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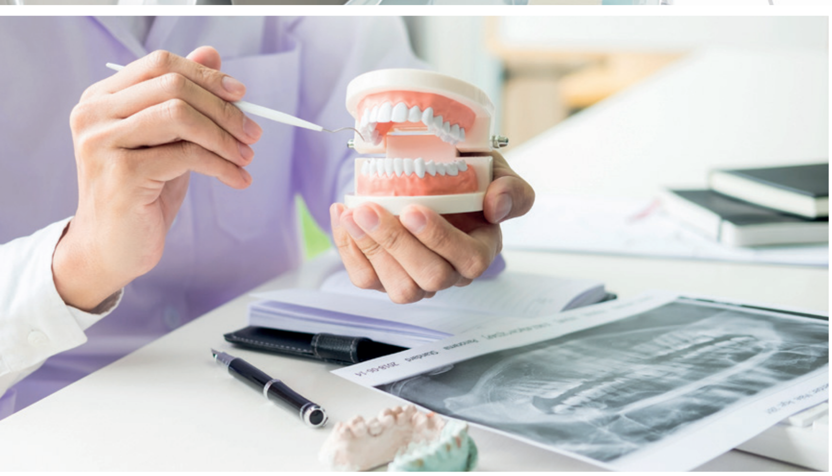

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ILUSTRE COLEGIO OFICIAL DE ODONTÓLOGOS Y ESTOMATÓLOGOS DE LA 1ª REGIÓN

SPECIAL SUPPLEMENT 2025
volume 22

CONTENTS

editorial

Dra. Mª Isabel Leco Berrocal
Scientific Director
Científica Dental

Dra. Mª Victoria Mateos Moreno
Deputy Scientific Director
Científica Dental

Dear readers,

It is a pleasure to present this **special English-language issue** of Científica Dental, an edition that brings together this year's award-winning papers and reflects the commitment of researchers and professionals to advancing evidence-based dentistry. Through this publication, we aim to promote the international visibility of dental research, enabling these distinguished contributions to reach a broader audience within the global scientific community. The articles included in this volume were selected for their methodological excellence, clinical relevance, and contribution to knowledge across different areas of our discipline.

The **Best Scientific Article Award** was presented to "Comparison of available retromolar bone space for maxillary molar distalization in adult patients with class I and class II malocclusions", by Jatziri Baeza-Rivera, Aida Nabile Silva-Zatarain, and Jaime Fabián Gutiérrez-Rojo. This study provided highly valuable information for orthodontic treatment planning and delivered relevant evidence on a key aspect of maxillary molar distalization in adult patients.

The **Second Best Scientific Article Award** was granted to "4.5-mm-length implants used in vertical bone atrophy (residual bone height ≤ 4.5 mm): A retrospective Sstudy", by Eduardo Anitua, who presented valuable research on the use of short implants as a therapeutic alternative for patients with severe bone atrophy, demonstrating their potential to support less invasive and highly predictable treatments.

In the **Best Clinical Case Report** category, recognition was awarded to "Microinvasive approach for the management of white spot lesions in a case of amelogenesis imperfecta", by Edy Angamarca Alvarado, Silvia Camacho Terciado, Marina Olea Vielba, and Laura Ceballos García. This case highlighted the value of minimally invasive dentistry in improving both function and aesthetics in patients with developmental enamel defects.

The **Second Best Clinical Case Report** Award was granted to "Detection of carotid calcifications by panoramic dental radiography: A general health promotion action from the dental clinic", by M.ª Cristina Serrano Sánchez-Rey, Lourdes Rubio Ramírez, Agustín Casas Hernández, Miguel Carasol Campillo, and Bettina Alonso Álvarez. This work emphasized the dentist's role in the early detection of findings with systemic implications and underscored the close relationship between oral health and overall health.

In the **Best First Publication** category, the award was presented to "Analysis of potential complications of a mandibular dentigerous cyst in close proximity to neural structures: A case report", by Alireza Sharif Ardestanian Moghadam, Melika Amirbagloy Darian, Natalia Martínez Rodríguez, Blanca Miró Cuadrado, and José María Martínez-González. This paper represented an outstanding contribution from emerging researchers by addressing a case of considerable surgical complexity and highlighting the importance of appropriate diagnostic and therapeutic planning.

Finally, the **Second Best First Publication Award** was granted to "Influence of a cyanoacrylate-based adhesive on pain and healing of the palatal donor site after connective tissue graft harvesting: preliminary results of a multicenter randomised clinical trial" by Marc Cárceles-Raga, Ignacio Fernández-Baca, María Mascaró Sintes, Juan Sánchez Santos, and Joaquín López-Malla Matute. The preliminary findings of this trial provided relevant evidence on strategies aimed at improving postoperative comfort and optimizing healing of the donor site in periodontal surgery.

On behalf of the Editorial Committee, we would like to express our sincere appreciation to all authors, reviewers, and collaborators who made this issue possible. Their dedication, scientific rigor, and commitment to excellence contribute to strengthening a form of dentistry that is increasingly innovative, interdisciplinary, and focused on patient well-being.

We trust that the papers included in this issue will engage our readers, stimulate critical thinking, and inspire future research as well as the continuous improvement of clinical practice.

We would also like to take this opportunity to wish all our readers, authors, and collaborators a **happy summer**, hoping that this period of rest will provide an opportunity to recharge, share new projects, and return with renewed enthusiasm for research, education, and excellence in dental practice.

Kind regards.

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ILUSTRE COLEGIO OFICIAL DE ODONTÓLOGOS Y ESTOMATÓLOGOS DE LA 1ª REGIÓN

ORIGINAL ARTICLE

Comparison of available bone retromolar space for maxillary molar distalization in adult patients with class I and class II malocclusions

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ABSTRACT

Introduction: The distalization of upper molars is a conservative alternative in the treatment of class II malocclusion to achieve a class I dental relationship. The available bone space is measured from the distal root of the second upper molar to the vestibular cortical bone, rather than the distance from the crown of the second molar to the maxillary tuberosity.

Objective: To compare the available retromolar bone space for maxillary molar distalization in adult patients with class I and class II malocclusions.

Methods: A descriptive, observational, cross-sectional, and retrospective study. The sample consisted of 120 cases from the database of the Orthodontics Graduate Program at the Universidad Autónoma de Nayarit. The space was measured using a line parallel to the upper occlusal plane passing through the furcation of the second upper molar. Distances were taken from the most distal point of the distal root of the second upper molar to the inner edge of the maxillary cortical bone.

Results: Using a Student's t-test, statistically significant differences were found in the retromolar space between patients with class I and class II. It was found that there was an association between retromolar space and sex and the SNA angle in class II.

Conclusions: There are significant differences in retromolar space between patients with class I and class II malocclusions, with higher values in class II. Sex and the SNA angle were found to influence retromolar space in patients with class II.

KEY WORDS

Distalization; Malocclusion; Class I; Class II; Retromolar space.

INTRODUCTION

The maxillary tuberosity (MT) is a bilateral anatomical structure located at the distal and inferior border of the infratemporal surface of the maxilla. The alveoli of the third molars are located in this region, which is closely related to other anatomical structures, including the pterygomaxillary fissure at its posterior boundary and the floor of the maxillary sinus at its superior boundary. These anatomical relationships give the maxillary tuberosity an important role in molar distalization procedures[1].

This anatomical arrangement facilitates an efficient biomechanical approach to molar distalization, as it allows en masse retraction of the maxillary dentition. Molar distalization may be performed bilaterally or unilaterally, particularly in cases of Class II malocclusion[1].

Maxillary molar distalization offers a means of avoiding dental extractions. Distalization mechanics are indicated for the treatment of patients with skeletal and dental Class II malocclusion. This procedure involves moving the molars distally to achieve Class I molar and canine relationships and relieve anterior crowding by creating space for dental alignment. It is commonly used when extractions are to be avoided, particularly in patients with compromised facial profiles[2,3].

Distalization is indicated in patients with erupted second molars close to the occlusal plane, increased overjet due to protrusion of the anterior teeth (maxillary or mandibular, depending on the malocclusion class), minimal skeletal discrepancies, a neutral or horizontal growth pattern, mild or moderate crowding, and in those who do not wish to undergo extractions[4].

It is essential to consider the patient's facial biotype and growth pattern. The available bone space must also be assessed during distalization. This space is measured from the distal root of the second molar to the buccal cortex, rather than from the crown of the second molar to the MT[5].

Various options are available for gaining space in conjunction with distalization, including proclination of the anterior teeth, expansion, interproximal enamel reduction (stripping), extractions and orthognathic surgery. The choice of the most appropriate option depends on the severity of the case and the patient's facial profile[3].

Early molar distalization mechanics were associated with undesirable effects, such as anchorage loss in the premolars and incisors, which delayed treatment. Adverse effects were also observed in the maxillary first molar, including extrusion, tipping and distal rotation. Adverse effects of distalization mechanics include posterior rotation of the mandible, increased lower facial height, increased facial convexity and an increase in the mandibular plane angle. These effects are favourable in patients with a deep bite and those with a brachyfacial pattern, but unfavourable in patients with an open bite and those with a dolichofacial pattern[6].

Several methods can be used to achieve molar distalization, including extraoral appliances (such as headgear) and intraoral appliances (such as the Pendulum appliance and spring-based orthodontic appliances). Patient cooperation is essential, particularly with extraoral mechanics, which led to the development of fixed intraoral appliances that deliver light, continuous forces[4,7].

Temporary skeletal anchorage techniques are currently used, including mini-implants inserted into bone and miniplates placed in the maxilla, palate and zygomatic bone. These advances help improve anchorage and accelerate distalization[8].

Orthodontists must be familiar with the protocol for measuring the available bone space using cone-beam computed tomography (CBCT), as this facilitates treatment planning. This measurement is essential for determining whether molar distalization is a viable option and likely to be successful, and directly influences treatment duration and effectiveness.

The aim of the present study is to compare the available retromolar bone space for maxillary molar distalization in adult patients with Class I and Class II malocclusions.

MATERIALS AND METHODS

This was a descriptive, observational, cross-sectional study. The amount of space available for maxillary distalization was assessed using CBCT scans from 120 patients in the database of the Postgraduate Programme in Orthodontics at the Universidad Autónoma de

Nayarit. The patients had previously undergone CBCT scanning with a VATECH PaX-i3D unit for orthodontic indications. The participants were selected by non-probability sampling until 60 Class I and 60 Class II patients had been included.

The inclusion criteria were: all patients aged between 20 and 40 years with available CBCT scans, skeletal Class I or Class II malocclusion, complete dentition up to the second molars, an alveolar bone level coronal to the molar furcations and full patient records.

The exclusion criteria were previous orthodontic treatment, previous tooth extractions (except third molars), facial asymmetry (>3 mm according to Ricketts' posteroanterior cephalometric analysis), dental prostheses and craniofacial syndromes.

