or both upper canines; agenesis or absence of one or both upper central incisors; agenesis or absence of one or both upper first premolars; syndromic patients or those with medical complications, including metabolic and/or endocrine disturbances related to eruption alterations.

A sample of 28 patients with 36 impacted maxillary canines was selected after applying the inclusion and exclusion criteria. The CBCT and orthopantomography scans performed during the orthodontic study were then analysed and a new cephalometric tracing was created by a single investigator using Nemotec 3D software. In this analysis, a series of dental and skeletal points of reference were created and selected, both in the

orthopantomography and in the CBCT, upon which planes and measurement axes were drawn according to the Alqerban method[29]. Three linear distances were measured from the cusp of the canine using these points, planes and axes: to the occlusal plane (L1); to the midline (L2); and to the canine's ideal eruption site (L3), as described in Figures 1-3 for both diagnostic methods.

A descriptive data analysis of the variables L1, L2 and L3 was carried out in 2 and 3 dimensions using the mean, standard deviation and confidence intervals.

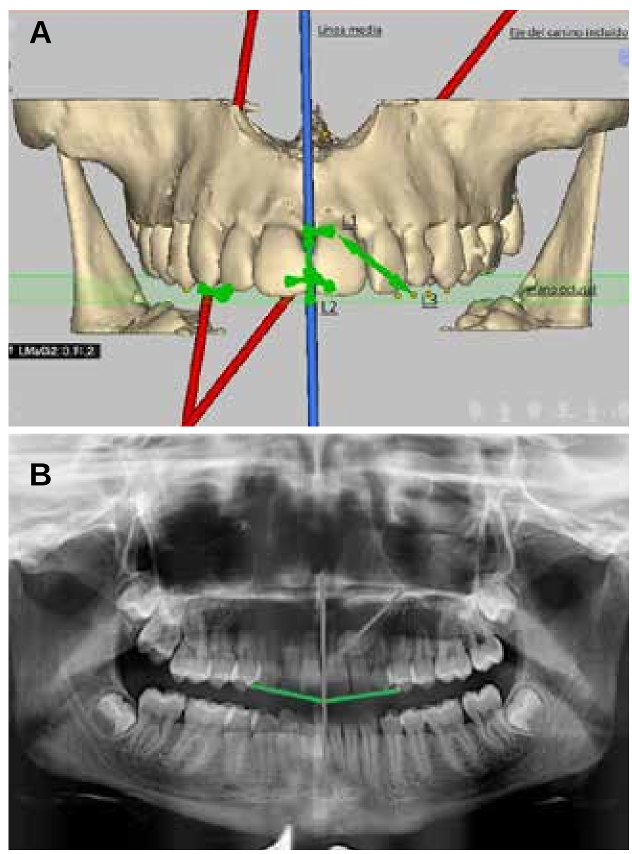

Figure 1A. Measurements, axes and planes in CBCT.
Figure 1B. Measurements, axes and planes in orthopantomography.

From these data and applying the Anderson-Darling contrast test of normality, the normal distribution of the sample was observed. The results of the radiographic methods in 2 and 3 dimensions were compared by means of the Student's t test for the difference of means.

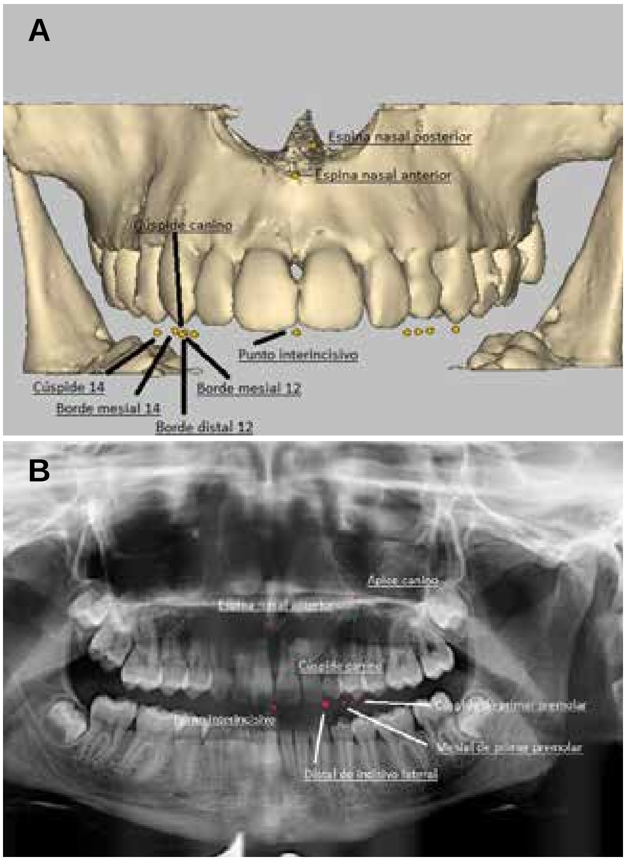

Figure 2A. Points marked on CBCT.
Figure 2B. Points marked in orthopantomography.

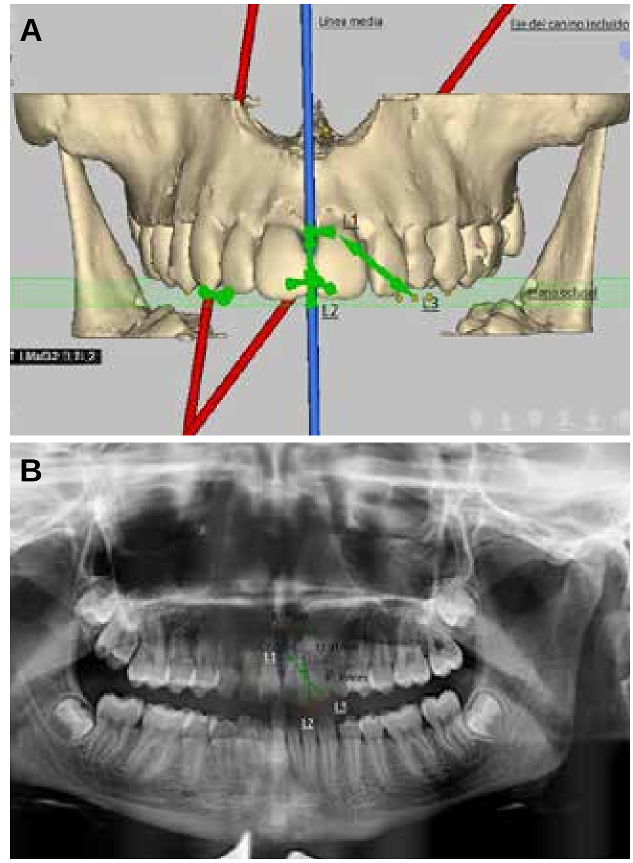

Figure 3A. Reference lines in CBCT.
Figure 3B. Reference lines in orthopantomography.

Table 2. Results for the sample of 36 canines in 3D and 2D. The value of "P" is obtained by the Student's t test.

DISTANCE VARIABLE	MEAN ($\bar{X}$) and standard deviation		P	CONFIDENCE OF INTERVAL 95%	
				Maximum	Minimum
From canine to occlusal plane (L1)	2D	13.31±3.28	0.930	14.76	11.86
	3D	13.30±4.44		14.80	11.80
From canine to midline (L2)	2D	9.35±5.90	0.914	11.35	7.35
	3D	9.04±5.26		10.82	7.26
From canine to its ideal eruption site (L3)	2D	14.84±4.16	0.620	16.25	13.43
	3D	15.31±3.94		16.65	13.98

RESULTS

The statistical analysis results for the mean, p value and confidence interval are summarised in millimetres in Table 2. As can be seen in Table 3, no statistically significant differences were obtained at a value of $p < 0.05$ for any of the three variables studied (L1, L2 and L3).

Of the three variables, L1 showed less deviation between 2D and 3D, with similar values for both. On the other hand, L2 tended to overestimate the values obtained in 2D, if it is considered that 3D measurements are "real or gold standard". The 2D values for the variable L3 tended to underestimate those in 3D. The difference in the variables prevented any attempt at obtaining a mathematical formula to calculate the degree of deviation for these measurements for any of the variables.

DISCUSSION

An impacted tooth is a pathological condition defined by its failure to erupt in the oral cavity within the time and conditions considered normal for it, based on clinical and radiographic diagnostic methods. The radiographic method of choice for initial diagnosis is orthopantomography.

However, panoramic radiography does not always provide us with all the necessary information for a proper diagnosis and planning of the case. According to Ericson and Kurol[30], panoramic radiography is not sufficient for the detection of impacted teeth, with additional diagnostic radiographic methods being necessary.

Regarding prevalence, in the study of 28 patients, 11 (39.29%) were men and 17 (60.71%) women. This gives us a greater number of patients included in the female sample with a ratio slightly lower than the 2:1 proposed by Ericson and Kuro[l30] or the 78.9% proposed by Walker in 2005[31], as shown in Figure 4. All the authors consulted obtained results similar to those seen in the classic articles, with a ratio of approximately 2:1. This ratio has been associated for years with population density, the eruptive sequence and early bone growth in females. Regarding the canine deviation trajectory, 65% of these were located palatally, which is lower than that proposed by other authors such as Walker[30], or Ericson

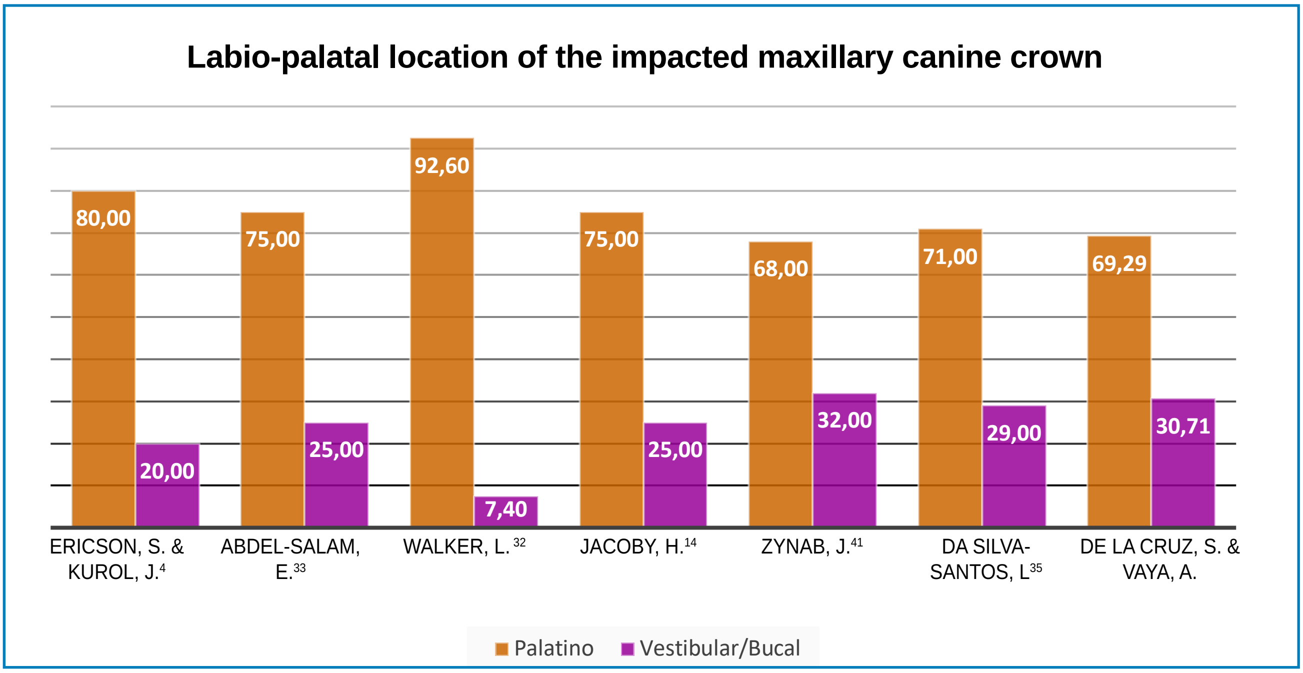

Figure 4. Distribution of the sample by labiopalatal location according to various authors.

and Kurol[32], with palatal impaction percentages of 80% and 91%, respectively; as shown in Figure 5.

As confirmed in Figure 4, all authors agree that palatal displacement of the canine is more frequent in Caucasian patients. All the samples taken in the preparation of Figure 4 refer to Caucasian, African-American or African patients. For the Asian population, there is apparently a greater predisposition to impaction vestibularly over palatally, for an as yet unknown reason[34].

Finally, the present study gave values of 67.86% for unilateral impactions, which is similar to those obtained by Da Silva-Santos[35], and clearly lower than those obtained by Dachi in 1961[36] and as compiled by Bishara in 1992[20], as shown in Figure 6.

The values for impacted canines are similar to those obtained by Alqerban. For the distance from the cusp of the canine to the midline, Alqerban obtained a mean value of 9.60 mm, while, the mean in our sample was 7.62 mm; for the distance of the impacted canine to the occlusal plane, Alqerban had a mean distance of 10.60 mm compared to 12.67 mm in our sample. Due to its condition and eruptive trajectory, the maxillary canine is a major risk factor in root resorption of the lateral incisor, so its early diagnosis not only lies in avoiding impaction of the canine, but also plays an important role in avoiding lateral incisor injury. As Stivaros demonstrated in his 2000 study[37], 2.3% of canines deviate their eruption in a higher position than normal, which is a risk factor and an indicator of lateral incisor root reabsorption.

This study shows that, compared to the 2-dimensional method, the CBCT provides us with information and clear images of the intraosseous position, inclination, morphology of the impacted tooth and the proximity and relationship of the impacted maxillary canine with various anatomical structures and root dilacerations that cannot be detected with the 2D radiographic method, as stated by Chen[2], Sawamura[38] and Walker[39] in their studies.

As we have mentioned in the results section and following, the difference in the lines and measurements proposed by Alqerban, and transferred to an orthopanthograph as a reference, are not statistically significant ($p > 0.05$), which indicates that

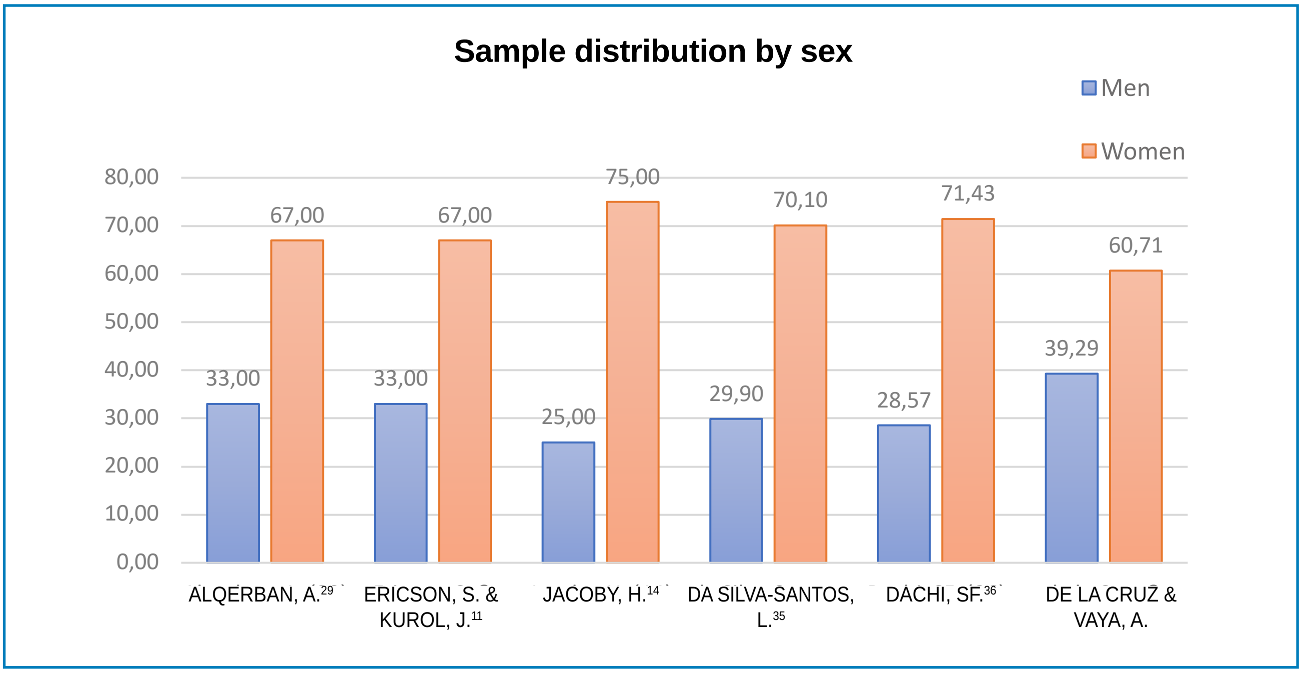

Figure 5. Comparison of the samples by sex according to various authors.

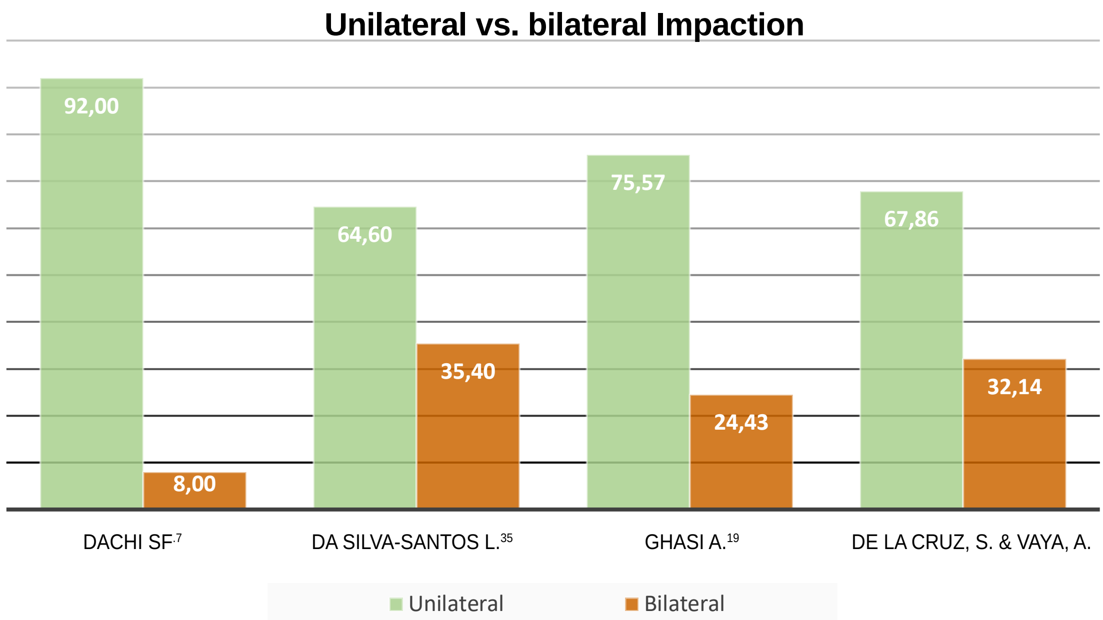

Figure 6. Distribution of the sample by unilateral or bilateral location, according to various authors.

the linear measurement performed in a CBCT or in an orthopantomography would provide the same result. For more accuracy, the data from a larger sample size would have to be studied, since our sample size is not comparable to that of other authors mentioned.

Although the diagnostic advances in image processing in recent years with CBCT represent a great advance in dentistry and, in this case, in orthodontics, the ideal diagnostic method for each patient must be chosen individually. The choice of radiographic method to be used depends on the type of treatment to be performed. With new advances, the 3-dimensional technique can select specific regions of the face, thus minimising the amount of radiation. These advances represent a double-edged sword when it comes to updating protocols and systems, since clinicians need to update their 3-dimensional knowledge to offer patients optimal treatment and diagnosis[40].

CONCLUSIONS

In evaluating the linear position of the impacted maxillary canine, orthopantomography provides sufficient information for initial planning of the case, without giving clear information on the relationship of the canine to the adjacent structures. However, CBCT remains the method of choice for diagnosing the linear and angular position of the impacted maxillary canine. This study represents a first phase in the diagnosis and planning of the treatment, with angular measurements needing to be introduced to determine the degree of impaction of the maxillary canine, as well as to predict the difficulty of treatment.

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Original article

Craniocervical position characteristics for different occlusions in developing patients: Craniocervical relationship and occlusion

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ABSTRACT

Currently, the relationship between occlusion and posture arouses great scientific interest, especially during the establishment of a multidisciplinary treatment. However, the diversity of studies refers mostly to the adult population and there is no common agreement among the different investigations. Based on this, we aimed to study the craniocervical position in different occlusions in the developing pediatric population. Through a cross-sectional design, 64 pediatric patients with complete clinical history and high-quality lateral skull radiographs were selected. The variables analyzed by *ImageJ™* and *Nemoceph™* software's were FP-MP, ANB angle, OPT-SN, CVT-SN and Ad1-Ba. Descriptive and comparative statistical analysis were carried out with IBM SPSS Statistics™ software, subsequently finding intra-examiner agreement. P-values obtained for each of these variables were 0.846 for FP-MP, 0.008 for ANB angle, 0.155 for OPT-SN, 0.415 for CVT-SN, and 0.221 for CVT-SN. Based on these results, we believe that the craniofacial position in the different occlusions could be determined by the fact that the development has not yet been completed.

KEYWORDS

Occlusion; Posture; Postural disorders; Dentofacial manifestations; Scoliosis; Cephalometry.

INTRODUCTION

The relationship between dentistry and posture has been a constant source of interest and research in recent decades[1-3]. Malocclusion is not only the result of the action of genetic and environmental factors, but also postural ones. Cervical alterations such as fusions and posterior arch deficiencies can be observed in patients with occlusal alterations[2].

However, there are several systematic reviews that demonstrate a lack of reliable scientific information on this relationship, especially in developing patients. This confusion is partly due to the great variety of methodological approaches and errors in studies carried out[4-7].

Authors such as Aranitasi et al,[2] affirm that non-syndromic patients with skeletal class II or III have a high prevalence of fusion between cervical vertebrae. According to Lippold et al,[8] there are associations between occlusion anomalies and scoliosis in preschool populations. Solow and Sonnesen[9] observed a clear association pattern between crowding of more than 2 mm and craniocervical posture in paediatric patients.

For D'Attilio et al,[10] children with skeletal class III may have a significantly lower angle of cervical lordosis compared to those of skeletal classes I and II; with a significantly greater extension of the head over the spine in class II malocclusions, when compared with skeletal classes I and III.

According to Gogola et al,[11] infants with defective postures have more marked malocclusions than those with correct body posture.

Another aspect to take into account in this area is the importance of the airway. Therefore, when evaluating the nasal pathway and oropharyngeal volumes in children and with different dentofacial skeletal patterns, it was observed that the position of the mandible with respect to the cranial base had an effect on the airway volume[12]. For Kim et al,[13] head posture in children and adolescents is associated with different craniofacial dimensions, thereby determining an aetiological respiratory component in cases with open bite.

Sidlauskiene et al,[14] analysed occlusion and general body posture in children, as well as nasopharyngeal pathology, such as deviations in the nasal septum, hypertrophy of adenoids, tonsils and allergic rhinitis. They found a statistically significant relationship between the presence of a kyphotic posture and a reduction in the SNB angle, representing the sagittal position of the jaw; and a statistically significant association between kyphotic posture and nasopharyngeal obstruction.

Rocha et al,[3] when evaluating the mode of respiration, occlusion and posture parameters in children and adolescents, observed a lower position of the hyoid bone with respect to the plane of the jaw in some study groups with oral respiration. For Silvestrini et al,[15] postural, orthoptic, osteopathic and occlusion variables were often clinically associated in children; therefore, all these disorders seem to require a multidisciplinary medical approach for their treatment.

These aforementioned precedents demonstrate that the relationship between occlusion and posture has been a continuing source of interest for all professionals in the provision of health care over the last decades. According to Perinetti[16], this importance lies in the fact that dental malocclusion is very highly prevalent among children; therefore, its potential negative effects on body posture could provide other indications for orthodontic treatments.

The lack of consensus among different investigations and the few studies in developing patients invites us to study the craniocervical position in different occlusions in this population.

MATERIALS AND METHODS

After obtaining informed consent and the approval of the Clinical Research Ethics Committee, a cross-sectional study was carried out on paediatric patients with the following selection criteria: being 6-years old with a complete medical history and lateral skull x-rays, non-syndromic, without craniofacial malformations or a surgical history of the upper airway, who had

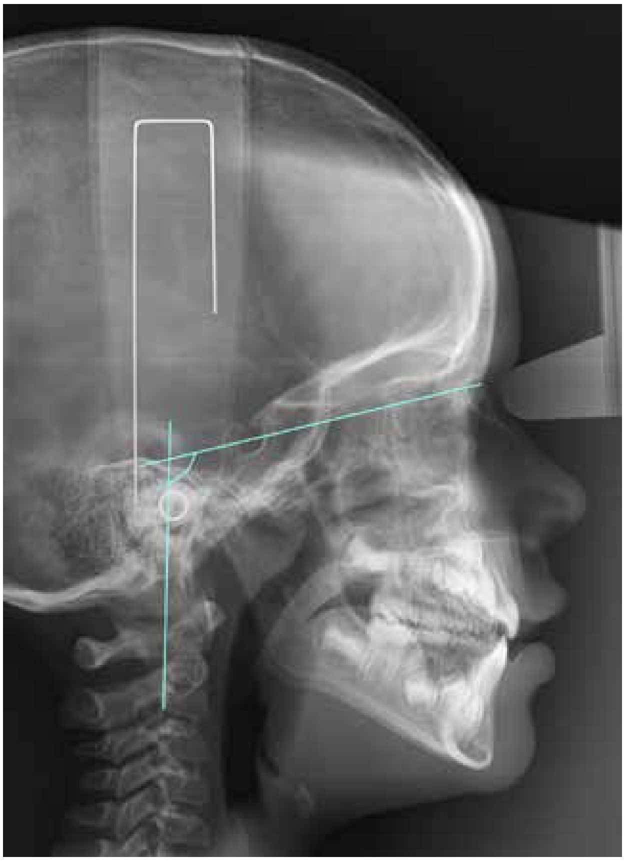

Figure 1. Graphic representation of the OPT-SN angle.

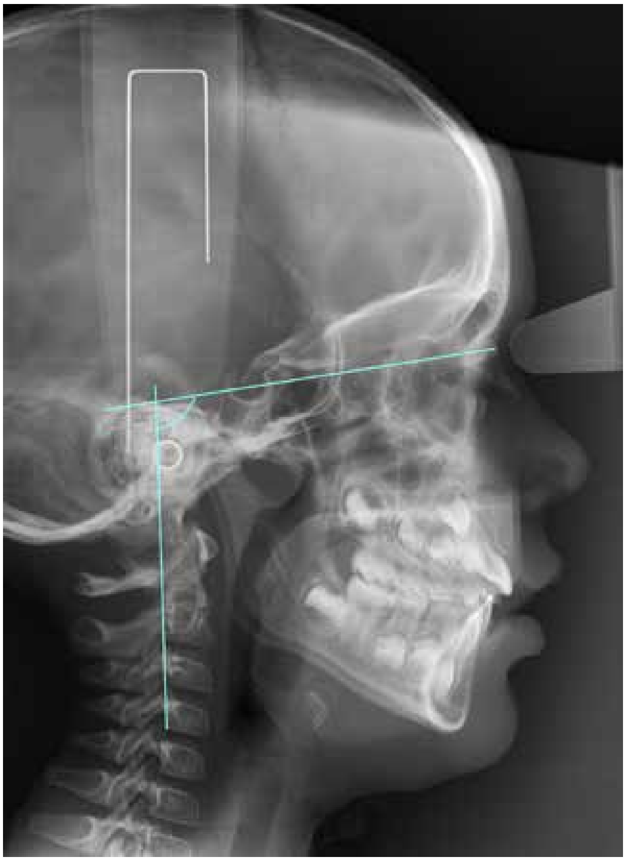

Figure 2. Graphic representation of the CVT-SN angle.

not received orthodontic treatments and with lateral skull radiographs without distortion, enlargement, superposition of structures or difficulty in identifying and recording anatomical points. No contact was made with the sample for this study, with only the medical history data and radiographic records being reviewed.

The growth predisposition pattern was quantitatively determined using the FP-MP cephalometric parameter, defined as the angle formed between the facial and mandibular planes. Skeletal class was diagnosed through Steiner's analysis using the ANB angle measurement.

Craniocervical posture was assessed via the variables OPT-SN, which refer to the angle formed by SN and the line that runs through the most postero-superior and postero-inferior point of the odontoid process (Figure 1).

Another variable studied was the CVT-SN, which is the angle formed between SN and the line that runs through the postero-superior and postero-inferior points of the four cervical vertebrae (Figure 2).

Finally, the distance was measured between the intersection point of the posterior pharyngeal wall and the line formed between the posterior nasal spine along with the basion (Ad1-Ba), refer to Figure 3.

All these study variables were obtained after calibration of the radiographs, using the length of the metal rods as a reference point, after locating and establishing the structural reference points; by using ImageJ™ and Nemoceph™ software. Finally, the results of the variables were tabulated for each of the selected subjects.

The measurement for each radiographic record took around 40 minutes on average. To detect any errors in intra-examiner identification, 10% of the records studied were randomly selected and measured 2 weeks later.

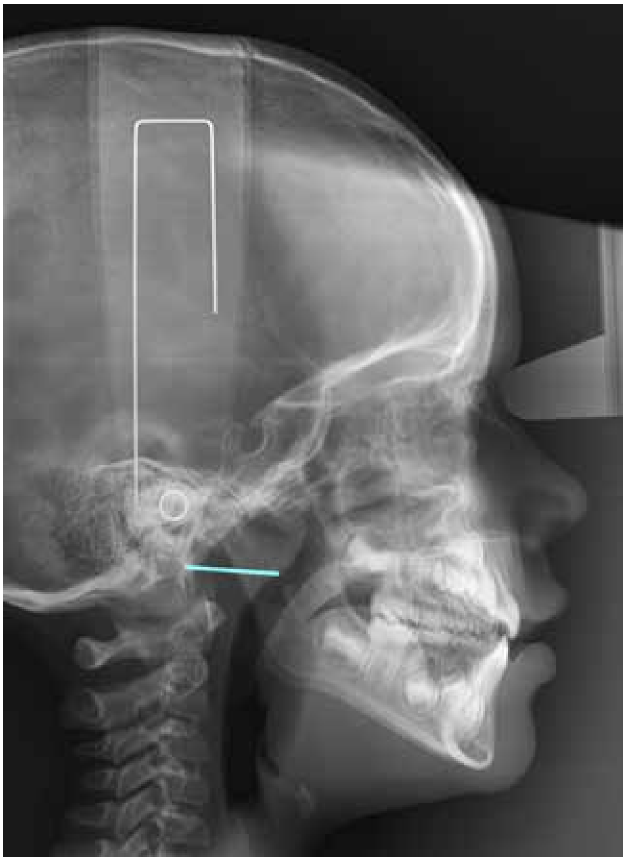

Figure 3. Graphic representation of the variable Ad1-Ba.