The maxillary occlusal plane was used as a reference for measuring the available bone space. This plane connects the mesiobuccal cusps of the maxillary first molars with the incisal edge of the maxillary right central incisor. An additional plane parallel to the maxillary occlusal plane and passing through the furcation of the maxillary second molar was designated the 0-mm plane. Three further parallel planes were defined 2, 4 and 6 mm apical to this plane (Figure 1).

At each of these levels, the cusp line was used as the reference for measuring the retromolar distance. The cusp line was defined as the line connecting the buccal cusps of the maxillary first and second molars.

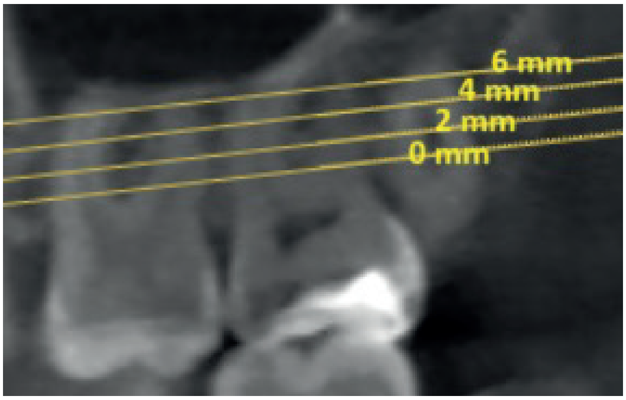

Figure 1. Planes parallel to the occlusal plane passing at 0, 2, 4 and 6 mm through the furcation of the maxillary second molar.

Linear distances were measured along the cusp line from the most distal point of the distal root of the right maxillary second molar to the inner border of the buccal cortical plate of the MT (Figure 2).

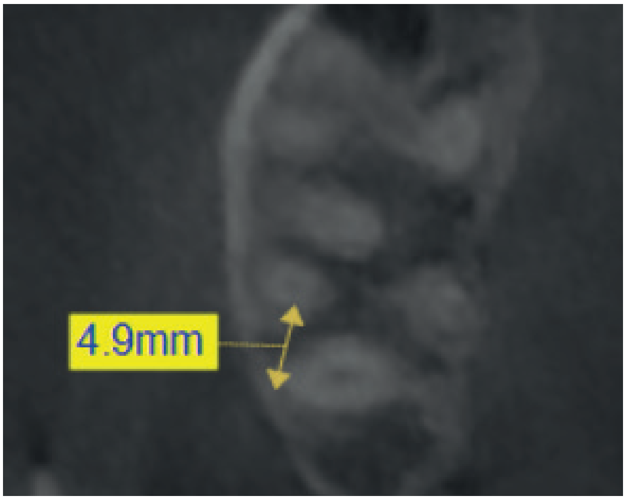

Figure 2. Linear distance from the most distal point of the distal root of the right second molar to the inner border of the buccal cortical plate.

Cephalometric analyses were performed by manual tracing on acetate sheets using a light box to identify and measure the relevant cephalometric landmarks and planes:

SNA: Angle used to assess the anteroposterior position of the maxilla relative to the cranial base. It is formed by the Sella–Nasion (S–N) and Nasion–Point A (N–A) lines.

SNB: Angle used to assess the anteroposterior position of the mandible relative to the cranial base. It is formed by the Sella–Nasion (S–N) and Nasion–Point B (N–B) lines.

ANB: Angular difference between the N–A and N–B lines. It is used to assess the sagittal relationship between the maxilla and the mandible.

IMPA: Angle formed between the long axis of the mandibular incisor and the mandibular plane (Go–Gn). It assesses the inclination of the mandibular incisor relative to the mandible.

U1-SN: Angle between the long axis of the maxillary incisor and the S–N plane. It is used to assess the inclination of the maxillary incisor relative to the cranial base.

U1/ANS–PNS: Angle between the long axis of the maxillary incisor and the palatal plane formed by the anterior nasal spine and posterior nasal spine (ANS–PNS). It reflects the inclination of the maxillary incisor relative to the hard palate.

The data and descriptive statistics were tabulated in a Microsoft Excel spreadsheet. Student's t-test and analyses of variance (ANOVA) were performed using StatCalc version 8.1.3.

This study was approved by the Research Ethics Committee of the Academic Unit of Dentistry at the Universidad Autónoma de Nayarit (approval number UAO/CEI/038/2025).

RESULTS

The mean age was 24.52 ± 5.05 years in the Class I group and 24.04 ± 5.54 years in the Class II group. The following mean values were found in the skeletal Class I group: the ANB angle was 2.76° ± 1.11°; retromolar space was 3.95 ± 1.89 mm at 0 mm, 4.4 ± 2.01 mm at 2 mm, 4.70 ± 1.98 mm at 4 mm and 4.94 ± 2.35 mm at 6 mm. The descriptive statistics for all the variables are in Table 1.

In the skeletal Class II group, the mean ANB angle and retromolar measurements were as follows: ANB angle, 6.54° ± 1.54°; retromolar space, 5.08 ± 1.90 mm at

Table 1. Descriptive statistics and comparison of Class I and Class II values using Student's t-test

	CLASS I				CLASS II				*p*
	Mean	**SD**	**Maximum**	**Minimum**	**Mean**	**SD**	**Maximum**	**Minimum**	
0 mm	3,95	1,89	10,4	1	5,08	1,90	9,9	1,7	<0,001
2 mm	4,40	2,01	9,4	0,6	5,55	1,91	9,9	1,8	<0,001
4 mm	4,70	1,98	9,7	0,4	5,65	2,002	10,4	1,9	<0,001
6 mm	4,94	2,35	10,1	0,10	5,53	2,05	11,1	2	<0,05
SNA	82,32	3,72	90	74	84,84	4,27	92	70	<0,001
SNB	79,59	3,723	88	71	78,32	3,87	86	69	<0,05
ANB	2,76	1,11	4	0	6,54	1,54	10	5	<0,001
IMPA	95,93	7,31	114	76	97,9	6,50	112	87	<0,05
U1-SN	105,33	8,22	121	80	105,22	6,78	124	95	0,902
U1/ANS–PNS	66,76	6,7	81	55	65,96	8,3	79	33	0,466

Table 2. ANOVA results for linear regression

	CLASS I		CLASS II	
	F	***P***	***F***	***P***
Age	0,981	0,426	1,465	0,226
Sex	1,111	0,361	3,332	0,016*
SNA	1,34	0,264	4,973	0,002**
SNB	0,953	0,441	1,854	0,132
ANB	0,905	0,468	2,495	0,54
IMPA	1,580	0,193	2,042	0,102
U1-SN	0,948	0,443	1,112	0,361
U1/ANS–PNS	1,996	0,108	0,534	0,711

**Statistically significant at p < 0.05; ** statistically significant at p < 0.01*
F: statistic comparing between-group variability with within-group variability. A high F-value indicates that the differences between groups are greater than the variation within groups.

0 mm, 5.55 ± 1.91 mm at 2 mm, 5.65 ± 2.02 mm at 4 mm and 5.53 ± 2.05 mm at 6 mm (Table 1).

Age, sex and the SNA, SNB, ANB, IMPA, U1/SN and U1/ANS–PNS angles were assessed by linear regression to determine whether they were associated with retromolar space. In the Class I group, none of these variables was associated with retromolar space. In patients with Class II malocclusion, retromolar space was associated with both sex and the SNA angle, with greater values in men and in those with a higher SNA angle (Table 2).

Student's t-test was used to compare the variables between the Class I and Class II groups. Statistically significant differences were found for all variables except the angle between the maxillary central incisor and the Sella–Nasion plane and the angle between the maxillary central incisor and the palatal plane (ANS–PNS) (Table 1).

DISCUSSION

The space available for molar distalization has been assessed in different studies, each using specific methods and approaches to evaluate retromolar space. Hui et al.[9] measured the available space in the maxilla using six levels based on plane 0, with 1.5-mm increments distally, and three additional planes extending apically at 3-mm intervals. The results ranged from 3.89 to 4.30 mm, with a mean available distalization space of 4.06 mm in patients with Class II malocclusion. This type of measurement is relevant because it reflects the amount of space available for molar movement, a crucial factor in planning orthodontic distalization treatment.

Yilmaz et al.[10], on the other hand, analysed maxillary retromolar space using lateral cephalometric radiographs, measuring from the line marking the anterior border of the mandibular ramus to the posterior border of the maxillary second molar. The study found a mean retromolar space of 11.3 mm and observed that this space was smaller in women than in men. This sex-related difference in the amount of space suggests that anatomical characteristics may influence the success of distalization treatment.

Ye et al.[11] compared the space available for maxillary distalization using two methods: panoramic radiographs with cephalometric landmarks and CT images with anatomical boundaries. On the three-dimensional images, the mean sagittal distance from the posterior nasal spine (PNS) to the posterior border of the maxillary tuberosity was 1.80 ± 1.81 mm, whereas the shortest distance between the distal border of the maxillary tuberosity and the most distal root of the maxillary second molar was 5.24 ± 2.26 mm. In addition, the cephalometric distance from the distal height of contour of the maxillary second molar to the PNS was 5.98 ± 2.62 mm. These results highlight the importance of using three-dimensional imaging to assess the available space more accurately.

Choi et al.[12] compared the available mandibular space on 110 CBCT scans from patients with Class I and Class III malocclusions. The results showed that the available space was greater in patients with Class III malocclusion. In this group, the mean distance along the posterior line of occlusion was 6.0 ± 3.3 mm at the furcation level and decreased to 2.7 ± 2.8 mm as the measurement was taken closer to the root apex. This decreasing pattern suggests that patients with Class III malocclusion have less space for molar distalization closer to the root apex.

Regarding mandibular retromolar space, previous studies based on panoramic radiographs assumed that the anterior border of the mandibular ramus was the posterior anatomical limit for molar distalization. However, recent studies have shown that the true limit is the inner cortical plate of the mandible because of the cortical resistance encountered when the root reaches the inner border of the buccal cortical plate[13].

Following this criterion, the maxillary limit could be considered the distance from the distal root of the maxillary second molar to the inner border of the buccal cortical plate of the MT. This underscores the importance of considering bone anatomy when planning distalization treatment.

Distalization involves moving the molars towards the MT; therefore, the amount of distalization depends on the volume of bone available in the direction of root movement. The success of this procedure is closely related to the topography of the MT, which may vary between patients.

In this regard, López et al.[1] analysed 277 MTs and found that both width and height were smaller in the absence of the third molar. This suggests that the presence of the third molar may influence the space available for distalization and should therefore be considered during treatment planning.

In the present study, patients with Class II malocclusion had greater retromolar bone space than those with Class I malocclusion at all the levels assessed (0, 2, 4 and 6 mm). This finding suggests that molar distalization planning may be more favourable in individuals with Class II malocclusion, increasing the feasibility of non-extraction treatment.