The data were analysed by descriptive and comparative statistical methods using the IBM SPSS™ program. The quantitative variables were described using the mean and standard deviation, and the difference in means was analysed by using either Student's t test, for variables that had a normal distribution, or the Mann Whitney U test, for those that did not; with $p < 0.05$.

RESULTS

Data from 64 patients was collected, of which 31 (48%) had Steiner cephalometric values of ANB class I and 33 (52%) were class II. The table shows the results obtained in relation to the study parameters. Of all the variables measured, there was only significance for the values relative to ANB (p = 0.008). Intra-examiner agreement was calculated using the Kappa index and was 100%.

DISCUSSION

Studies reviewed in the literature with comparable samples were Rocha et al,[3] Solow and Sonnesen[9], D'Attilio et al,[10] Arntsen and Sonnesen[17], Kim et al,[13] and Gogola et al,[11] since the subjects in these studies were of a similar age to those in our study.

For sample size, Perinetti, and Tardieu et al,[18] had a smaller sample than ours, 20 and 26 subjects, respectively; Castro-Silva et al,[19] had a similar sample size to ours, 60 participants; while Arntsen and Sonnesen[17], Ei and Palomo[12], Silvestrini et al,[15]

Table. Growth pattern: values for maxilo-mandibular. craniocervical posture and the AD1-Ba variable. Mean. standard deviation. maximum and minimum confidence intervals and p-value.

Parameter	Variable	Class I						Class II						p value
		Mean	Standard deviation	Maximum	Minimum	Confidence Interval 95% maximum	Confidence Interval 95% minimum	Mean	Standard deviation	Maximum	Minimum	Confidence Interval 95% maximum	Confidence Interval 95% minimum	
Growth pattern	FP-MP (º)	67.32	3.46	74.19	60.45	68.59	66.05	67.71	3.75	76.68	60.26	69.04	66.38	0.846
Maxilo- Mandibular	ANB (º)	2.5	1.09	3.96	0.34	2.89	2.09	6.37	1.99	12.85	4.05	7.08	5.66	0.008
Craniocervical postur	OPT-SN (º)	97.9	7.96	114.7	83.61	100.82	94.98	96.89	16.31	115.16	19.69	102.67	91.1	0.155
	CVT-SN (º)	98.01	7.64	113.96	85.02	100.81	95.2	99.06	8.56	114.46	84.34	102.09	96.02	0.415
Adl-Ba variable	Ad1-Ba (mm)	21.53	3.2	27.79	13.26	22.71	20.36	23.6	11.49	84.89	13.13	27.68	19.53	0.221

Kim et al,[13] Gogola et al,[11] Sidlauskas[14], Solow and Sonnesen[9], D'Attilio et al,[10] and Rocha et al,[3] had larger samples than ours: ranging from 94 in Sidlauskas[14] up to 605 subjects in Silvestrini et al.[15]

Although the majority of the posture and occlusion studies shared a common feature with ours in being cross-sectional studies, the methodology, variables and approach given in the objectives were different in all.

The D'Attiiio et al study[10] investigated the differences between cervical posture and skeletal classes and, although we shared the software used in this study, we did not agree with the posture parameters.

Perinetti[16] determined this relationship through posturography. This research was different from ours; not only in the sample study variables and age, but also in being designed to determine a dynamic relationship between both variables.

However, Tardieu et al,[18] investigated the influence of an occlusion disturbance on posture control according to the difficulty of the requested task. In our study there was no direct contact with patients and this task was not required.

Arntsen and Sonnesen[17] associated both study parameters by examining the cervical column and craniofacial morphoiogy in subjects with class II malocclusion and overjet; they also used different software to ours (TIOPS 2005™). Meanwhile, Silvestrini et al,[15] added parameters such as ocular convergence to the studied relationship.

Kim et al,[13] designed a study where the morphology of the cervical spine was described for the first time in children and adolescents with open bite. Our research did not take into account the occlusion alteration in the vertical plane and had different study variables. Gogoia et al,[11] used different occlusion parameters as well as an approach to the posture of the craniocervical area.

Sidiauskas[14] investigated the relationship between occlusion and the patient's general body posture, also including nasopharyngeal pathology, such as deviations in the nasal septum, hypertrophy of the adenoids and tonsils, and allergic rhinitis. However, in our study neither the general body posture nor nasal pathology was evaluated.

Rocha et al,[3] included oral or nasal breathing mode, in addition to the occlusion and posture relationship, and was the most similar study to ours in terms of variables; they used the Ortho TP™ orthodontic software and an airflow sensor for the digital e-Health Platform™. In subjects aged 7-9 years, they also found no statistically significant results in relation to posture a similitude with us. There is some similarity between the two in relation to some descriptive results. The values corresponding to variable FP-MP, regarding the facial growth pattern, were 66.81 and 67.03 for group I in the Rocha et al study[3] , while they were 67.3 and 67.1 for classes I and II, respectively, in our study. Their ANB parameters were 2.06 and 4.25, while in our study they were 2.49 for class I and 6.37 for class II.

CONCLUSIONS

The craniocervical parameters in both occlusions lacked statistical significance; thus a larger sample size study is required. Also, perhaps the young age of the population meant that this relationship was not so obvious.

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Clinical case

Atrophic posterior maxilla: sinus elevation with lateral approach Vs. Extra-short implants. Clinical case with eight years of follow-up

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ABSTRACT

Vertical bone loss in the posterior maxillary sectors is a frequent occurrence after tooth extraction. These areas can often be rehabilitated using regeneration techniques or by opting for a more conservative approach with short implants.

The present clinical case shows bilateral rehabilitation with two different techniques: sinus lift and the insertion of short implants, with a follow-up of 8 years where both techniques have achieved equally predictable results.

KEYWORDS

Short implants; Sinus lift; Atrophic maxilla.

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INTRODUCTION

Approaching the posterior sectors of the maxilla with extreme resorption is a common situation in dental practice. The loss of antral teeth produces pneumatisation of the maxillary sinus, which progressively occupies the space corresponding to the dental roots, in some cases leading to complete atrophy and in a residual bone height of 1-2 mm after the dental socket heals. This pneumatisation occurs over time after tooth extraction, but is unpredictable in terms of quantity and speed, and appears to be slightly related to the type of relationship that occurs between the apex and the sinus. This relationship was described by Sharan and Madjar in 2008, who established a classification with greater pneumatisation is expected in its types 3 and 4 (Figure 1)[1].

Until the arrival of short and extra-short implants, the only alternative treatment in these cases was sinus elevation (laterally or transcrestally), and there were different techniques and procedures for this. The attempt was to gain the lost bone volume and the subsequent insertion of conventional length implants at this level[2-6].

The development of short implants and the entire technique for their use sometimes allows the insertion of implants in large posterior vertical atrophies of the maxilla, avoiding sinus elevations.

Nowadays, most authors accept short implants to be those with a length less than 8.5 mm, although there are many cases of lengths well below this figure[7-9]. Extra-short implants, meanwhile, have more variation in terms of their classification; although the latest articles published consider extra-short implants to be those with a length less than 7 mm[10-12]. These shorter implants mean less morbidity for patients, at the same time as it is now possible to rehabilitate patients who may refuse to have additional techniques performed. These are sinus elevation and even more complex techniques which may be contraindicated in these patients for different medical reasons[13-17]. These short and extra-short implants can be inserted in the atrophic areas of the maxilla directly without displacement of the lower sinus cortex and without therefore having to manoeuvre the maxillary sinus. The main surgical challenge with this technique is to

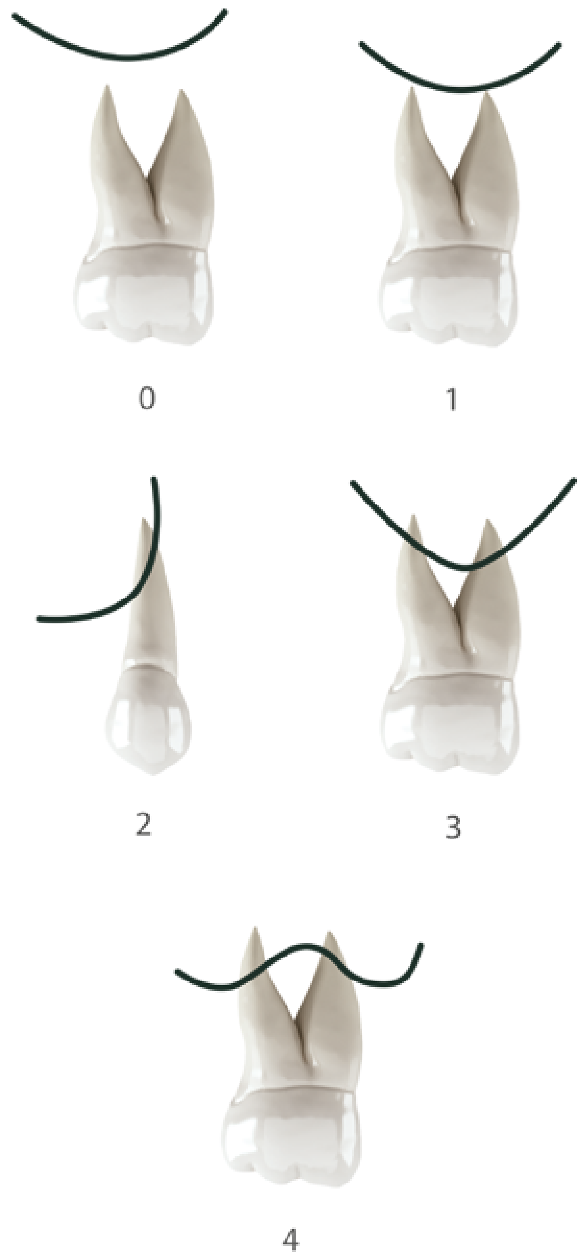


Figure 1. Different associations of the roots of the antral teeth and the floor of the maxillary sinus.

Type 0: The root is not in contact with the sinus cortex.
Type 1: The sinus cortex is less convex and makes slight contact with the upper area of the root apex.
Type 3: The sinus cortex describes a curve of lower convexity and the apices of the roots of the antral teeth project into the sinus.
Type 4: The sinus cortex is less concave surrounding the apices of the antral teeth, and there may be a slight prolongation of the root apices inside the sinus.

achieve implant stability, since generally in these cases we are faced with little remaining bone height and with high porosity[18-22]. Therefore, the establishment of a careful surgical protocol based on drilling into the receptor bed depending on its condition is key to the success of these treatments[13-17].

Figure 2. Initial radiographic image, showing the poor prognosis of teeth 16 and 17.

Figure 3

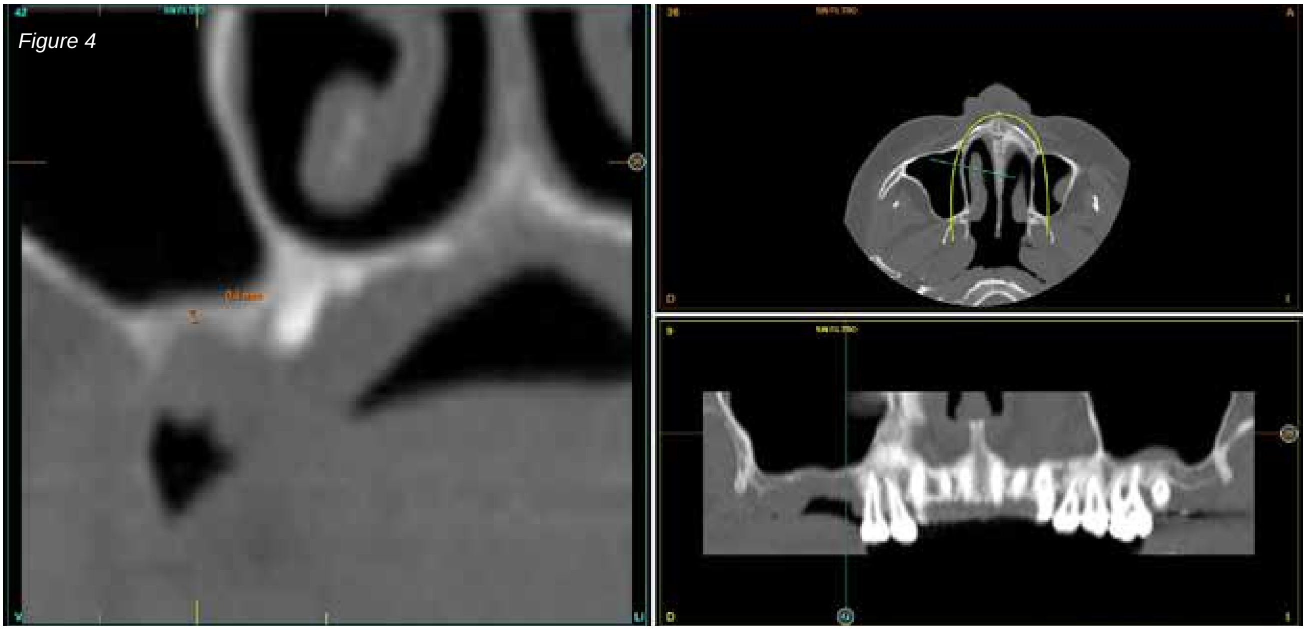


Figure 4

Figures 3 and 4. Images of the planning CT showing not enough height for insertion of the implants directly, so a sinus lift had to be carried out using a lateral approach.

The clinical case described is of a patient receiving both procedures: extra-short implants inserted directly into one maxillary quadrant and a sinus lift with conventional length implants in the other quadrant. The evolution of both treatments in the same patient was able to be observed over eight years.

CLINICAL CASE

This was the case of a 58-year-old female patient who attended the dentist practice to assess the 16th and 17th molars for pain and mobility. On clinical examination, mobility of both was observed with suppuration at the level of the sulcus. Radiography confirmed our diagnosis of considerable bone loss and sinus perforation at the apex of both molars (Figure 2).

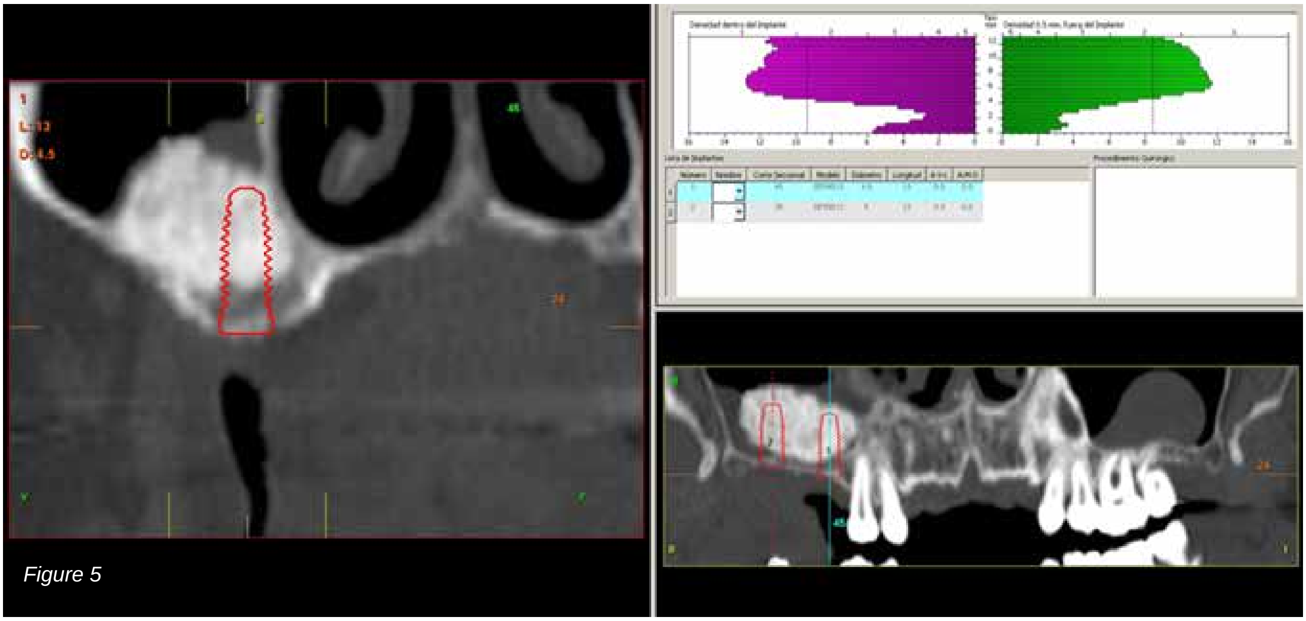


Figure 5

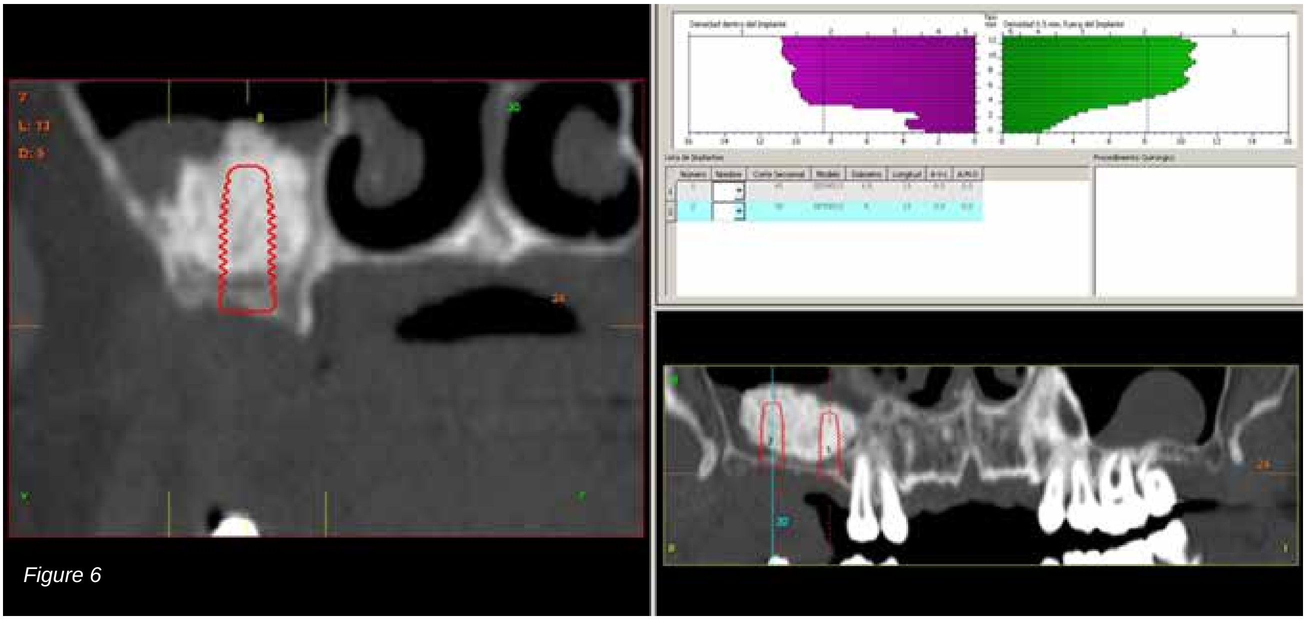


Figure 6

Figures 5 and 6. CT images after sinus lift, 6 months later, for planning the implants to be inserted.

Both teeth were extracted and alveoli regenerated with PRGF-Endoret to seal the perforation and provide the most favourable evolution possible for subsequent insertion of the implants in the area.

After two months, the dental cone-beam showed the perforation had closed completely but the residual bone volume provided 2 mm of bone height only, which was insufficient to insert the implants (Figures 3 and 4).

Therefore, it was decided to carry out a sinus lift using biomaterial (bovine hydroxyapatite) bound to PRGF-Endoret. The elevation was performed and after five months a new dental cone beam displayed the quantity and quality of the graft obtained for the insertion of dental implants. In the cuts corresponding to the molars of the first quadrant, we observed excellent consolidation of the graft with space to insert 13 mm implants. Today, we would not choose this implant length, since studies published by our group with short and extra-short implants support their use, in addition to showing their diameter is more important than the length to distribute the loads of an already integrated implant; where an 8.5 mm length implant would work in the same way as a 13 mm implant of the same diameter[18].

Back in 2007, the therapeutic protocol for these cases was very different (Figures 5-7), with short implants without full development - and without studies demonstrating the importance of diameter over implant length - efforts were focused on the search for anchorage by implant length instead of looking for the bicortical (vestibular-lingual) stability that short and wide implants perform. During this time, the failure of molars 46 and 47 also occurred; these were also extracted and replaced with dental implants.

Six months after implant placement, the final prosthesis was made by using a cemented bridge. This prosthetic protocol is also not one we currently use, where tightness, sealing and the use of screw-retained prostheses using an intermediate or transepithelial component prevail. However, at that time, this type of rehabilitation and the conformation of a “bio” emergence profile in the abutments was how these cases were treated (Figure 8)[13-18]. The implementation of transepithelial implants in screw-retained prostheses opens a new horizon in the prosthesis, changing our working group protocol of towards an improvement in the implant-prosthesis seal, at the same time as prosthetic imbalance is reduced (due to taking the impression directly on the transepithelial and not on the implant connection) and tightness is improved; which reduces the risk of peri-implantitis, among other things[19-20].

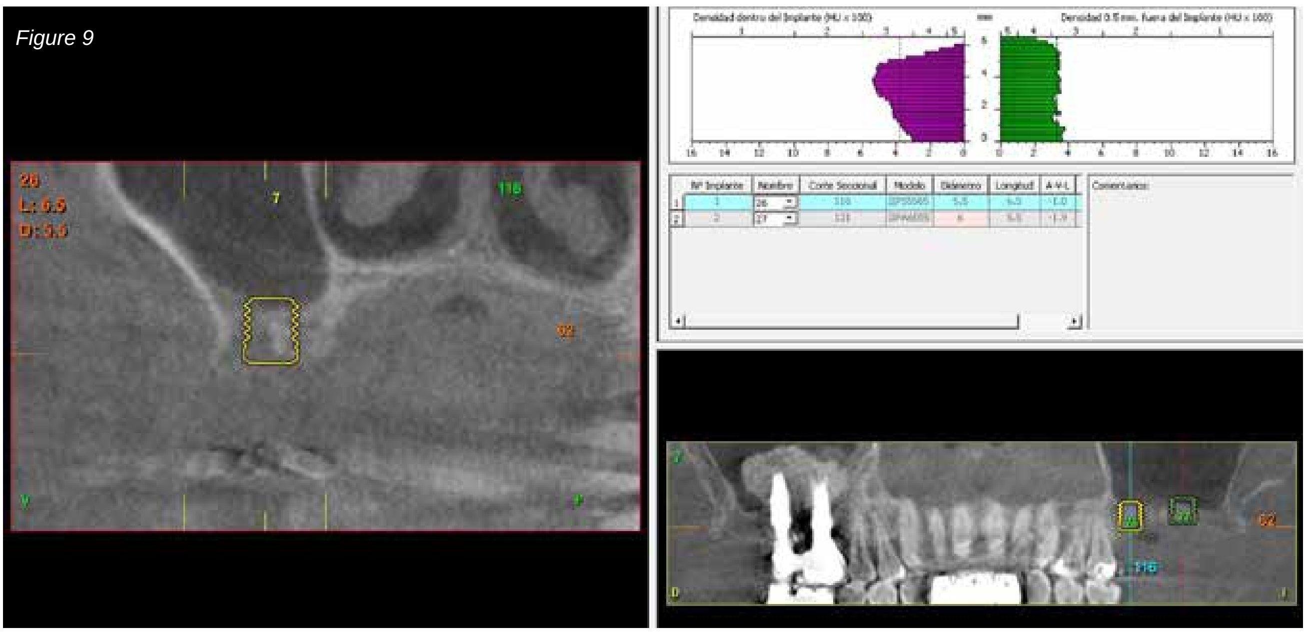
After 4 years, the second and third quadrant molars began to have excessive mobility and serious periodontal problems, so it was decided to remove them and regenerate the alveoli with PRGF-Endoret. Once the area was regenerated (a month and a half later), a cone-beam was performed to evaluate the residual bone volume. It can be seen how there was an uneven bone crest with areas of 3.3 mm in height up to a maximum of 7 mm (Figures 9 and 10). On this occasion, due to the protocol change described above, we opted for the

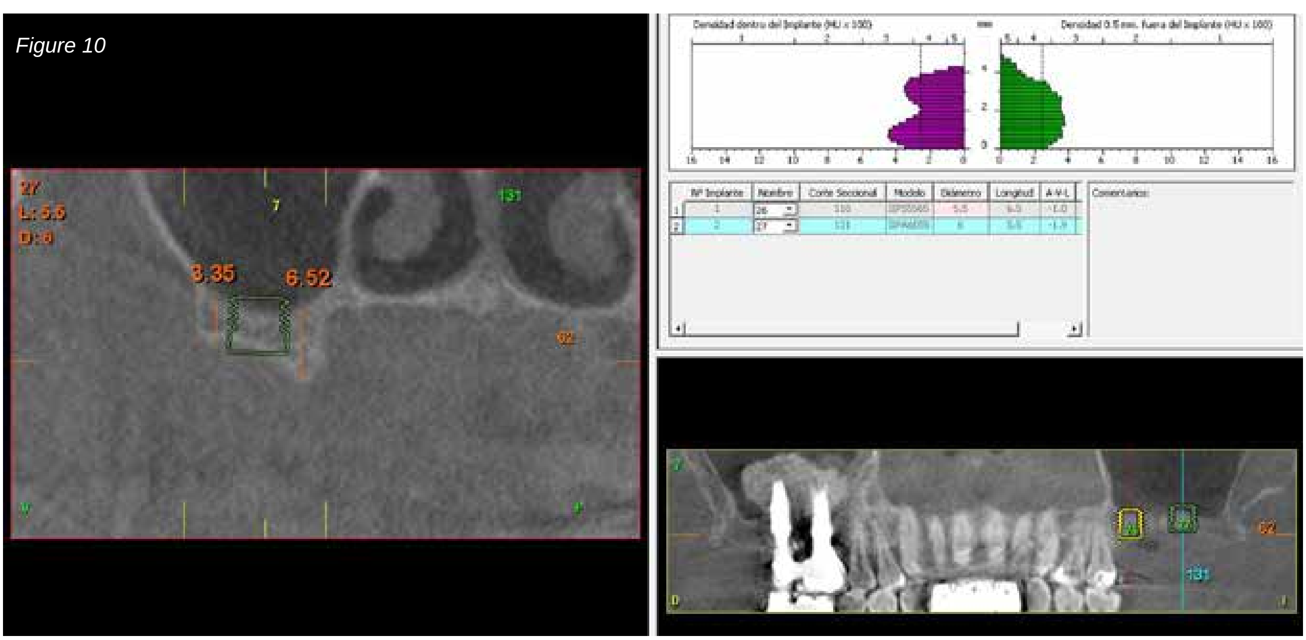
Figure 7. Final radiograph after insertion of the upper implants.

Figure 8. Radiograph with the final cemented prosthesis.

direct insertion of extra-short implants, since the surgical protocols to address this type of situation in 2011 varied substantially, with these implants being a first-line tool for the treatment of this type of atrophy (Figure 11). Two extra-short implants were selected (5.5 mm diameter x 6.5 mm length for tooth 26, and 6 mm diameter x 5.5 mm length for tooth 27).

Six months after the insertion of the extra-short implants, the final prosthesis was inserted; in this case, screwed and with an intermediate (transepithelial) component; just as the lower prosthesis in the third quadrant was made. At this point in time, the philosophy of work using a screw-retained prosthesis with a transepithelial and the search for tightness and passive fit were the dominant concerns for implant rehabilitation, and this is still so today (Figure 12).





Figures 9 and 10. Sections of the planning CT scan of the area corresponding to the second quadrant, where the molars were also lost, with severe vertical atrophy after extraction and regeneration. Nowadays, the concept of rehabilitation of these sectors has changed and short implants without a sinus approach is planned..

Finally, the stability of both treatments can be seen in the final X-ray at 8 years of age, where both are stable without bone loss (Figure 13).

DISCUSSION

Therapeutic protocols in implantology have evolved markedly in recent years, moving towards minimally invasive approaches, without renouncing reliability. Therefore, short and extra-short implants are an option used increasingly to avoid aggressive surgeries with high morbidity, and are also an alternative for the rehabilitation of the atrophic posterior maxilla in height, avoiding having to use techniques to lift the sinus when the residual bone height allows[15-17].

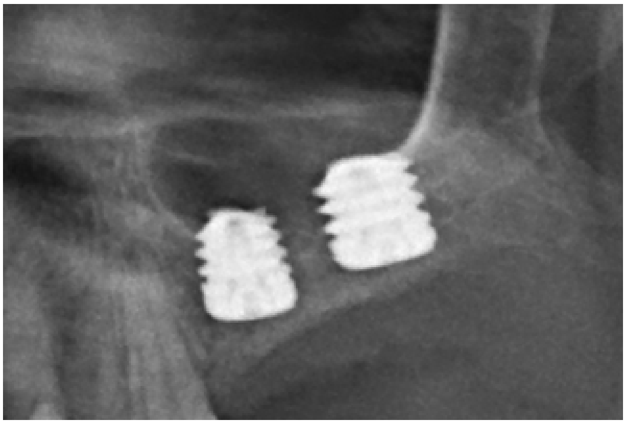


Figure 11. Radiograph after insertion of the upper extra-short implants.

Since the description of the conventional sinus lifting technique (lateral window) by Tatum in 1986[22], this procedure has been used for the rehabilitation of posterior maxillary sectors with vertical atrophy, with highly successful rates, currently around 98%, and long-term follow-up (over 15 years)[26-27]. A drawback of this technique is that it can cause perforation of the Schneiderian membrane and, although today this is no longer an exclusion for the insertion of implants in the same surgery (depending on the extent of the perforation and the case), when this perforation occurs, the success rates of implants inserted in these areas decreases to 88.6%[6]. In addition, the need for several surgeries together with a greater increase in patient morbidity, make us opt for less invasive techniques, such as short implants. When inserted in edentulous posterior sectors with elevated vertical resorption, these implants have a lower rate of surgical and prosthetic complications and less marginal bone loss; they are therefore a reliable alternative to bone augmentation procedures and subsequent implant insertion[28].

Summers in 1994 described the first variation of the lateral approach technique with a modification to reduce its invasiveness. This technique consists of an approach from the alveolar crest through the use of progressive calibre osteotomes that make a hole that serves both for the elevation of the Schneiderian membrane and the subsequent placement of the dental implant[29]. This

Figure 12. Transepithelial screw-retained prosthesis, 6 months after implant insertion surgery. As can be seen in the prosthesis, we have also made a significant conceptual change, with respect to the one performed in the first quadrant.

Figure 13. Final X-ray at 8 years of follow-up with stability in both therapeutic options, with the difference in the morbidity of both techniques and the times, which have been drastically reduced with the use of short

technique has been widely used for the crestal approach of the extreme posterior resorption of the maxilla, with survival figures of the inserted implants between 88.65%[30] and 100%[31].

Other techniques have been used to approach the atrophic posterior maxilla to varying degrees; such as bone distraction, zygomatic implants, en bloc grafts and guided bone regeneration. All of them have similar success rates to the two shown in this clinical case; with the short and extra-short implants being the ones with the lowest rate of complications and morbidity for the patient[32-35].

Long-term survival of short implants also has a very similar rate to that of long implants with sinus lift; therefore, both can be considered as the technique of choice. However, from the point of view of morbidity, the short implants are the better alternative[36-37].