In the regression analysis, sex and the SNA angle were significantly associated with retromolar space in the Class II group. Male sex and a larger SNA angle were correlated with greater available space, which could be explained by anatomical differences in the size and shape of the maxilla between men and women.

One of the main limitations of the study was the age range of the patients (20–40 years), which limits the generalisability of the results to growing adolescents and older adults. In addition, third-molar status was not considered, although this factor may influence the space available for distalization.

Finally, it is recommended that the anatomical limit for molar distalization be determined using CBCT imaging, as this provides more accurate predictions than conventional radiography.

2D radiographs may be affected by errors arising from incorrect image orientation, superimposition of structures and magnification distortion, which could compromise measurement accuracy and treatment success.

CONCLUSIONS

Statistically significant differences in retromolar space were observed between patients with Class I and Class II malocclusions, with greater retromolar space values in patients with Class II malocclusion. This finding suggests that the space available for molar distalization may be more favourable in patients with Class II malocclusion, which could influence clinical decision-making when planning orthodontic treatment according to the type of malocclusion. Sex and the SNA angle were found to influence retromolar space in patients with skeletal Class II malocclusion.

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ORIGINAL ARTICLE

4.5 mm-length implants used in vertical bone atrophy (residual bone height ≤ 4.5 mm): A retrospective study

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ABSTRACT

Introduction: Vertical atrophy in the posterior maxilla represents a frequent challenge in dental implant rehabilitation. Transcrestal sinus floor elevation has gained relevance in these cases. When 5.5 mm implants are insufficient due to limited bone availability, 4.5 mm extra-short implants have emerged as a viable alternative. This study presents a retrospective series of cases treated with this approach.

Methods: Patients who received 4.5 mm-long implants in residual ridges with ≤4,5 mm of bone height were retrospectively analyzed. A transcrestal sinus lift was performed using autologous bone chips obtained from the drilling process and PRGF-Endoret as grafting material. The primary variable was implant survival; secondary variables included crestal bone stability after prosthetic loading. Qualitative variables were analyzed using frequency analysis; quantitative data were described with mean ± standard deviation. Implant survival was estimated using the Kaplan-Meier method.

Results: Sixteen patients with a total of 18 implants met the inclusion criteria. The mean residual bone height at implant sites was 3.96 mm (±0.38). Sinus lifts ranged from 0.2 to 1.3 mm. All implants were 4.5 mm in length. The mean follow-up was 36.3 months (±2.71). No implant failures were recorded, resulting in a cumulative survival rate of 100%. Mean marginal bone loss at the end of follow-up was 0.35 mm mesially and 0.11 mm distally.

Conclusions: 4.5 mm implants combined with transcrestal sinus floor elevation and PRGF-Endoret appear to be a predictable therapeutic option for the rehabilitation of severely resorbed posterior maxillae.

KEYWORDS

Bone atrophy; Transcrestal sinus lift; Extrashort dental implant.

INTRODUCTION

Transcrestal sinus floor elevation combined with extra-short implants has become a widely used approach for rehabilitating the posterior maxilla in cases of moderate-to-severe horizontal bone atrophy[1,2]. Different protocols are used for the surgical approach, implant site preparation and implant placement[3-6]. The choice of implant type depends directly on residual bone height. Where residual bone height permits, short implants (6.5–7.5 mm) or extra-short implants (5.5–6.5 mm) can be used[7,8]. However, when only 3–5 mm of bone is available, even shorter implants are required to facilitate a minimally invasive crestal approach. In situations involving less bone volume and shorter implants, achieving primary stability becomes more difficult, although it is essential for treatment success. Our research group is among those that have shown that transalveolar sinus floor elevation can be performed with short and extra-short implants even when residual ridge height is less than 5 mm, provided that the implant is adequately stabilised in three dimensions around the perimeter of the alveolar crest. To achieve this, the drilling sequence must be adapted to the characteristics of the residual bone, and implants designed to provide three-dimensional anchorage (buccopalatal and mesiodistal) must be used to achieve optimal fixation within the alveolar crest. This approach is essential to ensure stability even in challenging situations, such as those requiring an implant less than 5.5 mm long. The need to treat such cases led to the development of 4.5-mm-long implants. Few studies have evaluated implant survival and crestal bone loss in implants less than 5 mm long. Nevertheless, the available studies agree that these implants do not have higher failure rates or greater bone resorption than standard-length implants placed in conjunction with regenerative procedures in cases of severe bone atrophy or with procedures such as transcrestal sinus floor elevation. The present study reports a retrospective case series in which 4.5-mm-long implants were placed in the posterior maxilla at sites with a residual bone height of ≤5 mm, using particulate autologous bone combined with PRGF-Endoret as the graft material.

MATERIALS AND METHODS

Patients were retrospectively included if, between June 2020 and September 2021, they had undergone placement of 4.5-mm-long dental implants with direct cortical anchorage in residual ridges up to 4.5 mm in height, together with transcrestal sinus floor elevation using autologous bone harvested during drilling and PRGF-Endoret as the graft material. Before implant placement, all patients were assessed using diagnostic models, an intraoral examination and a cone-beam computed tomography (CBCT) scan. The scans were analysed using specialised software (BTI-Scan III) to determine the exact residual ridge height and bone density and to adapt the surgical protocol and implant selection accordingly. As part of the preoperative protocol, patients received antibiotic premedication with amoxicillin (2 g orally) one hour before the procedure, together with paracetamol (1 g orally) as an analgesic. After surgery, patients continued antibiotic therapy with amoxicillin (500–750 mg orally every 8 hours, according to body weight) for five days. All implants were placed by the same surgeon using the biological drilling technique, characterised by low-speed drilling without irrigation. The drilling protocol was adapted to the density and volume of bone at the recipient site to ensure adequate primary implant stability[8-9].

Final access to the cortical bone of the sinus floor was achieved with a drill specifically designed for this technique (a front-cutting drill), which allows controlled removal of the maxillary sinus floor without compromising the integrity of the Schneiderian membrane[10]. Once the membrane had been exposed through the crestal osteotomy, it was elevated in a controlled manner. The graft was then placed and consisted of autologous bone harvested during drilling at other implant sites prepared during the same surgical procedure and combined with PRGF-Endoret. The implant was placed using a surgical motor set to a maximum torque of 25 Ncm and a speed of 25 rpm. Final insertion was performed manually using a torque wrench to ensure optimal fixation (Figure 1).

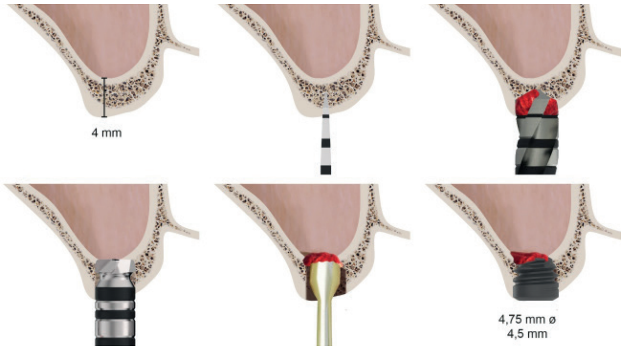


Figure 1. Drilling sequence in a ridge with extreme horizontal resorption, using a 4.5-mm-long implant and autologous bone combined with PRGF-Endoret as graft material.

Implant loading was performed four to five months later, initially with a provisional prosthesis under progressive loading, in all cases using transepithelial abutments. The definitive prosthesis was placed one to two months after initial loading.

To estimate marginal bone loss, a reference of known length on the radiographs, specifically, the implant length, was used to calibrate the measurements. Following calibration, the software used (Digora for Windows; SOREDEX Digital Imaging Systems) calculated the actual measurements. Marginal crestal bone loss was determined by measuring the distance from the implant shoulder to the first bone-to-implant contact. To assess changes in bone resorption in each patient, the radiograph taken at the time of prosthesis placement was used as the reference. The patients subsequently attended follow-up visits every six months, during which new follow-up radiographs were obtained. During postoperative visits and after placement of the prosthesis, any prosthetic or surgical complications were recorded in the clinical record and subsequently analysed.

Statistical analysis

The primary outcome was implant survival, and the secondary outcome was crestal bone stability after loading. The patient was considered the unit of analysis for variables such as age, sex and medical history, whereas the implant was the unit of analysis for all other variables.

The Shapiro–Wilk test was used to assess the normality of the data distribution. Qualitative variables were analysed using frequency distributions, whereas quantitative variables were described using the mean and standard deviation.

The implant survival rate was estimated using the Kaplan–Meier method. All statistical analyses were performed using SPSS version 15.0 (SPSS Inc., Chicago, IL, USA), with a significance level of 5% ($p < 0.05$).

This study was designed as a retrospective study based on the review of clinical data previously recorded in routine practice. All procedures were performed in accordance with the ethical principles of the Declaration of Helsinki and applicable local regulations governing research involving human participants. Written informed consent was obtained from all included patients, authorising both the clinical treatment and the use of their data for scientific purposes. As no additional interventions were performed and no treatment plans were modified for research purposes, and data collection was limited to the retrospective analysis of cases, prior review by an institutional ethics committee was not considered necessary.

RESULTS

A total of 16 patients were included, in whom 18 implants meeting the previously described selection

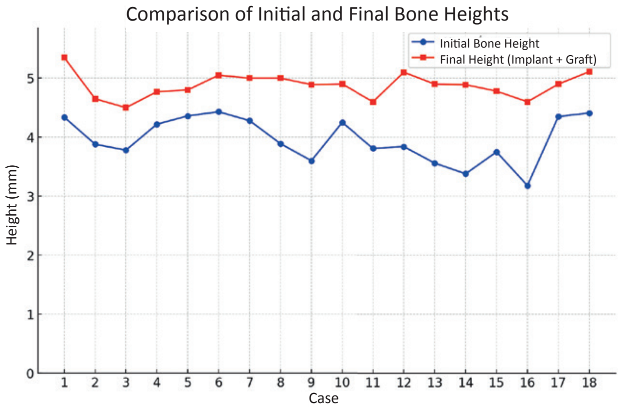


Figure 2. Implants placed, showing the residual bone height at each site and the number of millimetres gained above the implant apex.

criteria were placed. The mean age of the patients was 58.76 years (±11.43), and 12 patients were women. The mean preoperative bone height at the implant sites was 3.96 mm (±0.38), with a range of 3.18–4.43 mm.

In all cases, the amount of sinus floor elevation ranged from 0.2 to 1.3 mm. Figure 2 shows the initial and final bone heights for each implant. The most frequent implant positions were 16 and 26, each accounting for 33.3%, whereas position 27 was the least frequent (11.1%). All implant positions are shown in Figure 3.