CONCLUSIONS

In the clinical case described, both therapeutic alternatives show successful treatment for this clinical situation and this specific patient, and can be considered equally valid for resolving the vertical atrophy of the maxilla. For cases with a higher degree of vertical atrophy or those with different bone density and residual volume, the application of one or another technique must be assessed for the success of the treatment.

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Clinical case

Extreme vertical and horizontal atrophy combined in posterior mandibular sectors; use of short implants and 2-phase ridge expansion with transitional implants: A clinical case

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ABSTRACT

The objective of this work is the presentation of a clinical case in which we show two surgical techniques to solve the horizontal bone atrophy.

Currently in implant dentistry, we are increasingly faced with cases of extreme bone resorption that force us to implement different surgical dental implant techniques. The coexistence of vertical and horizontal atrophy makes successful resolution of these cases more difficult, as well as having to face these types of more complicated situations with increasing frequency, due to patients demanding implant treatment even in such very severe cases. It is not uncommon therefore to use combined techniques which include ridge expansion or short implants, for example. The following clinical case presented advanced horizontal and vertical alveolar atrophy in the right and left posterior regions of the mandible. The treatment plan included the use of short implants for the vertical atrophy and a two-stage alveolar ridge split to treat the horizontal atrophy.

KEYWORDS

Bone atrophy; Split crest; Short implants.

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INTRODUCTION

Approaching the posterior sectors of the maxilla with extreme resorption is a common situation in dental practice. The loss of antral teeth produces pneumatisation of the maxillary sinus, which progressively occupies the space corresponding to the dental roots, in some cases leading to complete atrophy and in a residual bone height of 1-2 mm after the dental socket heals. This pneumatisation occurs over time after tooth extraction, but is unpredictable in terms of quantity and speed, and appears to be slightly related to the type of relationship that occurs between the apex and the sinus. This relationship was described by Sharan and Madjar in 2008, who established a classification with greater pneumatisation is expected in its types 3 and 4 (Figure 1)[1].

Until the arrival of short and extra-short implants, the only alternative treatment in these cases was sinus elevation (laterally or transcrestally), and there were different techniques and procedures for this. The attempt was to gain the lost bone volume and the subsequent insertion of conventional length implants at this level[2-6].

The development of short implants and the entire technique for their use sometimes allows the insertion of implants in large posterior vertical atrophies of the maxilla, avoiding sinus elevations.

Nowadays, most authors accept short implants to be those with a length less than 8.5 mm, although there are many cases of lengths well below this figure[7-9]. Extra-short implants, meanwhile, have more variation in terms of their classification; although the latest articles published consider extra-short implants to be those with a length less than 7 mm[10-12]. These shorter implants mean less morbidity for patients, at the same time as it is now possible to rehabilitate patients who may refuse to have additional techniques performed. These are sinus elevation and even more complex techniques which may be contraindicated in these patients for different medical reasons[13-17]. These short and extra-short implants can be inserted in the atrophic areas of the maxilla directly without displacement of the lower sinus cortex and without therefore having to manoeuvre the maxillary sinus. The main surgical challenge with this technique is to achieve implant stability, since generally in these cases we are faced with little remaining bone height and with high porosity[18-22]. Therefore, the establishment of a careful surgical protocol based on drilling into the receptor bed depending on its condition is key to the success of these treatments[13-17].

Figure 1. Initial images of the patient where we can see (A) the removable prosthesis and (B) the critical defects, especially at the antero-inferior level.

Figure 2. Panoramic radiograph showing the defect in tooth 47 and the edentulous areas.

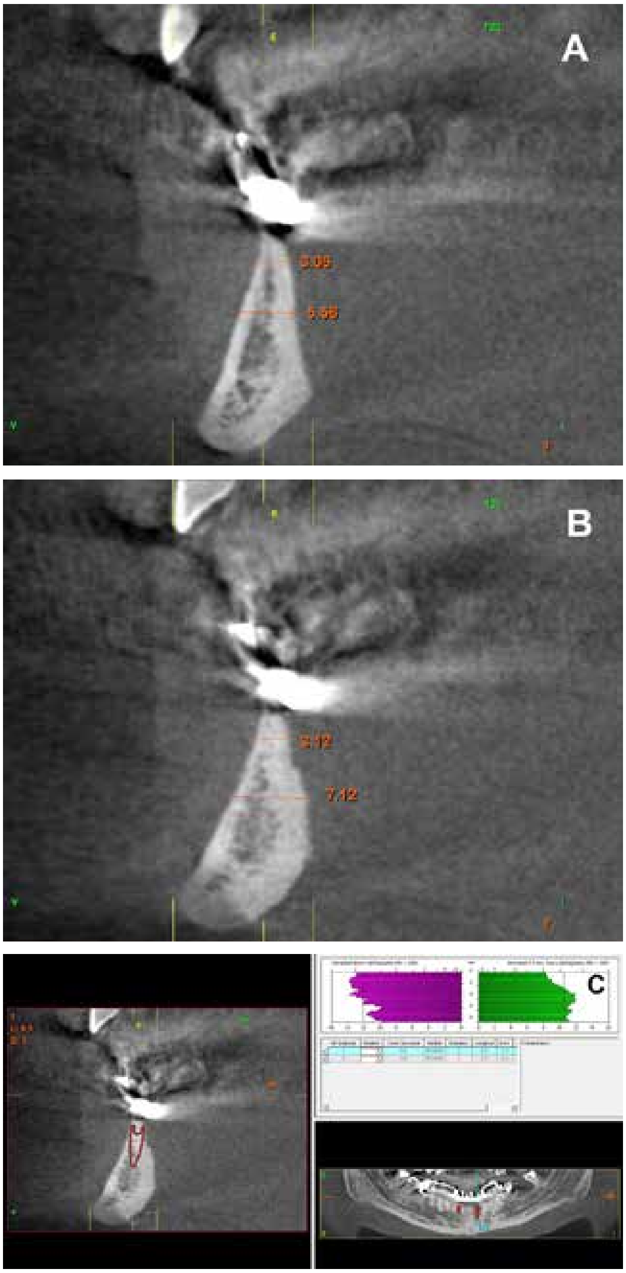

Figure 3. Dental CBCT planning images showing the extreme horizontal resorption of the antero-inferior sector in the incisor area; (A) area corresponding to tooth 42 (B) area corresponding to tooth 32 (C) Planning of the expander implant in the CT cut.

The clinical case described is of a patient receiving both procedures: extra-short implants inserted directly into one maxillary quadrant and a sinus lift with conventional length implants in the other quadrant. The evolution of both treatments in the same patient was able to be observed over eight years.

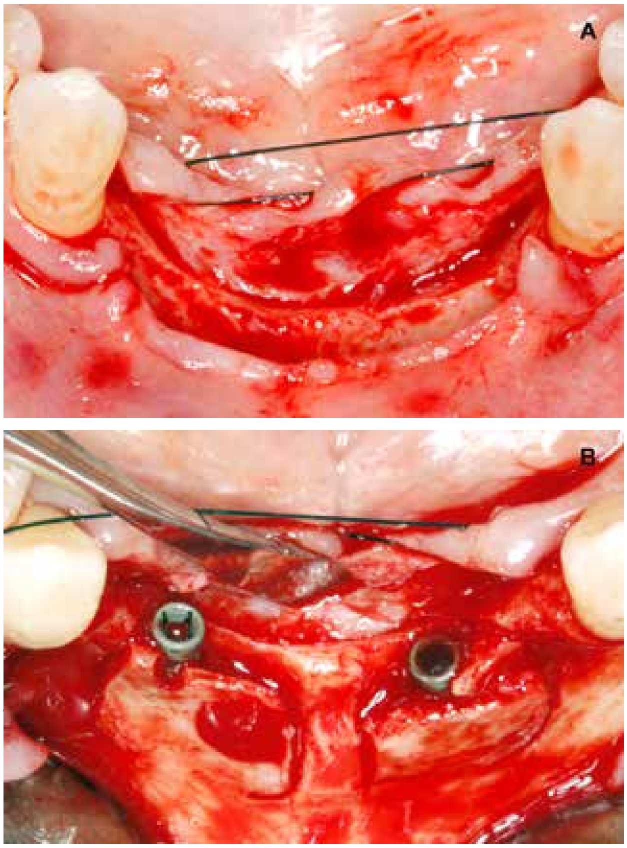

Figure 4. (A) surgery image showing extreme horizontal resorption and (B) the insertion of the two transitional implants for the ridge split in two phases.

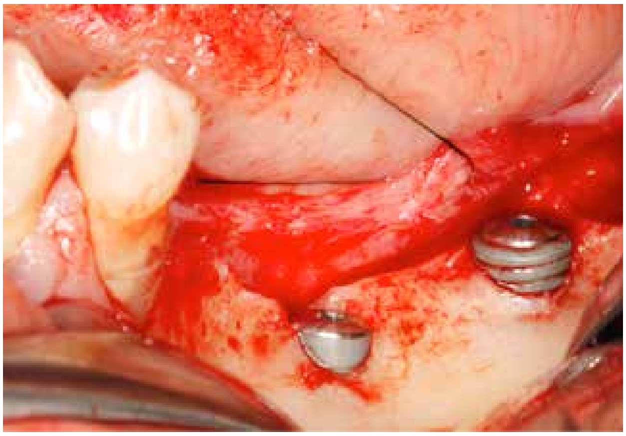

Figure 5 Insertion of the third quadrant implants where the uneven resorption of the mandible can be seen, leaving a lower bone height at the vestibular level. This leaves part of the coils uncovered.

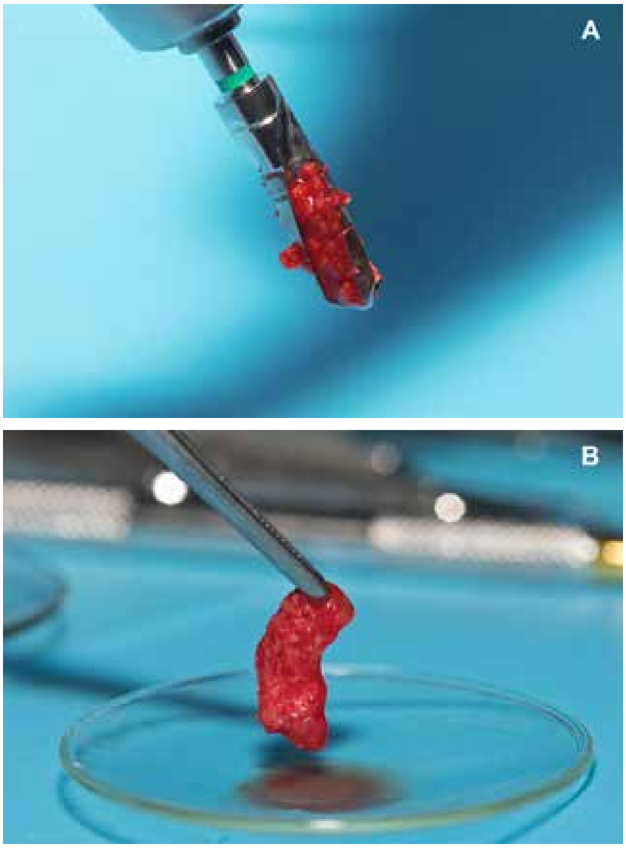

Figure 6. (A) Obtaining autologous bone from drilling and (B) performing a particulate bone graft composed of the bone from the drilling soaked in freshly activated PRGF-Endoret, ready for placement.

Figure 7. Particulate graft placed on the implants to achieve vertical growth.

CLINICAL CASE

This was the case of a 58-year-old female patient who attended the dentist practice to assess the 16th and 17th molars for pain and mobility. On clinical examination, mobility of both was observed with suppuration at the level of the sulcus. Radiography confirmed our diagnosis of considerable bone loss and sinus perforation at the apex of both molars (Figure 2).

Both teeth were extracted and alveoli regenerated with PRGF-Endoret to seal the perforation and provide the most favourable evolution possible for subsequent insertion of the implants in the area.

After two months, the dental cone-beam showed the perforation had

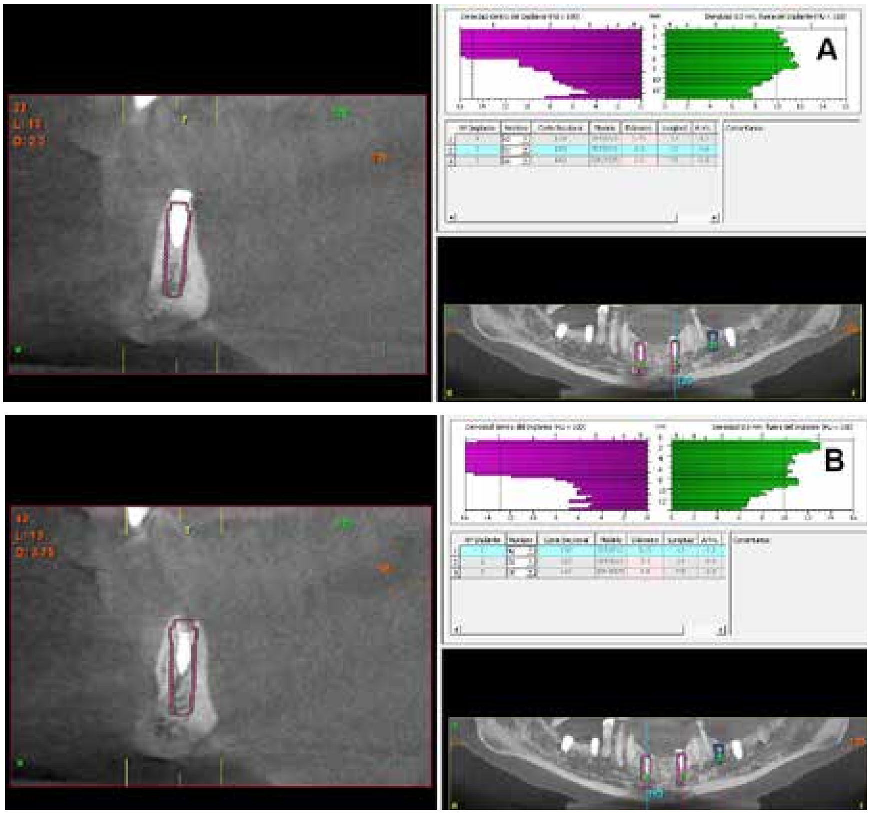

Figure 8. Planning the implants, where the gain in width achieved at the antero-inferior level can be observed. (A) position 42, (B) position 32.

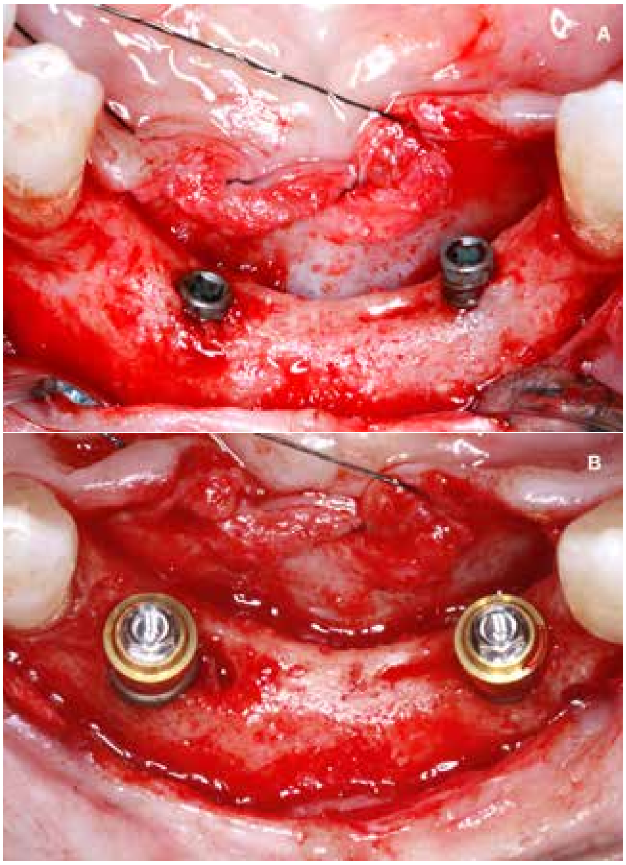

Figure 9. Surgery images showing (A) the appearance of the area before removing the transitional implants and (B) the new implants inserted in the anterior area with the transepithelial ones for immediate loading.

closed completely but the residual bone volume provided 2 mm of bone height only, which was insufficient to insert the implants (Figures 3 and 4).