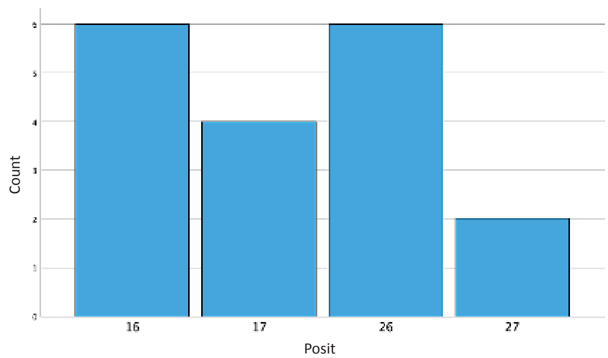


Figure 3. Positions of the implants included in the study.

Implant diameters ranged from 3.75 to 6 mm. The most frequent diameters were 4.25 and 4.75 mm, each accounting for 27.8%. All implants placed were 4.5 mm long. The diameters and lengths of the implants included in the study according to their position are shown in Figure 4.

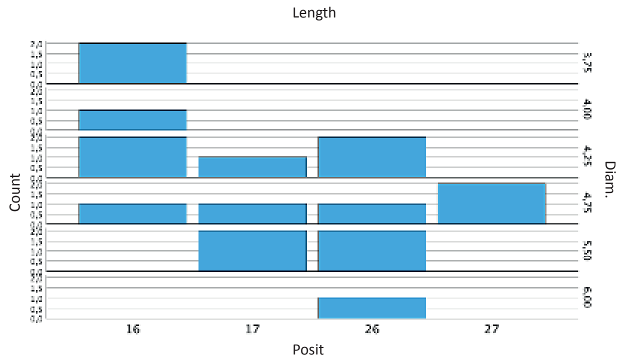


Figure 4. Implant diameters and lengths included in the study according to their position.

Type IV bone was the most common bone type at the implant sites, occurring in 46.7% of cases, with a mean density of 263.89 HU (±134.82). Figure 5 shows the bone densities for all implants according to position and diameter.

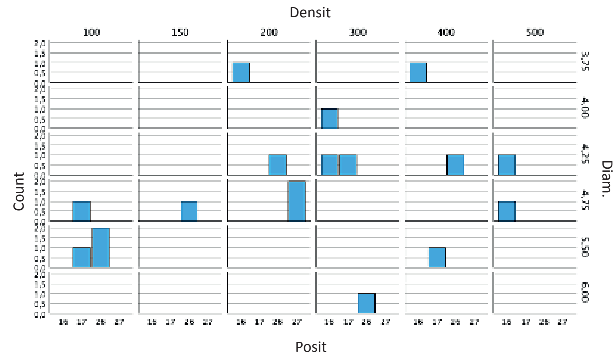


Figure 5. Implant positions and diameters according to bone density at the recipient site.

The implant insertion torque ranged from 5 Ncm to 60 Ncm, with a mean of 28.33 Ncm (±17.65). The most frequent insertion torque was 15 Ncm (27.8% of cases). Figure 6 shows the insertion torque values obtained according to bone density in Hounsfield units.

The mean follow-up period for the implants was 36.3 months (±2.71; range, 36–42 months). No implant failures occurred during this period, resulting in a cumulative survival rate of 100%. The mean mesial bone loss at the end of follow-up was 0.35 mm (±0.62) for all implants, while the mean distal bone loss was 0.11 mm (±0.49).

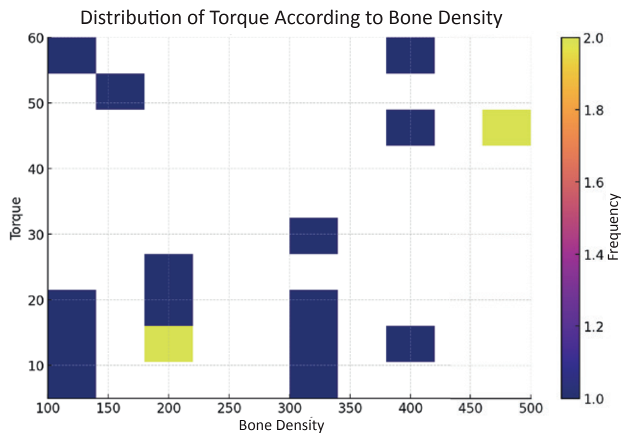


Figure 6. Insertion torques according to bone density.

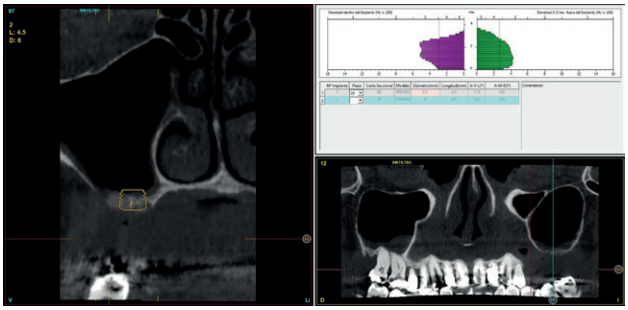


Figure 7. Cross-sectional CBCT planning image showing the limited residual ridge height and the planned placement of a 4.5-mm-long, 6-mm-diameter implant.

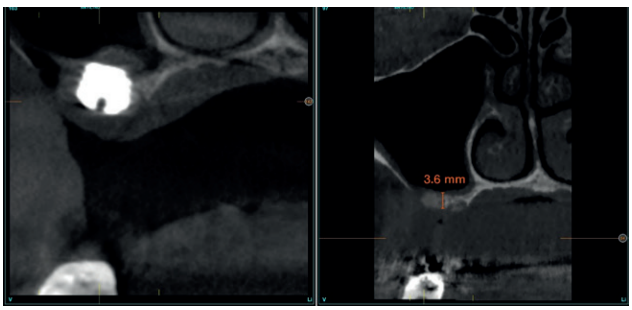
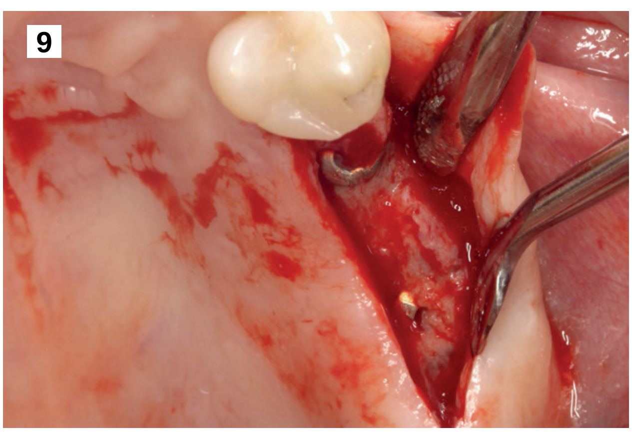
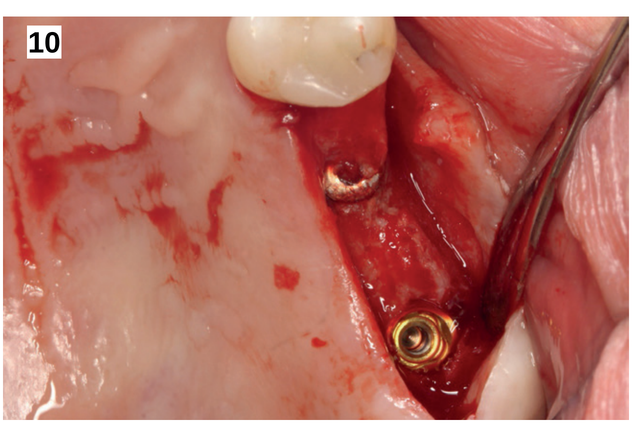


Figure 8. Cross-sectional image after implant placement, showing the bone graft and the initial residual bone height.





Figures 9 and 10. Images obtained during re-entry surgery 6 months after implant placement, showing successful osseointegration and bone growth, even above the implant cover screw.

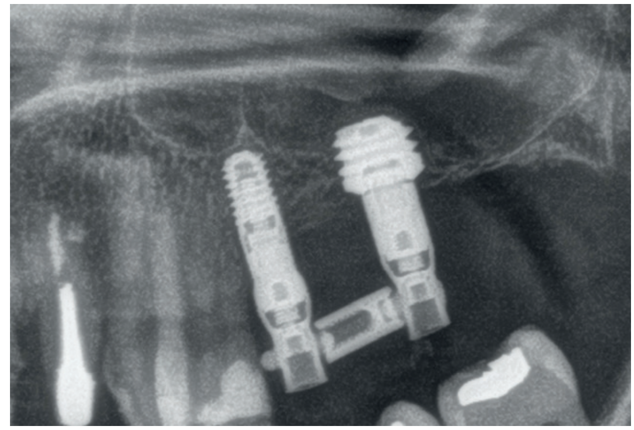


Figure 11. Radiograph showing progressive loading after second-stage implant surgery.

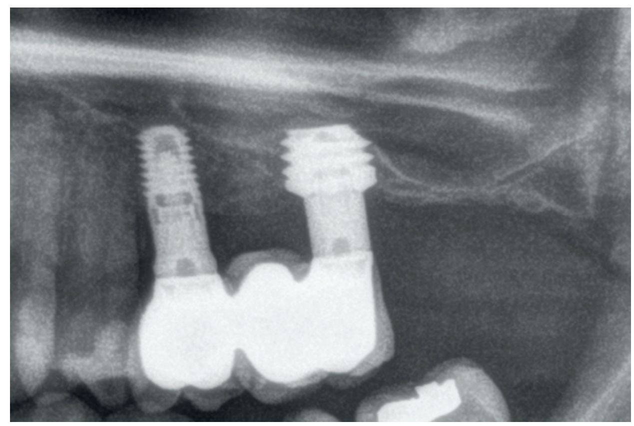


Figure 12. Definitive prosthesis 3 months after progressive loading.

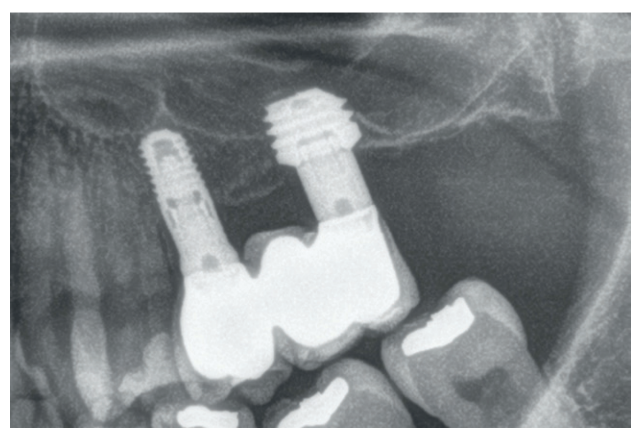


Figure 13. Definitive prosthesis 4 years after implant placement.

Figures 7–13 show one of the cases included in the study.

DISCUSSION

Implant dentistry is increasingly moving towards minimally invasive procedures, in line with other medical specialties. In this context, the use of smaller implants has become particularly important. In particular, 4.5-mm-long implants, such as those analysed in the present study, represent a viable therapeutic alternative for the rehabilitation of patients with moderate-to-severe bone atrophy in the posterior maxilla, with or without the need for transcrestal sinus floor elevation. This strategy can optimise functional outcomes and reduce the surgical morbidity associated with more invasive procedures, such as sinus floor elevation via a lateral approach[11-15]. Short and extra-short implants have also proved to be a predictable treatment option, as demonstrated by systematic reviews with meta-analyses reporting survival rates for extra-short implants ranging from 86.7% to 100%[16,17]. In particular, 4-mm-long implants have more recently been included in this category. Existing studies of their survival, crestal bone loss and surgical or prosthetic complications indicate outcomes comparable to those of conventional-length implants placed in conjunction with regenerative techniques[17-19]. However, regenerative techniques are generally associated with increased patient morbidity, reinforcing the importance of extra-short implants as a less invasive treatment option. The introduction of 4.5-mm-long implants, combined with an appropriate diagnostic and surgical protocol, has made it possible to optimise primary stability even

at sites with very low bone density or in patients with minimal residual bone volume. This development has facilitated the use of transcrestal sinus floor elevation, allowing 4.5-mm-long implants to be placed at sites with a residual bone height of only 1–2 mm[12]. As a result, the treatment approach to rehabilitation of the atrophic posterior maxilla has changed significantly, reducing the need for more invasive procedures and improving clinical outcomes. At sites with greater residual bone height, these implants can also be placed without the need for sinus access. This is an advantage, as transcrestal sinus floor elevation would have been necessary with 5.5-mm-long implants[20-23].

CONCLUSIONS

According to the data obtained in the present study, 4.5-mm-long implants proved to be a predictable treatment option for rehabilitation of the posterior maxilla in cases of limited residual bone height when combined with transcrestal sinus floor elevation. These implants therefore represent a suitable treatment option in cases where residual bone height is between 4 and 5 mm.

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CLINICAL REPORT

Microinvasive approach to the management of white spot lesions in a case of amelogenesis imperfecta

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ABSTRACT

Introduction: White spot lesions are opacities in the dental enamel as a consequence of a defect in its mineralization. This hypomineralization can be an initial sign of a carious lesion, or due to a defect in the enamel as a consequence of an alteration during its formation. The etiology and extent of the lesions determine the therapeutic approach. The aim of the present case report is to describe the microinvasive approach of a case of amelogenesis imperfecta in a mild form of presentation.

Materials and Methods: A clinical case of a 33-year-old non-smoker female patient with no previous registered medical records (ASA I), with the presence of white spot lesions as a clinical manifestation of amelogenesis imperfecta hypomature type, subtype IIC, that were treated by a microinvasive approach combining bleaching which improves the optical properties of the lesion as it has a refractive index similar to that of healthy enamel.

Results: Dental bleaching is a non-invasive procedure, which in this case partially masked the white spot lesions and improved the substrate for subsequent resin infiltration. Infiltration is a microinvasive, fast and safe procedure, which allows good esthetic results achieving complete masking of most lesions.

Conclusions: Resin infiltration combined with bleaching is a conservative procedure that respects tooth structure and provides satisfactory esthetic results in the treatment of white spot lesions caused by amelogenesis imperfecta.

KEY WORDS

White spot lesions; Amelogenesis imperfecta; Resin infiltration; Tooth bleaching; Microinvasive treatment.

INTRODUCTION

White spot lesions (WSLs) are defined as non-cavitated whitish opacities on the surface of dental enamel resulting from enamel hypomineralization or hypomaturation[1,2]. The presence of these lesions, particularly on anterior teeth, may cause significant aesthetic alterations and may even affect patients' self-esteem. WSLs have multiple etiological factors and may develop during either the pre-eruptive or post-eruptive phase. The former group includes dental fluorosis, traumatic hypomineralization, molar-incisor hypomineralization (MIH) and amelogenesis imperfecta, whereas the latter includes initial caries lesions. Regardless of their etiology, all WSLs involve a reduction in subsurface enamel mineral content, resulting in changes in its chemical composition and consequent alterations in its optical properties[3].

The clinical features of WSLs include loss of enamel translucency, an opaque white appearance, particularly when the tooth is dehydrated, and a porous, rough surface. This mineralization defect and a possible reduction in the density of the surface enamel layer may be detectable radiographically or by transillumination[2].

The characteristic opacity of WSLs is caused by increased microporosity between the hydroxyapatite crystals, with the resulting spaces being occupied by organic fluids that alter the refractive index (RI) of enamel.

Healthy enamel has an RI of 1.62, whereas organic fluids, which consist mainly of water, have an RI of 1.33. This difference in RI within the same tissue alters the perception of light and is the physical phenomenon responsible for the optical changes observed in enamel affected by WSLs. When the enamel is dehydrated, these fluids are replaced by air, which has an RI of approximately 1. As this value differs more markedly from that of healthy enamel, the WSL becomes more evident in the dehydrated tooth and appears whiter and more opaque[4,5]. It should be noted that the surface layer of some lesions may be hypermineralized, particularly in long-standing lesions or lesions that have been treated with remineralizing agents, which may influence the treatment approach.

Determining the etiology, size and depth of WSLs is essential before selecting a treatment option, as treatment outcomes vary according to the enamel substructure1 and the patient's aesthetic expectations. A thorough visual examination allows the main characteristics of WSLs to be assessed; however, supplementary diagnostic methods such as photography and, particularly, transillumination enable their shape, size, color, location, depth and extent to be evaluated more accurately[5].

Pre-eruptive WSLs result from disturbances during amelogenesis, either during the secretory phase or the maturation phase, producing enamel of normal volume but with a lower degree of mineralization and, therefore, qualitative defects. This article focuses on one of the conditions included in this group: amelogenesis imperfecta (AI)[6].

Amelogenesis imperfecta (AI) is a disorder of enamel formation and mineralization characterized by hypoplasia and/or hypomineralization. It is genetic in origin and may be inherited in an autosomal dominant, autosomal recessive, or X-linked dominant pattern; sporadic cases also occur. It affects the structure and clinical appearance of the enamel of all or nearly all teeth in a similar manner. One of the most widely used classifications is that proposed by Witkop in 1988, which takes into account the enamel phenotype and mode of inheritance (Table) . As this classification shows, AI is a complex disorder that may have different clinical expressions or forms. Because of its genetic origin, it affects both the primary and permanent dentitions, irrespective of the chronology of tooth eruption[6,8,9].

This developmental enamel defect results from pathogenic variants in, or altered expression of, genes encoding proteins involved in amelogenesis, including enamelin (ENAM), amelogenin (AMELX), enamelysin (MMP20), kallikrein-related peptidase 4 (KLK4), FAM83H, WDR72, FAM20A, SLC24A4, DLX3, AMBN, LAMB3, ITGB6, and C4orf26. The possible roles of ALB and TUFT1 in amelogenesis are also under investigation.

These genetic alterations disrupt normal ameloblast function, resulting either in enamel of reduced thickness in the hypoplastic forms of AI or in enamel of normal thickness but with defective mineralization and maturation in the hypocalcified or hypomaturation forms[10,11]. The clinical presentation of AI depends on the gene involved and the stage of amelogenesis at which the defect is expressed. It may range from superficial changes in color to complete enamel aplasia12 and may be accompanied by aesthetic impairment and hypersensitivity[12,13]. Although AI is primarily an enamel-specific disorder, it is frequently associated with other abnormalities, including pulp calcifications, delayed tooth eruption, congenitally missing teeth, root resorption, open bite, negative overjet, and discrepancies in the vertical relationship of the jaws[9,14,15].

This article focuses on type II hypomaturation AI, which presents a less severe qualitative enamel defect because the disturbance occurs during the maturation stage of amelogenesis. It is characterized by reduced enamel mineral content. The enamel may be less translucent, opaque, and pigmented; it is harder than in the hypocalcified forms and with a normal thickness. The enamel surface is usually smooth, although it may appear mottled or show vertical bands of alternating normal and highly permeable hypomature enamel[12-15].

Enamel discoloration may be white, yellowish, grayish, or brownish. The mildest form of this type of AI often goes undiagnosed, and patients generally seek treatment for aesthetic reasons[15]. This type of AI includes a clinical variant known as “snow-capped enamel” or “snow-capped teeth,” in which an area of opaque whitish enamel is present in the occlusal or incisal third of the teeth. Because of the clinical appearance of the teeth, it may sometimes be necessary to differentiate this condition from dental fluorosis[14].

The principal treatment options for WSLs of pre-eruptive origin include tooth bleaching, which is generally the first step in almost all cases, followed by or combined

Table. Classification carried out by Witkop in 1988, based on phenotype[7].

Amelogenesis Imperfecta classification. Witkop 1988		
TYPE I	HYPOPLASTIC	
	IA	Hypoplastic, pitted, autosomal dominant
	IB	Hypoplastic, local, autosomal dominant
	IC	Hypoplastic, local, autosomal recessive
	ID	Hypoplastic, smooth, autosomal dominant
	IE	Hypoplastic, smooth, X-linked dominant
	IF	Hypoplastic, rough, autosomal dominant
	IG	Enamel agenesis, autosomal recessive
TYPE II	HYPOMATURATION	
	IIA	Hypomaturation, pigmented, autosomal recessive
	IIB	Hypomaturation, X-linked recessive
	IIC	Hypomaturation, snow-capped teeth, X-linked
	IID	Hypomaturation, snow-capped teeth, autosomal dominant
TYPE III	HYPOCALCIFIED	
	IIIA	Autosomal dominant
	IIIB	Autosomal recessive
TYPE IV	HIPOMADURACION-HIPOPLASISM WITH TAURODONTISM	
	IVA	Hypomaturation-hypoplastic with taurodontism, autosomal dominant
	IVB	Hypoplastic-hypomaturation with taurodontism, autosomal dominant

with enamel microabrasion, resin infiltration, or, where necessary, direct composite restorations.

Tooth bleaching does not treat the lesion itself; its main purpose is to mask it by reducing the contrast between the lesion and the surrounding sound enamel. Its principal advantage is that it is a non-invasive procedure that also provides a more favorable aesthetic substrate for subsequent procedures[16]. Its disadvantage is that it does not usually produce satisfactory results when used alone.

Enamel microabrasion is particularly effective for superficial WSLs. This procedure combines abrasive agents, such as pumice or silica, with an acid, such as 37% phosphoric acid or 6% hydrochloric acid. One disadvantage is that it removes a greater thickness of enamel than resin infiltration; it may also cause sensitivity in some cases, reduce enamel thickness and even initiate the restorative cycle[5,17]. It is important to note that all these procedures may be combined to obtain better aesthetic results while remaining as conservative as possible.