Therefore, it was decided to carry out a sinus lift using biomaterial (bovine hydroxyapatite) bound to PRGF-Endoret. The elevation was performed and after five months a new dental cone beam displayed the quantity and quality of the graft obtained for the insertion of dental implants. In the cuts corresponding to the molars of the first quadrant, we observed excellent consolidation of the graft with space to insert 13 mm implants. Today, we would not choose this implant length, since studies published by our group with short and extra-short implants support their use, in addition to showing their diameter is more important than the length to distribute the loads of an

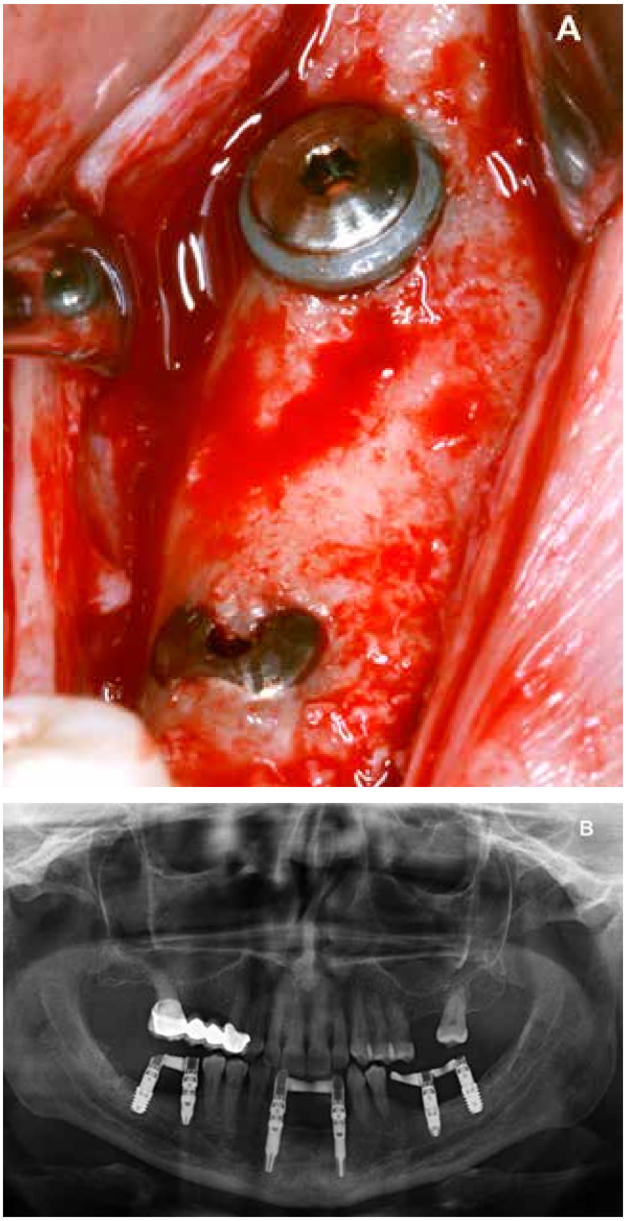

Figure 10. (A) Clinical image after vertical growth of dental implants and (B) radiography with immediate anterior loading prosthesis and posterior progressive loading prosthesis

already integrated implant; where an 8.5 mm length implant would work in the same way as a 13 mm implant of the same diameter[18].

Back in 2007, the therapeutic protocol for these cases was very different (Figures 5-7), with short implants without full development - and without studies demonstrating the importance of diameter over implant length - efforts were

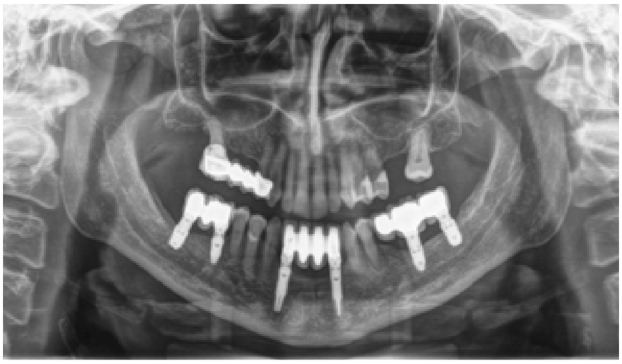

Figure 11. Follow-up radiograph at 5 years.

focused on the search for anchorage by implant length instead of looking for the bicortical (vestibular-lingual) stability that short and wide implants perform. During this time, the failure of molars 46 and 47 also occurred; these were also extracted and replaced with dental implants.

Six months after implant placement, the final prosthesis was made by using a cemented bridge. This prosthetic protocol is also not one we currently use, where tightness, sealing and the use of screw-retained prostheses using an intermediate or transepithelial component prevail. However, at that time, this type of rehabilitation and the conformation of a "bio" emergence profile in the abutments was how these cases were treated (Figure 8)[13-18]. The implementation of transepithelial implants in screw-retained prostheses opens a new horizon in the prosthesis, changing our working group protocol of towards an improvement in the implant-prosthesis seal, at the same time as prosthetic imbalance is reduced (due to taking the impression directly on the transepithelial and not on the implant connection) and tightness is improved; which reduces the risk of peri-implantitis, among other things[19-20].

After 4 years, the second and third quadrant molars began to have excessive mobility and serious periodontal problems, so it was decided to remove them and regenerate the alveoli with PRGF-Endoret. Once the area was regenerated (a month and a half later), a cone-beam was performed to evaluate the residual bone volume. It can be seen how there was an uneven bone crest with areas of 3.3 mm in height up to a maximum of 7 mm (Figures 9 and 10). On this occasion, due to the protocol change described above, we opted for the direct insertion of extra-short implants, since the surgical protocols to address this type of situation in 2011 varied substantially, with these implants being a first-line tool for the treatment of this type of atrophy (Figure 11). Two extra-short implants were selected (5.5 mm diameter x 6.5 mm length for tooth 26, and 6 mm diameter x 5.5 mm length for tooth 27).

Six months after the insertion of the extra-short implants, the final prosthesis was inserted; in this case, screwed and with an intermediate (transepithelial) component; just as the lower prosthesis in the third quadrant was made. At this point in time, the philosophy of work using a screw-retained prosthesis with a transepithelial and the search for tightness and passive fit were the dominant concerns for implant rehabilitation, and this is still so today (Figure 12).

Finally, the stability of both treatments can be seen in the final X-ray at 8 years of age, where both are stable without bone loss (Figure 13).

DISCUSSION

Therapeutic protocols in implantology have evolved markedly in recent years, moving towards minimally invasive approaches, without renouncing reliability. Therefore, short and extra-short implants are an option used increasingly to avoid aggressive surgeries with high morbidity, and are also an alternative for the rehabilitation of the atrophic posterior maxilla in height, avoiding having to use techniques to lift the sinus when the residual bone height allows[15-17].

Since the description of the conventional sinus lifting technique (lateral window) by Tatum in 1986[22], this procedure has been used for the rehabilitation of posterior maxillary sectors with vertical atrophy, with highly successful rates, currently around 98%, and long-term follow-up (over 15 years)[26-27]. A drawback of this technique is that it can cause perforation of the Schneiderian membrane and, although today this is no longer an exclusion for the insertion of implants in the same surgery (depending on the extent of the perforation and the case), when this perforation occurs, the success rates of implants inserted in these areas decreases to 88.6%[6]. In addition, the need for several surgeries together with a greater increase in patient morbidity, make us opt for less invasive techniques, such as short implants. When inserted in edentulous posterior sectors with elevated vertical resorption, these implants have a lower rate of surgical and prosthetic complications and less marginal bone loss; they are therefore a reliable alternative to bone augmentation procedures and subsequent implant insertion[28].

Summers in 1994 described the first variation of the lateral approach technique with a modification to reduce its invasiveness. This technique consists of an approach from the alveolar crest through the use of progressive calibre osteotomes that make a hole that serves both for the elevation of the Schneiderian membrane and the subsequent placement of the dental implant[29]. This technique has been widely used for the crestal approach of the extreme posterior resorption of the maxilla, with survival figures of the inserted implants between 88.65%[30] and 100%[31].

Other techniques have been used to approach the atrophic posterior maxilla to varying degrees; such as bone distraction, zygomatic implants, en bloc grafts and guided bone regeneration. All of them have similar success rates to the two shown in this clinical case; with the short and extra-short implants being the ones with the lowest rate of complications and morbidity for the patient[32-35].

Long-term survival of short implants also has a very similar rate to that of long implants with sinus lift; therefore, both can be considered as the technique of choice. However, from the point of view of morbidity, the short implants are the better alternative[36-37].

CONCLUSIONS

In the clinical case described, both therapeutic alternatives show successful treatment for this clinical situation and this specific patient, and can be considered equally valid for resolving the vertical atrophy of the maxilla. For cases with a higher degree of vertical atrophy or those with different bone density and residual volume, the application of one or another technique must be assessed for the success of the treatment.

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Original article

Comparative densitometric analysis between a new bone graft material composed of calcium phosphate vs. bovine hydroxyapatite in alveolar ridge preservation. A pilot study

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ABSTRACT

Introduction: In the present study, bone density from the new biomaterial composed by calcium phosphate and added silicon is compared with bovine hydroxyapatite by means of Hounsfield units in alveolar ridge preservation. Alveolar ridge preservation is a surgical technique proposed to reduce bone resorption caused by dental extraction, using a bone graft. This technique´s final goal is to facilitate implant insertion and rehabilitation.

Materials and methods: A study was carried out on 6 patients from the Faculty of Dentistry of the Complutense University of Madrid performing the technique of alveolar ridge preservation. Two groups were established, a test group in which the alveolar socket was filled with calcium phosphate and added silicon and a control group where the socket was filled with bovine hydroxyapatite. After 3 months, a cone-beam computed tomography was performed to evaluate the bone density achieved by both biomaterials.

Results: The average bone density achieved in the group treated with calcium phosphate and added silicon was 1100,40 ± 111,19 Hounsfield units whereas in the group treated with bovine hydroxyapatite the average bone density was 1029,46 ± 95,16 Hounsfield units.

Conclusions: Both biomaterials seem to present a similar behaviour in terms of densitometric results obtaining a density greater than 1000 Hounsfield units, having the calcium phosphate and added silicon the highest density.

KEYWORDS

Calcium phosphate, Biomaterials, Bone graft, Alveolar ridge preservation, Dental implant.

INTRODUCTION

The loss of alveolar bone can be triggered by different circumstances, such as trauma, an infectious process or as a consequence of periodontal disease. The most frequent cause of bone deficiency in the alveolar ridge is produced by the absence of mechanical function caused by the extraction or loss of a tooth[1].

Since the alveolar process depends on the presence of teeth, its loss leads to the unleashing of significant structural changes that are manifested in a vertical and horizontal reduction of the bone crest[2, 3].

According to Seibert[4], alveolar ridge defects can be divided into three categories according to bone deficiency:

- Class 1: when bone deficiency predominates in the horizontal dimension.
- Class 2: when it predominates in the vertical dimension.
- Class 3: when it affects both vertical and horizontal dimensions.

Taking these into account, it has been observed that the horizontal bone component is the most affected after tooth loss, mainly affecting the vestibular cortex. Whereas, the crestal reduction in height is milder, and is also predominant in the vestibular cortex[3]. Numerous studies have shown that most of the bone resorption, which occurs after tooth loss, occurs during the first 3 months of healing, and dimensional changes can be observed up to a year later[2].

Schropp et al,[5] revealed that the bone crest loses 50% of its alveolar width during the first 12 months after tooth extraction, which represents a crestal reduction of 5 to 7 mm. Because of this, the ideal implant placement may be compromised[2, 6].

Andrés-Veiga et al,[7] observed that this amount of bone resorption can vary between one individual and another and even in the same individual at different times of life, due to the influence of a series of local and systemic factors. Post-extraction alveolar ridge preservation (PAP) is a surgical technique aimed at reducing the collapse of the alveolar ridge after tooth extraction with a biomaterial, to facilitate subsequent implant rehabilitation[8-10].

Different types of biomaterials have been investigated for bone grafts in recent years, both in preclinical models and in clinical studies. However, none as yet has managed to stop resorption of the alveolar ridge completely after tooth extraction. The different studies carried out show that clinical, radiological and histological results vary according to the type of biomaterial used. Among such materials examined are autologous bone, allografts, xenografts, alloplastics and bone morphogenetic proteins[10, 11].

Research lines, aimed at minimising or blocking bone resorption produced after tooth loss, have grown recently, due to the direct impact that this bone reduction has on the reliability of future dental implants[12, 13]. Adequate bone volume leads to a better chance of obtaining optimal aesthetics, thus reducing the need for additional grafts[12].

A systematic review by Vignoletti et al,[2] concluded that the PAP technique manages to significantly reduce crestal bone resorption in both width and height. The differences observed between the bone resorption of the groups treated with biomaterial and control groups, which were not treated, was 1.47 mm in height and 1.83 mm in width.

Despite this known reduction in bone resorption, there is still not enough scientific evidence to determine which alveolar filling biomaterial is superior in this technique[2, 8, 14].

The aim of this study was to evaluate the bone density, measured in Hounsfield units (HU), achieved by a new biomaterial, composed of calcium phosphate with added silicon (CAPO-Si), and to compare it with bovine hydroxyapatite (HAB) in the PAP technique.

MATERIALS AND METHODS

A retrospective cohort study was carried out on 6 patients with single or biradicular teeth susceptible to tooth extraction, and later rehabilitated with implants, from the Faculty of Dentistry at Madrid's Complutense University. Two groups of 3 patients were formed: a test group having the socket filled with CAPO-Si after tooth extraction, and a control group in which it was filled with HAB.


Figure 1. Socket of the extracted tooth.


Figure 2. Filling the alveolus with the biomaterial.

In selecting the sample, the criteria were no patients having pathology or treatment that could compromise PAP (e.g. calcium disorders, treatment with immunosuppressants, bisphosphonates or corticosteroids; or radiotherapy or drugs that interfere with calcium metabolism). Furthermore, the integrity of the four corticals of the alveolus was necessary for their inclusion in the study.

After disinfection of the surgical field with povidone iodine (Betadine™, Meda Pharma SAU, Madrid, Spain), infiltration with articaine and epinephrine 40/0.01 mg/mL (Ultracain™, Laboratorios Normon SA, Madrid, Spain) was performed. The tooth in question was then extracted, the integrity of all its cortices checked and the socket rigorously managed (Figure 1). Subsequently, using a full thickness flap, the alveolus was filled with the biomaterial in question (Figure 2) and a 25 x 30 mm size resorbable collagen membrane added (Osgide™, Curasan AG, Kleinostheim, Germany), see Figure 3. The flap was then closed using a 4-0 suture (Figure 4).

As postoperative measures, anti-inflammatory treatment (diclofenac sodium 100 mg every 12 hours for 4 days) and rinses with an antiseptic solution of 0.12% chlorhexidine (Chlorhexidine Lacer™, Lacer SA, Barcelona, Spain) were used. The patients returned 7 days later for suture removal and check-up appointments arranged during the first and second months using control periapical radiographs to evaluate correct tissue healing.