Resin infiltration is a microinvasive procedure initially used to treat non-cavitated proximal caries lesions, and its use has expanded in recent years to the aesthetic treatment of WSLs. The procedure is based on etching the enamel surface with 15% hydrochloric acid for 2 minutes, thereby increasing the porosity of the surface enamel, followed by dehydration with 99% ethanol and, finally, infiltration with a low-viscosity resin[18], which penetrates the body of the lesion by capillary action and fills the microporosities[3,4,18]. It is a low-molecular-weight resin, specifically triethylene glycol dimethacrylate (TEGDMA), which improves the optical properties of the lesion because it has an RI of 1.52, similar to that of sound enamel (1.62), thereby masking the lesion. Its effectiveness in improving the aesthetic appearance of WSLs has been demonstrated-[3-5]. The advantages of resin infiltration include its microinvasive nature, as only a minimal layer of enamel, 34 µm per application, is removed[19,20]; it does not cause sensitivity and provides better aesthetic results than other procedures. However, resin infiltration does not remineralize the enamel, and satisfactory results are not always achieved in deep lesions. It must therefore be combined with other procedures, such as microabrasion or even composite restorations[15,16].

CASE REPORT

A patient was referred to the Master in Lifelong Training in Aesthetic Restorative Dentistry and Endodontics at Rey Juan Carlos University for aesthetic treatment of her WSLs. She was a 33-year-old woman with no medical conditions recorded in her medical history. She reported that she had been born in Orense and raised in Málaga and Madrid, Spain. Clinical examination revealed generalized WSLs in the incisal third of the maxillary anterior teeth and isolated lesions in the posterior regions. The lesions showed a homogeneous distribution and color pattern (Figure 1). A photographic record was also obtained using a Nikon D7200 camera and an AF-S Micro-Nikkor 105 mm lens. This was supplemented with photographs taken using a polarizing filter (Polar_eyes; Nikon R1C1) and with transillumination, for which the tip of a Mini LED light-curing unit (Acteon Satelec, France) was positioned palatally. These non-invasive adjunctive examinations made it possible to determine the extent and depth of the WSLs.

Most lesions were superficial and well demarcated, with a homogeneous lesion body (type I), according to the transillumination-based classification of Marouane and Manton (2021)[21].

Because WSLs were present on nearly all the teeth and the information obtained during history-taking did not indicate another cause, a diagnosis of type II AI, hypomaturation subtype IIC ("snow-capped enamel" or "snow-capped teeth"), was made[13,14]. Because as it is a genetically determined disorder, genetic testing is required to confirm the diagnosis and determine the inheritance pattern; however, the patient did not consider it necessary to undergo this test.

These superficial, well-demarcated lesions are considered to respond better to resin-infiltration treatment than deep lesions with heterogeneous

Figure 1. Initial situation. Intraoral view of the maxillary anterior teeth showing white and brownish spots.

Figure 2. Situation following home teeth whitening. A reduction in the contrast between the lesions and the sound enamel can be observed, with the brown lesions becoming less visible.

lesion bodies, which may require modifications to the infiltration protocol or more invasive restorative treatments[21].

A combined treatment was therefore proposed, beginning with tooth bleaching followed by resin infiltration of the WSLs, as this was the most conservative option[15,16].

After basic periodontal treatment had been completed, at-home bleaching was initiated using 16% carbamide peroxide (Pola Night, SDI, Australia), applied overnight in custom-made trays fabricated from thermoplastic sheets. The initial shade, 3M1, was recorded using the VITA Toothguide 3D-MASTER shade guide (VITA Zahnfabrik, Bad Säckingen, Germany). The aim of bleaching was to reduce the contrast between the lesions and the sound enamel. During the final week of treatment, the patient was instructed to apply the bleaching agent every other day because she developed mild tooth sensitivity. After 4 weeks of application, a final shade of 1M1 was obtained(VITA Toothguide 3D-MASTER shade guide), and bleaching was discontinued because the aesthetic objective was considered to have been achieved (Figure 2).

Despite the marked tooth-whitening effect, the WSLs were not completely masked (Figure 3); resin infiltration was therefore performed. Before resin infiltration, photographs were taken using a polarizing filter and transillumination to confirm the extent and homogeneity of the lesions (Figure 4).

The Icon Vestibular resin infiltration kit (DMG, Hamburg, Germany) was used in accordance with the manufacturer's instructions, with slight modifications to the protocol. Absolute isolation was achieved from

Figure 3. Right-side view (A), front view (B) and left-side view (C). Lesions can be observed extending to the premolars on both sides.

teeth 15 to 25 using a Nic Tone rubber dam (MDC Dental, Mexico) and No. 00 clamps (Figure 5).

The WSLs were etched with Icon Etch, a 15% hydrochloric acid, for 2 minutes (Figures 6 and 7). The treated

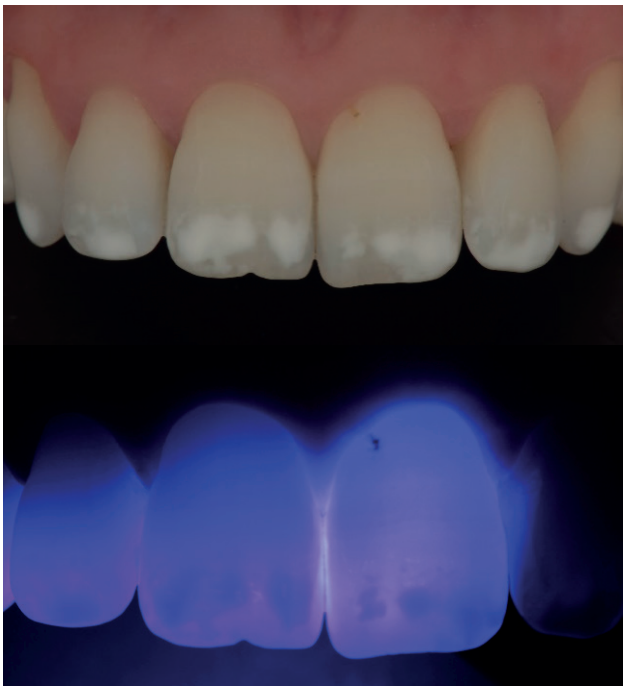

Figure 4. Polarized-light photograph of the post-bleaching clinical appearance (A). Palatal transillumination photograph of the maxillary incisors (B), showing well-defined lesion boundaries and a homogeneous lesion body.

Figure 5. Intraoral view under absolute isolation.

surfaces were then rinsed with water spray and dried. A 99% ethanol solution (Icon Dry) was then applied. Three seconds after its application, transillumination was used to determine whether the lesions disappeared, in what is known as the ethanol test[19,21].

Figure 6. First resin infiltration session. Etching with 15% hydrochloric acid for 2 minutes using Icon Etch.

Figure 7. Rinsing with water spray for 30 seconds.

As the lesions did not disappear, the etching procedure was repeated four times. The number of applications was therefore increased beyond that recommended by the manufacturer in order to achieve deeper etching of the lesions and improve the degree of infiltration[22-24]. The hydrochloric acid was also applied actively to eliminate CO_2 bubbles, improve lesion conditioning[24] and achieve deeper removal of the superficial hypermineralized layer.

Icon Dry was then applied for 30 seconds (Figure 8), followed by drying with moisture-free air for 30 seconds. The principal function of ethanol is to dehydrate the microporosities of the WSLs and facilitate resin infiltration. It is recommended that the process be repeated at least once to remove as much water as possible. However, as noted above, it may also help predict whether the lesion can be masked by infiltration: if the lesion disappears within the first 3 seconds after being moistened with ethanol[20,21,23,24].

The low-viscosity infiltrating resin, Icon Infiltrant, was then applied to the white spot lesions and left in place for 3 minutes, after which it was light-cured for 40 seconds using a Mini LED light-curing unit

Figure 8. Application of a 99% ethanol solution for 30 seconds, followed by drying (Icon Dry).

Figure 11. Removal of interproximal excess using dental floss and a No. 12 scalpel blade.

(Acteon Satelec) (Figures 9 and 10). The procedure was repeated, allowing the infiltrant to remain in place for 1 minute, after which it was light-cured again for a further 40 seconds[25].

Once infiltration had been completed, the interproximal excess was carefully removed using dental floss and a No. 12 scalpel blade (Swann-Morton) (Figure 11), and the isolation was removed. The facial surfaces were polished using fine- and superfine-grit Sof-Lex discs (3M ESPE, USA), DIACOMP PLUS TWIST polishers (EVE, Germany), and Enamelize aluminum oxide polishing paste (Cosmedent,USA). At a follow-up appointment 7 days later, the lesions on teeth 23, 24 and 25 had not completely disappeared (Figure 12). A further application of Icon Vestibular was therefore performed on these teeth after roughening the lesion surfaces with a medium-grit Sof-Lex disc. The entire procedure described above was repeated, with favorable aesthetic results (Figure 13).

After 4 months, the results were reviewed (Figures 14 and 15), and polarized-light and transillumination photographs were taken again (Figure 16).

Figure 9. Application of the infiltrating resin for 3 minutes (Icon Infiltrant).

Figure 12. Clinical appearance after the first infiltration procedure. The lesions on teeth 23, 24 and 25 remain visible.

Figure 10. Light curing for 40 seconds.

Figure 13. Clinical appearance after the second application, with the lesions completely masked.

Figure 14. Right-side (A), front (B) and left-side (C) view of the intraoral clinical appearance at 4 months after infiltration.

Figure 15. Details of the clinical appearance at 4 months: right-side view (A) and left-side view (B).

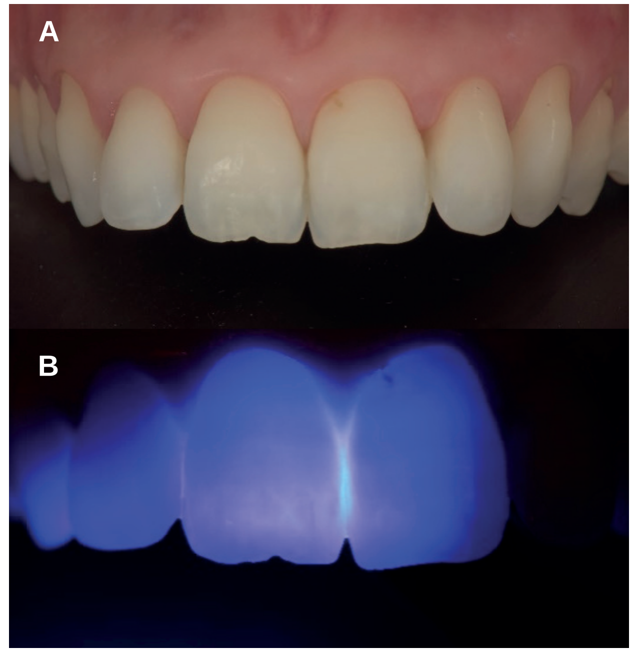

Figure 16. Polarized-light photograph (A) and post-treatment transillumination photograph (B).

DISCUSSION

AI is a genetically determined disorder of enamel formation that, in its mild forms, may present solely as WSLs. The treatment of aesthetic alterations represents a challenge for the clinician, and the treatment approach is selected according to lesion severity, the patient's age and the patient's aesthetic expectations[12,15,16]. This case demonstrates the good aesthetic results achieved by combining tooth bleaching with low-viscosity resin infiltration (Figures 17 and 18). These microinvasive procedures should therefore be considered before conventional procedures when treating these clinical presentations of AI.

Tooth bleaching is a non-invasive procedure that, in this case, partially masked the WSLs by reducing the differences between sound and affected enamel and improved the substrate for subsequent resin infiltration[16]. Therefore, even when tooth bleaching does not achieve the desired result, it may improve the final outcome when combined with other procedures, as it removes other types of stains, such as the brown stains present in this case, which is necessary before the infiltration procedure[26].

With regard to resin infiltration, the greatest challenge is adequately conditioning the hypermineralized

Figure 17. Detailed image of the masking of white spot lesions.

Figure 18. Final result.

surface enamel layer, because if this layer remains, the resin cannot infiltrate or mask the subsurface lesion. The use of 15% hydrochloric acid has been shown to be the best option for conditioning the surface enamel layer, removing approximately 34 µm of tooth structure with each application performed according to the manufacturer's recommended protocol. In this case, the conditioning protocol was modified because, when the ethanol test and transillumination were performed during the first 3 seconds after application of Icon Dry, some lesions showed a negative ethanol-test pattern. It was therefore necessary to repeat the Icon Etch application procedure, as indicated by Marouane and Manton[21]. Arnold et al. (2015)[22] had previously found that repeating the conditioning procedure increases the etching depth. Other authors have reported that the number of hydrochloric acid applications may be increased, provided that no more than seven applications are performed[22-25]. Although the number of applications recommended by the manufacturer was exceeded, resin infiltration would still be more conservative than microabrasion, which may remove up to 360 µm of enamel[22], or the use of a bur.

The low-viscosity TEGDMA resin fills the microporosities of the lesion by capillary action, preventing them from being occupied by oral fluids or air. Its ability to penetrate the lesion is determined by the previous conditioning of the enamel and the resin infiltration time. Although a 3-minute application is recommended, the infiltration time may be extended to up to 15 minutes to achieve a greater degree of infiltration[25,27,28]. However, in our case, the application time was not extended because the ethonol test was positive, which led us to expect a good response to infiltration[21].

The advantages of this resin infiltration procedure are that it is microinvasive, preserves tooth structure, is safe and rapid, provides good aesthetic results in a single visit, and is highly acceptable to patients[29-32]. One disadvantage is that it does not achieve complete masking in deep lesions and that, despite producing a good aesthetic result, its application does not remineralize the lesion but only masks it[28,33].

Finally, although the color stability of infiltrated WSLs has been questioned, published clinical studies agree that the aesthetic results are maintained[34], even 6 years after infiltration[35].

CONCLUSION

Resin infiltration, preceded by tooth bleaching, is an effective and conservative alternative for treating WSLs caused by a mild form of AI. This therapeutic combination not only provides satisfactory aesthetic results but also preserves tooth structure. The use of ethanol and simultaneous observation of its effect using transillumination are valuable diagnostic tools that can predict the success of resin infiltration, thereby optimizing the clinical management of these lesions.

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CASE REPORT

Detection of carotid calcifications using panoramic dental radiography: A general health promotion action from the dental clinic

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ABSTRACT

Introduction: Ischemic stroke is one of the leading causes of disability and mortality in adults. Arterial stenosis caused by carotid atheromas is a primary cause, making early identification crucial.

Aim: Although Doppler ultrasound is the most reliable diagnostic method, oral panoramic radiography can be effective preliminary detection tool.

Methods: The article presents three clinical cases where incidental detection of carotid calcifications in patients with periodontitis during routine radiographic examinations and their referral to a family physician allowed for preventive measures.

Results and conclusions: The dentists could actively contribute within the multidisciplinary medical team to the prevention of cerebrovascular accidents.

KEYWORDS

Carotid atheromas; Carotid calcifications; Carotid bifurcation; Panoramic radiographs; Stroke; Cerebral infarction; Oral health.

INTRODUCTION

Cerebral infarction, or ischemic stroke, is the leading cause of disability among adults in Europe and the second leading cause of death in developed countries[1,2]. According to the latest estimates, one in four people worldwide will experience a stroke at some point in their lifetime[3]. Stroke can be classified into two main types: ischemic stroke, which accounts for 80% of cases and occurs when blood flow to part of the brain is interrupted because of a blocked blood vessel; and hemorrhagic stroke, which accounts for the remaining 20% and occurs when a blood vessel ruptures, causing bleeding in the brain and damage to the surrounding brain tissue[4].

Although stroke most commonly occurs after the age of 65 years, its incidence is increasing among younger people. In recent years, a 25% increase has been recorded among individuals aged between 20 and 64 years.

According to data from the Spanish Ministry of Health, approximately 120,000 people experience a stroke in Spain each year, around 25,000 of whom die. In addition to its high morbidity and the substantial associated healthcare costs, it is important to emphasize that this disease has a profound impact on every aspect of life, affecting both those who experience it and their families[5].

One of the main causes of ischemic stroke is arterial stenosis caused by the formation of atheromas in the carotid arteries. Carotid atheromas are plaques composed of lipids and inflammatory cells that may thicken, calcify and project into the vascular lumen over time, thereby altering blood flow. These plaques may also release fragments that form clots and may obstruct the intracranial arteries, triggering a stroke. Between 5% and 10% of individuals over 65 years of age have asymptomatic carotid stenosis of more than 50%; therefore, early identification of these calcifications could prevent many strokes[5].

Risk factors associated with atheroma formation include a history of heart disease, physical inactivity, obesity, arterial hypertension, elevated serum cholesterol and triglyceride levels, hyperglycemia, smoking, excessive alcohol consumption and an unhealthy diet. Preventive action targeting lifestyle and modifiable risk factors could prevent up to 80–90% of cases[6]. However, it is important to note that in most cases, the symptoms of atherosclerosis appear at a late stage or may even be absent. The Stroke Action Plan for Europe 2018–2030 addresses the management of cerebrovascular disease from a multidisciplinary perspective, emphasizing the importance of effective coordination among the numerous professionals involved in patient care[5].

Given that prevention is clearly the best approach, a diagnostic method capable of detecting atherosclerotic plaques before symptoms appear or blood flow is reduced would be highly valuable, as it would help prevent their progression and the development of subsequent complications.

The most widely used and reliable diagnostic method for detecting carotid atheromas is Doppler ultrasonography. This technique not only evaluates the presence of fatty plaques or clots in the carotid arteries but also determines whether blood flow is normal or obstructed, which may increase the risk of stroke.

Panoramic radiography is one of the most widely used diagnostic examinations in dental practice. It provides extensive information about the oral and facial structures, as well as the region of the upper cervical vertebrae. In this regard, Friedlander and Lande noted in 1981 that dentists have an important opportunity to contribute to the early detection of carotid calcifications in their patients, findings indicative of a high risk of stroke, simply by carefully examining the panoramic dental radiographs routinely obtained for them[7].

Available studies agree that radiopaque findings consistent with carotid calcifications observed on panoramic radiographs at the level of the second to fourth cervical vertebrae are generally subsequently confirmed as carotid atheromas by Doppler ultrasonography[7-12].

These calcifications, which are generally located at the carotid bifurcation, appear as radiopaque masses in the region of the panoramic radiograph corresponding to the soft tissues of the neck, approximately at the level of the C2, C3 and C4 cervical vertebrae and 1–4 cm posteroinferior to the mandibular angle[13]. They may vary in size and shape and may be vertically oriented and linear, nodular or heterogeneous. They may be unilateral or bilateral and single or multiple[13-15].

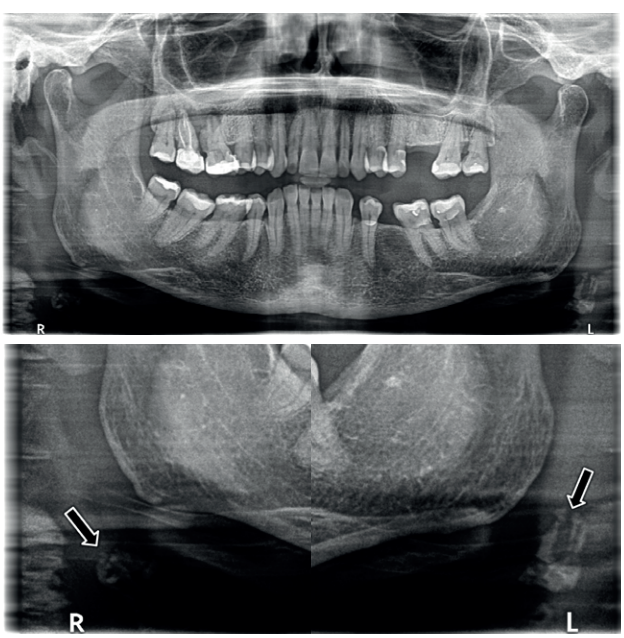
Some studies also indicate that carotid artery calcifications are more frequent in patients with periodontitis[13].

The aim of this article is to contribute to the prevention of cerebrovascular disease from the dental clinic by presenting three clinical cases in which carotid artery calcifications were incidentally detected on follow-up panoramic radiographs obtained from patients with periodontal disease undergoing maintenance therapy.

CASE REPORTS

Patient 1

We present a 75-year-old woman with generalised stage III, grade A periodontitis. She has received periodontal treatment at our practice, where she continues to attend regular follow-up appointments. In July 2022, she attended a periodontal maintenance appointment. A follow-up panoramic radiograph was requested to assess the stability of her alveolar bone levels and rule out caries or other oral diseases. The radiograph revealed bilateral, irregularly shaped radiopacities with a linear, vertical configuration in the soft tissues of the neck, below the mandibular angle and between the third and fourth cervical vertebrae (Figures 1, 2 and 3). The presumptive radiographic diagnosis was bilateral carotid artery calcifications.



Figures 1, 2 and 3. Panoramic radiograph showing calcified images in the right and left lateral cervical regions, posterior to the mandibular angle. They have a linear, rectangular appearance and extend vertically for approximately 12 mm.