Three months after extraction, all patients underwent a cone beam computed tomography (CBCT) test (Newtom


Figure 3. Placement of the resorbable collagen membrane.


Figure 4. Closure of the flap by suture.

model 5G XL, Verona, Italy) to assess implant placement and the bone density achieved by the biomaterial (Figures 5 and 6). The densitometric measurements were performed with the NNT Viewer 7.2 program.

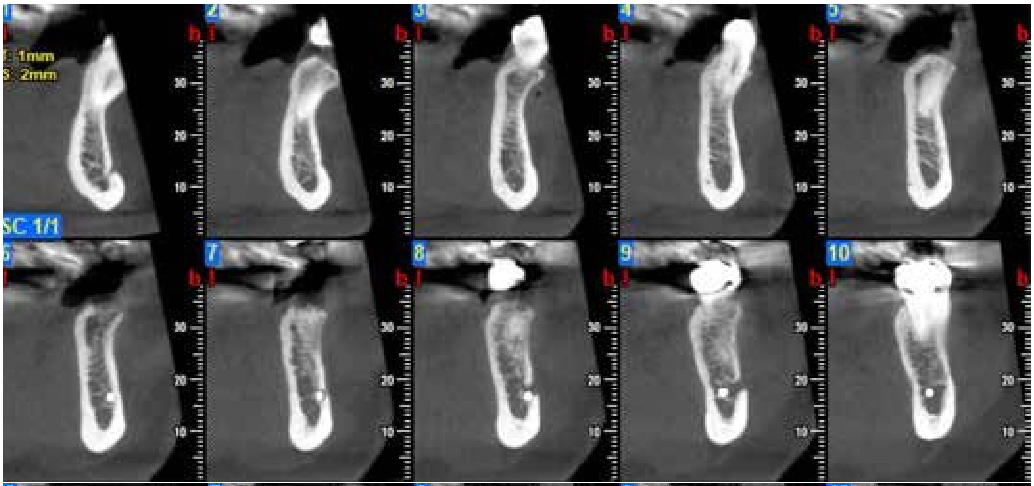

Figure 5. CBCT of the case taken 3 months after extraction.

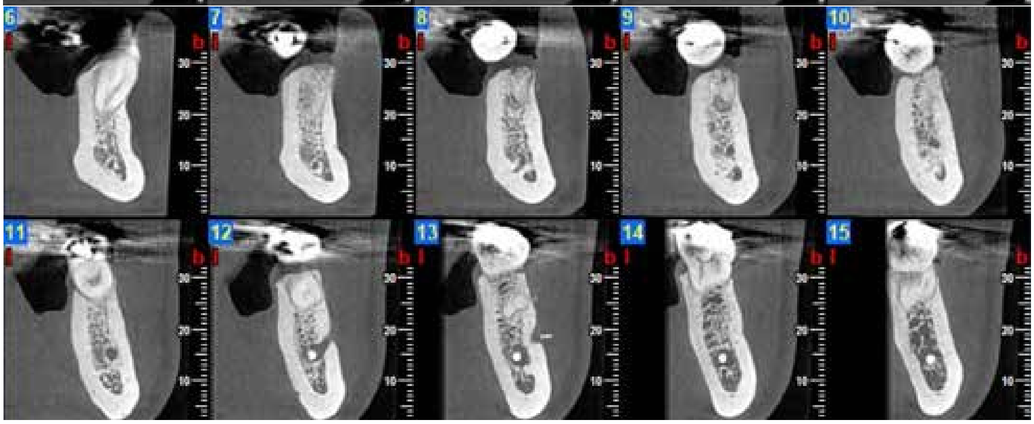

Figure 6. CBCT of the case taken 3 months after extraction.

For statistical analysis, a Student's t test was performed for independent samples after an evaluation of the homogeneity of variances. Data were presented as mean ± standard deviation and the level of statistical significance was established at $p < 0.05$.

RESULTS

In all cases, primary closure of the flap was achieved without any type of complication or exposure of the membrane being recorded during the follow-up period.

Table 1. Bone density for each study patient.

Case	Age	Sex	Biomaterial	Bone Density (HU)
1	57	F	CAPO-Si	1173.03 UH
2	46	M	CAPO-Si	972.38 UH
3	56	F	CAPO-Si	1155.78 UH
4	50	F	HAB	920.31 UH
5	43	M	HAB	1072.98 UH
6	44	F	HAB	1095.09 UH

NB: F: Female; M: Male; CAPO-Si: Calcium phosphate with added silicon; HAB: Bovine hydroxyapatite; HU: Hounsfield Units.

Table 2. Mean and standard deviation values for the two groups and Student's t test result

	CAPO-Si	HAB
Mean	1100.40	1029.46
Standard Deviation	111.19	95.16
Valor t	0.8396	
Valor p	0.4484*	

** p - not statistically significant*
CAPO-Si: Calcium phosphate with added silicon;
HAB: Bovine hydroxyapatite; HU - Hounsfield Units.

Three months after tooth extraction, the mean mineral density achieved in the CAPO-Si group was 1,100.40 ± 111.19 HU; while the HAB treated group recorded 1,029.46 ± 95.16 HU. The mean age of the test group was 53 years, and the mean age of the control group was 45 years. Table 1 shows the densities obtained by the study patients. Table 2 shows the mean and standard deviation values of the two groups and the Student's t test results.

Both groups demonstrated radiographically and clinically sufficient bone height for the mesial and distal ridges for implant placement. In addition, the width between the buccal and lingual cortices of the preserved alveoli was maintained, avoiding horizontal collapse of the alveolar ridge in both groups. None of the patients in the study showed dehiscence of the vestibular cortex.

Implant rehabilitation was possible in all cases 3 months after PAP; excellent primary stability was obtained without the need for additional bone grafting techniques.

DISCUSSION

In the present pilot study, the experimental biomaterial to perform the PAP treatment was a ceramic composed of CAPO-Si.

Silicon (Si) is an essential mineral for the proper growth and development of bones and cartilage. The justification for the incorporation of Si to the study biomaterial is due to the fact that it has been observed that those synthetic biomaterials based on calcium phosphate, which include levels of Si in their structures, demonstrate superior biological performance. This increase is attributed to the changes induced by Si in the properties of the material, since it stimulates osteoblast function and bone formation[15]. Furthermore, in different studies it has been observed that the incorporation of Si increases angiogenesis, promoting new bone formation[16, 17].

The Patel et al study[18] made a histomorphometric evaluation of the amount of newly formed bone by two compounds: one formed by hydroxyapatite and the other by hydroxyapatite with Si. The results revealed the compound with Si showed 15.5% more bone growth and 12.7% additional implant surface area covered by bone compared to the other without Si.

In this study, the combined use of membrane with the biomaterial is justified from a mechanical point of view, since it stabilises blood clotting, and acts as a support with a space maintenance effect to prevent epithelial growth. Also, it is biologically justified, since its composition provides an additional source of collagen, minerals and growth factors[3]. The meta-analysis by Ávila-Ortiz et al (2014)[11] on PAP concluded there are statistically significant differences in favour of using a membrane, as less vertical bone resorption was observed in the buccal and lingual cortices.

HU obtained from CBCT tests help evaluate bone density and quality and are used to evaluate the radiological density of materials, on a basis where air is < 1,000 HU, water is 0 HU, and the material with a higher density is > 3,000 HU. Most bone densities range from 100 and 1,900 HU[19]. Misch[20] established a classification for evaluating bone quality using HU as follows:

- D1: bone with a dense cortex: > 1,250 HU.
- D2: dense to porous cortical bone and thick trabeculae: 850-1,250 HU.
- D3: thin porous cortex bone and fine trabeculae: 350-850 HU.

• D4: bone with fine trabeculae:150-350 HU.

• D5: bone with incomplete mineralisation: <150 HU.

The results obtained in this study show that the mean mineral density of the biomaterial in the CAPO-Si group was higher than that obtained in the HAB group: 1,100.40 HU and 1,029.46 HU, respectively. The biomaterial density for both groups corresponds to a type D2 bone, according to the Misch classification[20]. Due to the small sample size, no statistically significant differences were found in the density of the biomaterials.

These results are in line with similar studies in which PAP was performed. For example, Henao et al (2016)[21] conducted a study on 37 alveoli in a test group using beta tricalcium phosphate, against a control group using a biphasic material of synthetic hydroxyapatite and tricalcium phosphate. CBCT tests performed at 3 months revealed a mean density of 1,052 HU for the group treated with beta tricalcium phosphate and 1,020 HU for the group treated with the biphasic material, with no statistically significant densitometric differences between the biomaterials.

In addition, the expected time for implant placement after PAP has been observed to vary notably between the different published studies. It could be argued that prolonged healing periods would help improve implant outcomes by allowing more time for bone tissue mineralisation in the socket. However, recent systematic reviews, such as that by Mardas et al in 2015[14] and De Risi et al in 2015[3] found no statistically significant differences in the survival and success rates obtained for implant studies with different healing periods after performing PAP. Thus, implant placement could be carried out after 3 or 4 months of healing, regardless of the bone graft materials used.

The sample size in this study was very small and, although our experimental group gave a higher densitometric mean than the control group, it was not a statistically significant difference. It would therefore be of interest to expand the sample in a future study, such as a clinical trial, and perform an additional histomorphometric analysis of both biomaterials to quantify the bone mineral density achieved and correlate it with the densitometric data.

CONCLUSIONS

Both study groups seem to have similar densitometric properties, with a density greater than 1,000 HU, and CAPO-Si giving the higher density.

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Clinical case

Digital flow in unitary dental implants rehabilitation in anterior sector. Surgical and prosthetic planning. Case report

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ABSTRACT

Aim: The purpose of this article is to present a clinical case of high aesthetic demand. Such planning and treat with digital flow, included diagnosis, prosthetic planning and finally, the placement of the final prosthesis.

Case report: A 52-year-old woman presents a fracture of the tooth 2.1. After diagnosis and analysis both clinically and radiographically, an impossible restorative prognosis is determined for 2.1, planning implant-supported rehabilitation as treatment. A scan of the area to be treated was carried out to carry out a detailed study of the case and the preparation of a provisional crown, which was screwed at the same time of surgery to an implant placed immediately post-extraction. Besides, hard and soft tissue graft were placed to guarantee the maintenance of the peri-implant contours. After the implant osteointegration, the contour of the provisional crown was scanned to obtain a suitable emergence profile and gingival tissue volume. Both the emergency profile obtained and the contour of the provisional were scanned together with the position of the implant for the preparation of the final metal-ceramic restoration. After six months, it can observe an ideal soft tissue aesthetic and perfect maintenance of the entire gingival architecture.

Conclusion: The management of the anterior superior aesthetic sector shows a clear aesthetic demand. In cases of tooth loss at this location, fixed implant rehabilitation is the treatment of choice. However, to achieve an adequate and predictable result, proper surgical and prosthetic management is essential. Digital flow it present like alternative and a quality leap in the therapeutic approach to these cases, a more accurate and individualized treatment, and the information that is transferred to the prosthetic laboratory is more simple and efficient.

KEYWORDS

Immediate loading; Post-extraction implant; Dental implant; Digital dentistry; Soft tissue.

INTRODUCTION

After the loss of a tooth, a series of physiological processes takes place throughout the dento-alveolar complex that culminates in atrophy and collapse of both the bone and gum tissues, with a horizontal and vertical component. This can have a significant repercussion aesthetically for patients when it affects the anterosuperior aesthetic sector[1-]. Following advances in rehabilitation of osseointegrated implants (OII), aimed at achieving greater primary stability in post-extraction sockets and allowing a reduction in integration times, new treatment protocols have emerged that can focus rehabilitation on aesthetic sectors much more efficiently. These protocols are based mainly on immediate placement of the screw-retained provisional crowns at the same time during surgery. This allows for the preservation and management of soft and hard tissue grafts and emergency profiles; thus preventing their collapse and giving the patient immediate aesthetic benefit[4-6].

Nowadays, digital workflow is increasingly integrating itself in practically all dentistry fields, although its application in oral rehabilitation and cosmetic dentistry is especially important. Implants can be planned following advances in technologies and the use of intraoral scanners and software programs. These digital programs can be used to design the case by computer, analyse the patient photographic study and make virtual study models to improve case planning; thus reducing treatment times and, in the long run, their costs, with respect to traditional methods[7, 8].

Digital planning as part of implant rehabilitation is a tool for optimising results and improving surgical planning, which is prosthetically guided from the outset and can lead to more exact handling of peri-implant tissues, thanks to scanning the emergence profiles obtained, and making definitive restorations of great aesthetic quality[7, 8].

The objective of this article is to describe the rehabilitation on implants in a high aesthetic demand case, with the treatment based entirely on digital planning.

CLINICAL CASE

This describes the clinical case of a 52-year-old woman who came to the dentist surgery due to de-cementation of a tooth-supported metal-ceramic crown on tooth 2.1 (ICSI), see Figures 1-3. The patient reported it as of high concern for her aesthetically.

She had no notable medical, personal or surgical history, and reported not being a habitual smoker or drinker, and was therefore an ASA class I patient.

Examination

The patient reported pain when chewing in the anterosuperior sector, located in the ICSI area, which disappeared after taking painkillers. An intraoral clinical examination revealed that the decemented crown retained remains of the ICSI stump, as well as a cast post that served as a scaffold for the restoration. The ICSI

Figure 1. Initial front view with tooth-supported crown.

Figure 2. Initial front view without tooth-supported crown.

was a root remnant, with total loss of tooth structure and no ferrule that might ensure a new rehabilitation[9]. The patient had a medium smile line and a fine gingival phenotype, which was accompanied by gingival recession in the affected tooth, as well as in the contiguous teeth of the second quadrant. She presented palpation, percussion and a positive bite test and negative vitality in the ICSI, with no periodontal pocket (probe depth < 3 mm) or mobility. An additional radiological examination was carried out, which included a periapical radiograph and cone beam computed tomography (CBCT), see Figure 4. After evaluating these tests, a subgingival complete horizontal coronary fracture without periapical bone involvement was observed.

Diagnosis and treatment plan

Following the examination and the additional tests, restoring the ICSI was considered impossible. Due to the clinical features of the case, and with the agreement of the patient, the treatment plan was to extract the ICSI and insert an osseointegrated implant (OII), associated with a provisional implant-retained prosthesis at the same time. The apical residual bone was favourable for inserting the OII, as it was a Class I socket according to Kan[10], and with practically total integrity of the vestibular surface, being a type I socket according to Elian[11].

Using a 3Shape™ scanner, an intraoral pre-scan was performed, first with the tooth-supported crown in place, to obtain the anatomy of the central incisor, and then without it; thus scanning the emergence profile of the root rest; the laboratory was informed of the modification of the critical profile, thus correcting the existing recession with respect to 1.1 (Figures 5-7). This scan served in turn to take the colour of the future provisional structure[7, 8]. The STL file was sent to the laboratory to make the Maryland-type provisional prosthesis, in polymethyl methacrylate (PMMA), with two supports on the incisor edges of

Figure 3. Initial occlusion view of second sextant.

Figure 5. Front view pre-scan, with fractured crown.

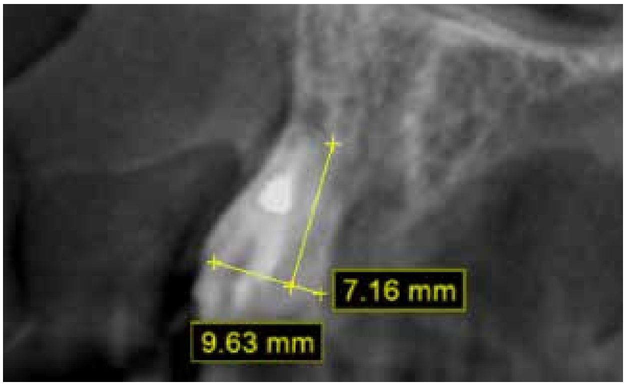

Figure 4. CBCT image.

Figure 6. Maxillary scan. Front view.

the adjacent teeth to ensure their correct positioning. According to the plan performed beforehand, this would serve as a provisional tooth, as well as surgical guide for the insertion of the OII in the ideal prosthetic position; thus avoiding possible future problems at the prosthetic level or in the integrity of the soft and hard tissues of the vestibular region (Figures 8 and 9).

Figure 7. Maxillary scan. Occlusion view.

Figure 8. PMMA provisional. Front view.

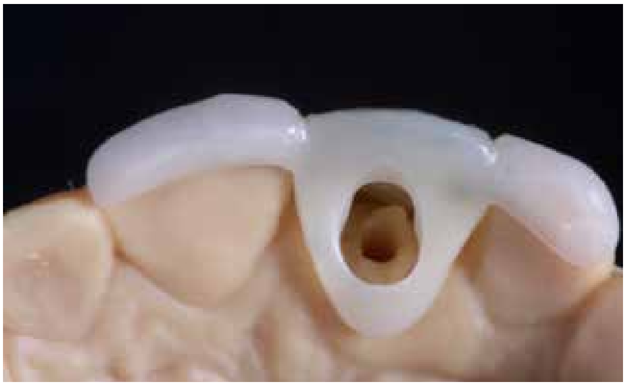

Figure 9. PMMA provisional. Occlusion view.

Surgical approach

After anaesthetic infiltration (4% articaine with 1: 100,000 adrenaline), the root of the affected tooth was extracted. As a complication of the extraction, the distal papilla was lacerated, which was repaired with a single stitch. The residual socket was then evaluated to prepare the bed to insert the OII. This was intact, with intact vestibular cortex.

The OII (ETK-Naturactis™, 4 x 12 mm) was placed at a depth of 4 mm with respect to the future gingival margin that needed to be achieved. The margin of the provisional prosthesis was used as a reference, similar to the gingival margin of the adjacent central incisor that was maintained without recession.

Proper primary stability was obtained, with anchorage achieved in the residual palatal bone at an insertion torque of 40 N/cm^2. A periapical radiograph was performed to confirm the position (Figure 10).

Provisional prosthetic phase

Before starting the provisional restoration screwed onto the OII, its disposition with respect to the metal abutment, the mesio-distal adaptation and the contact points to the adjacent teeth were all verified as correct, and the absence of compression on the interdental papillae was ensured. The critical contour of the provisional was designed at the same level as the gingival margin of the adjacent central incisor crown, which was considered ideal, thanks to the photos and the previous pre-scan, leaving 1.5 mm supragingival, due to the previous recession. The abutment was relined with the provisional using 3M™[12] flowable composite. Next, the subcritical profile was prepared, by providing a concave contour to allow space for the formation of connective tissue. Finally, it was verified that the provisional was completely polished over its entire surface[13].

Hard and soft tissue management

In these types of cases, the management of hard and soft tissue is of special importance. Due to the thin gingival phenotype, the collapse of the vestibular soft tissue, always associated with an extraction, and the pre-existing recession, a tuberous connective tissue graft (CTG) was performed using the envelope technique (Figure 11)[14,15].

The CTG was adapted to the recipient region using a 6.0 monofilament suture. Subsequently, the gap in the vestibular region of the alveolus was filled to minimise its collapse. For this, autologous bone collected from drilling was used in the area near the OII and xenograft in the most vestibular area (OsteoBiol™ Apatos)[16].

To complete the surgical approach, the provisional prosthesis was screwed in, and its complete anocclusion checked, both for maximum intercuspation and eccentric movements, using articulating paper (Figure 12). The patient was instructed to avoid any type of functional load on the provisional during the entire osseointegration time of the implant. Antibiotic treatment was prescribed, with amoxicillin/clavulanic acid, 500/125mg, 1 tablet every 8 hours for 7 days, as well as a painkiller regimen, with prescription of dexketoprofen 25mg, with the same dosage as the antibiotic.

The patient returned 7 days later for a check-up; good healing of the peri-implant tissues was observed (Figure 13). Another week later, 14 days after surgery, the suture was removed. The patient attended monthly check-up appointments until the end of the osseointegration time.

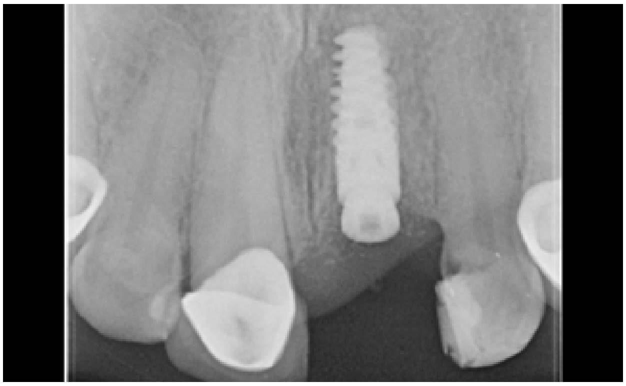

Figure 10. Radiographic verification of the implant position before inserting the provisional.

Figure 11. De-epithelialisation of the tuberous connective tissue graft.

Figure 12. Front view after operation.

Figure 13. Front view during review after 7 days

Figure 14. Front view after 3.5 months.

Soft tissue management with the provisional crown

The provisional was removed after 14 weeks, when the gingival margin was seen to be correctly positioned, along with 100% coverage of the recession, complete papillae maintenance and a correct emergence profile (Figures 14 and 15). However, from an occlusion view, there was a lack of buccal volume with respect to the adjacent tooth. Work began with the provisional crown, with progressive increases of composite in the subcritical profile, until a volume similar to tooth 1.1 was achieved. These increases were performed every 15 days (Figure 16)[13].

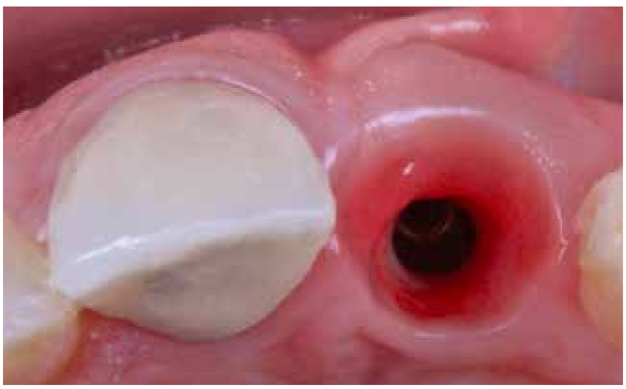

Figure 15. Emergence profile after unscrewing the temporary crown. Occlusion view.

Figure 16. Ischaemia after placing the provisional after modifying the subcritical profile. Front view.

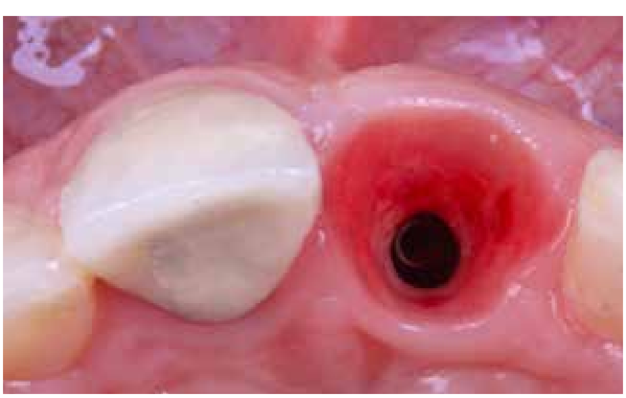

Figure 17. Occlusion view of soft tissue after handling the subcritical profile.

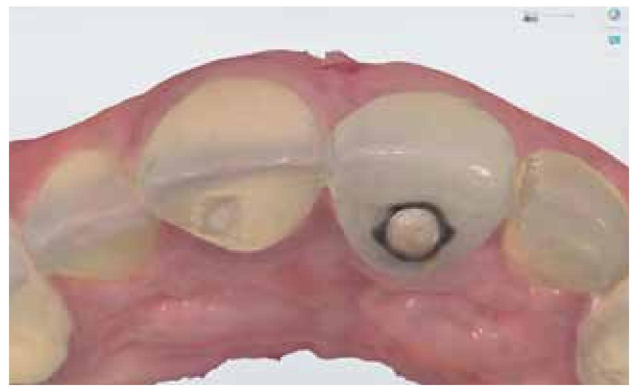

Figure 18. Pre-scan with the provisional crown to manufacture the final prosthesis. Occlusion view.

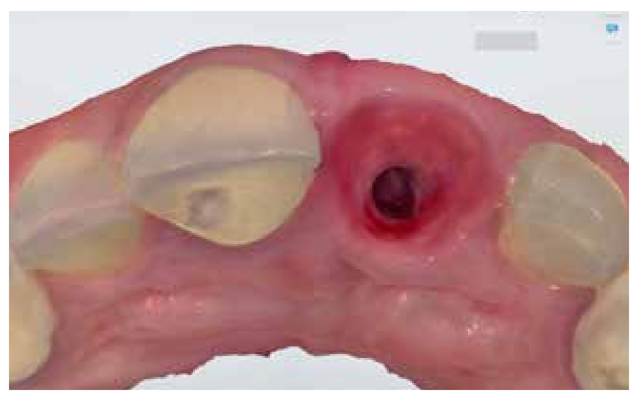

Figure 19. Scanning emergency profiles for making the final prosthesis. Occlusion view.

Figure 20. Placement of scan body to transfer the implant position. Front view.

Final measurements

After achieving optimal tissue volume by handling the provisional (Figure 17), an initial scan of the maxilla was performed with the screw-retained provisional crown to obtain the anatomy (Figure 18). Subsequently, a second scan was performed without it, with accurate recording of the gingival contours and the emergence profile achieved (Figure 19), as well as the implant position using the scan body (Figures 20 and 21). For proper recording of the emergence profile, the provisional crown was scanned outside the mouth (Figures 22 and 23); thus avoiding having to perform the classic technique of an individualised transfer[17]. These records were sent to the prosthetic laboratory, which designed a post-machined sintered metal structure (Figure 24). Once the framework test had been satisfactorily carried out (Figure 25), the colour of the restoration (A2 VITA guide) was taken using a polarised light filter (Figure 26). These records were sent back to the prosthetic laboratory for completion of the implant-retained crown on the printed models (Figures 27 and 28). Prior to the placement of the definitive crown, the emergence profile of the provisional crown was compared with the final one, and the similarity observed between them (Figure 29); thus managing to preserve the profiles maintained from the day treatment was started.

Figure 21. Scanning the scan body to make the final prosthesis.

Figure 22. Emergence profile of provisional prosthesis.

Figure 23. Scanning provisional prosthesis.

RESULTS

After the 6-month review, excellent stability of all peri-implant tissues was verified, with correct volume at the vestibular level, as well as the maintenance of optimal aesthetics and functionality (Figure 30).

DISCUSSION

In recent years, implantology has undergone a series of advances that have gone hand in hand with technology. At the beginning of this field of dentistry, placing an implant in a post-extraction socket was not conceivable, in the same way that the implant load was not evaluated in the same surgical act. However, this initial, classic vision[18, 19] has turned towards treatments where prosthetic rehabilitation takes on special importance, as well as for the time in which it occurs. Scientific endorsement of the new techniques is also supporting the use of digital resources[20, 21]. These resources in implantology have improved diagnosis and allowed for the establishment of more reliable treatment plans. The standardisation and quality of these procedures has increased in recent years, offering the patient a higher quality of treatment in a shorter time. Thus, digital workflow in dentistry has proven to be more efficient than the conventional working method in terms of cost and time, as well being better accepted by patients. Taking digital impressions allows for a better recording of occlusion and greatly reduces the distortions present in analogue procedures. As well as the use of photographic analysis, the different design software programs and the study of models at a digital level, this all means that dental prosthetic rehabilitation therapies are carried out with greater safety and quality[20-23].

Different studies have shown that there is a higher risk of failure in single implants subjected to immediate loading compared to multiple restorations, even with a high insertion torque. Therefore, the concept of "loading" has changed to that of "provisionalisation", since the provisional crown is completely exempt from function. The importance of these provisional restorations, in addition to immediate aesthetics, lies in the maintenance of the gingival contour and the interdental papillae; favouring the maintenance of volume and reducing horizontal and vertical collapse due to tooth loss[4-6, 24].

The implementation of intraoral scanning and digital flow in implant restorations of high aesthetic demand allows for the creation of more accurate provisional restorations due to greater precision in the analysis of the case. From study of the software, soft tissue status can be determined and provisionals developed according to individual needs to obtain optimal gingival contours and volume. Likewise, pre-scanning the provisional restorations means that the subcritical contour the final crown must have can be transferred to the laboratory, faithfully and almost exactly; ensuring the maintenance of the gingival morphology and the long-term success of the case[25,26]. In this instance, a surgical guide to perform guided surgery was not

Figure 24. Post-machined sintered metal structure. Front view.

Figure 25. Passive fit verification radiograph.

Figure 26. Colour capture with polarised filter. A2.

Figure 27. Final crown screwed on digital model. Front view.

manufactured, since the provisional rehabilitation itself was used as a guide, using support on the incisor edges and in the palatal region, thus simplifying the treatment complexity. Proper design of the provisional prosthesis, its digital scanning and scanning of the emergence profiles make it possible to shorten the times and the number of tests to perform the final prosthesis[23].

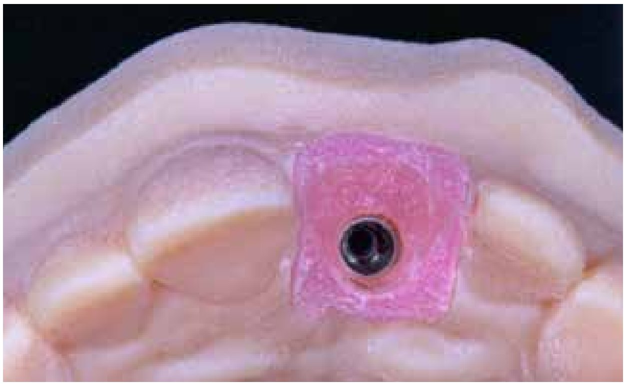

Figure 28. Occlusion view of the emergence profile in digital model.

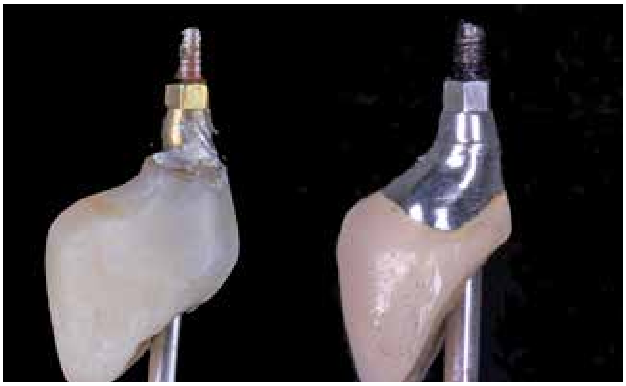

Figure 29. Comparison of the critical and subcritical profiles of the provisional and final prosthesis.

Figure 30. Review of final crown at 6 months.

CONCLUSIONS

Management of the anterior superior aesthetic sector shows a clear aesthetic requirement. In cases of tooth loss in this location, fixed rehabilitation on implants is the treatment of choice. However, to achieve an adequate, reliable result, proper surgical and prosthetic management is essential. Digital planning represents a leap in quality in the therapeutic approach to these cases, providing more exact, individualised and reliable treatment, with the information transferred to the prosthetic laboratory being simpler and more efficient.

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