The patient's medical history included a family history of Alzheimer's disease. She reported that she was a non-smoker and had osteoporosis treated with denosumab administered by subcutaneous injection every 6 months. She also reported that some previous blood tests had shown slightly elevated cholesterol levels, although she was unable to provide further details or copies of the test results. She had not been prescribed any specific cholesterol-lowering treatment and occasionally consumed Danacol®.

She was referred to her primary care physician, with an explanation of the incidental finding on the panoramic radiograph, so that the physician could consider requesting further diagnostic tests to confirm the presence of carotid atheromas. The physician requested Doppler ultrasonography, which revealed several calcified atheromatous plaques at the bifurcations of both carotid arteries and at the origins of the internal carotid arteries. These calcifications were not yet causing hemodynamically significant stenosis.

Blood tests were also requested and showed elevated cholesterol levels, for which her physician prescribed statin therapy.

In this patient, the diagnosis made by her physician was early and preceded the onset of symptoms, owing to the detection of the calcifications on a panoramic radiograph obtained during periodontal maintenance.

Patient 2

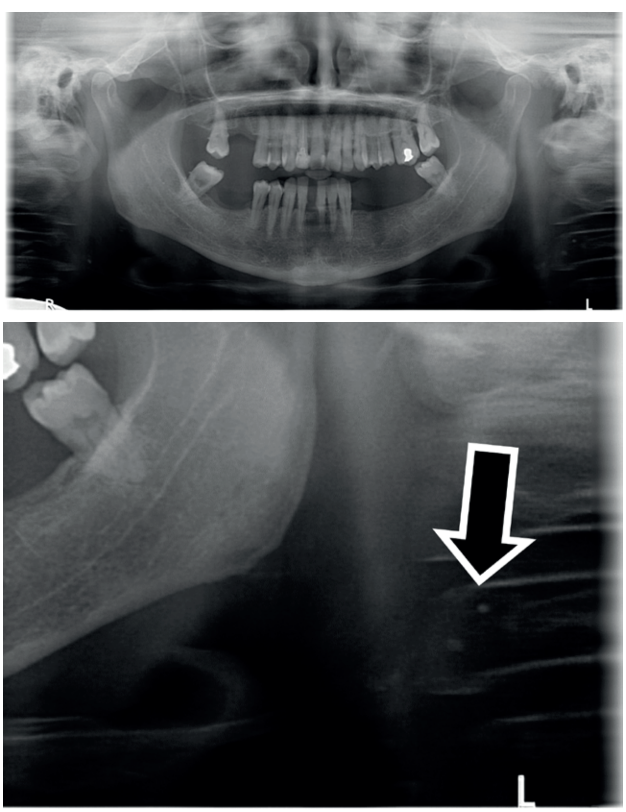
We present a 77-year-old woman who smokes 10 cigarettes per day and has generalised stage IV, grade C periodontitis. She has received periodontal treatment at our practice, where she continues to attend regular follow-up appointments. At her most recent maintenance appointment in 2024, when asked whether there had been any changes in her medical history, she reported that she had recently been diagnosed with calcifications in the left carotid artery after lower blood pressure had been observed in her left arm than in her right arm. In view of this finding, her family physician requested Doppler ultrasonography, which revealed the calcified atheromatous plaques.

Following the patient's explanation, her most recent panoramic radiograph, taken in 2016, was reviewed. Several small, round, nodular calcifications were already visible in the region of the second to fourth cervical vertebrae, although they had gone unnoticed at the time (Figures 4 and 5).

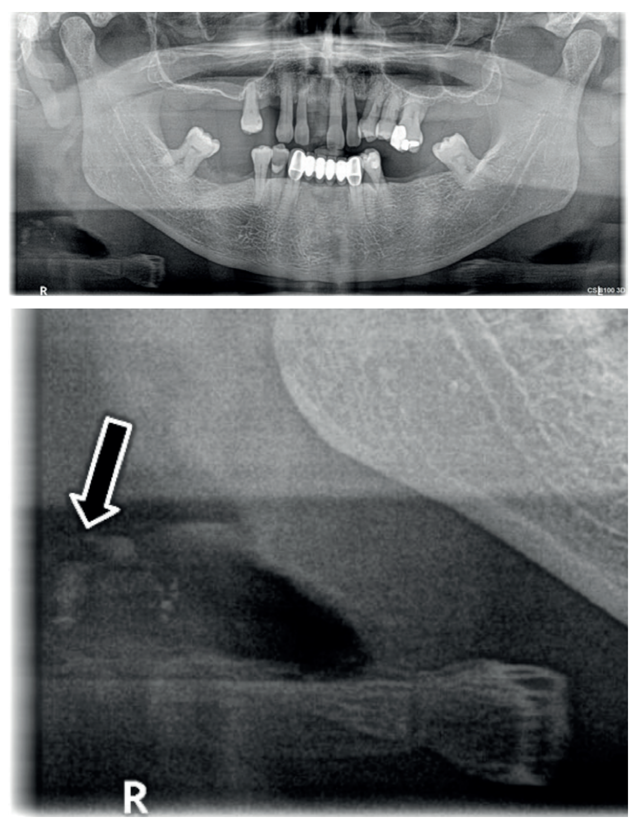
In this patient, the carotid atheromas were diagnosed after the onset of symptoms, although fortunately before any occlusive cardiovascular or cerebrovascular event had occurred. This case highlights the importance of identifying such images on panoramic radiographs, as this may allow early diagnosis and consequently help prevent associated complications.

Patient 3

We present a 64-year-old man with generalised stage IV, grade B periodontitis. He has received periodontal treatment and has been undergoing periodontal maintenance for 20 years. His relevant medical history included hepatitis C, for which he was not currently receiving treatment; ankylosing spondylitis, for which he received no regular treatment other than non-steroidal anti-inflammatory drugs during episodes of joint pain; and controlled hypertension treated with ramipril. At a periodontal maintenance appointment,



Figures 4 and 5. Panoramic radiograph obtained in 2016 showing several small, nodular, unilateral calcifications on the left side, located approximately at the border of the body of the third cervical vertebra, 3–4 cm posteroinferior to the mandibular angle.



Figures 6 and 7. Images of soft tissue calcifications in the soft tissues on the right side of the neck. Two larger rectangular calcifications and several smaller, more medially located, coalescent punctate calcifications are visible.

a follow-up panoramic radiograph was obtained. It showed two rectangular calcified images measuring approximately 5 mm in the soft tissues on the right side of the neck, together with smaller punctate images located more medially, approximately 3–4 cm from the mandibular angle (Figures 6 and 7). Because carotid calcifications were suspected, the patient was referred to his primary care physician to assess the need for specific diagnostic testing. A vascular surgeon requested Doppler ultrasonography, which confirmed a predominantly calcified atheromatous plaque at the right carotid bifurcation. The plaque measured approximately 5 × 1.5 mm and was not causing hemodynamically significant stenosis. Blood tests were also requested and revealed no significant abnormalities.

In this patient, as in Patient 1, carotid atheromas were diagnosed before the onset of symptoms and before the development of carotid stenosis, which is essential for preventing cerebrovascular events.

All three patients were informed through the informed-consent process that their data could be used for research purposes.

DISCUSSION

The use of panoramic radiographs as a diagnostic tool in dentistry is common because of the large amount of information they provide, their ease of acquisition and their low cost. The scientific literature recognizes their effectiveness in visualizing cervical calcifications[8,16].

When a calcification is suspected during the assessment of a panoramic radiograph, it is essential to establish a differential diagnosis with other radiopacities, whether anatomical or pathological. First, normal anatomical structures must be identified, including the hyoid bone, epiglottis, stylomandibular ligaments (Figure 8), stylohyoid ligaments and triticeal cartilage, which may sometimes appear calcified. They must then be differentiated from pathological processes, including other types of calcification that may be caused by carotid artery atheromas or by other conditions such as salivary gland calculi (Figure 9), phleboliths, tonsilloliths or even calcified cervical lymph nodes[16].

In 1998, Friedlander and Friedlander identified the sites most frequently affected by atheromatous lesions as the apex of the common carotid artery bifurcation and the posterior wall of the proximal internal carotid artery[8]. Radiographically, these areas correspond to two projections: one bounded anteriorly by the mandibular ramus and mandibular angle and posteriorly by the bodies of the 2nd, 3rd and 4th cervical vertebrae, and another located at the inferior border of the body of the third cervical vertebra, 1.5–4 cm inferior and posterior to the mandibular angle[11,17].

When small, they have a circular radiographic appearance. Large atheromas, however, have a linear or thin rectangular shape. In Patient 1, the calcifications were bilateral, large, rectangular and irregular, located 1–2 cm posteroinferior to the mandibular angle and superimposed over the prevertebral soft tissues. In Patient 2, however, the calcifications were unilateral, smaller, circular and multiple, superimposed over the prevertebral soft tissues and adjacent to the hyoid bone.

In Patients 1 and 3, the calcifications were located at the carotid bifurcation, the most frequent location according to Friedlander and Friedlander[8]. In Patients 2 and 3, the carotid atheromas were unilateral: on the left in Patient 2 and on the right in Patient 3. These findings corresponded to the unilateral calcifications observed on the panoramic radiographs obtained solely for periodontal follow-up.

Several publications have analyzed calcifications detected on panoramic radiographs in the region of the soft tissues of the neck superimposed over the carotid arteries and subsequently confirmed as carotid artery calcifications by Doppler ultrasonography. In 2005, Friedlander et al. were among the first authors to report this finding after analyzing 1,548 consecutive panoramic radiographs from neurologically asymptomatic patients over 50 years of age. They detected atheromas in 65 of these patients, which were subsequently confirmed by Doppler ultrasonography[9].

A relevant cross-sectional study because of its sample size was conducted in 2022 by Janiszewska-Olszowska et al., who analyzed 4,000 panoramic radiographs from patients aged between 45 and 87 years, with a mean age of 62 years. The study found that the mean age at which calcifications appeared ranged from 61 to 65 years. Calcifications were identified in 21.68% of cases, comprising 12.97% in women and 8.4% in men[14].

Calcifications may occur unilaterally or bilaterally. In 2019, Garoff et al.[18] concluded that bilateral calcifications with a vessel-outlining morphology, as in Patient 1, are independent risk markers for future cardiovascular events.

Similarly, a 2023 Swedish study by Bladh et al., which included 414 participants, concluded that, irrespective of their morphology, all carotid artery calcifications detected on panoramic radiographs were associated with a greater degree of cardiovascular disease findings on Doppler ultrasonography than in patients without calcifications on panoramic radiographs[12].

Some studies, such as that conducted by Madden et al. in 2007 in 54 patients, have found that panoramic radiographs may have relatively low sensitivity for detecting carotid artery calcifications compared with ultrasonography[19]. Nevertheless, when vascular examination by Doppler ultrasonography is performed following the incidental discovery of a radiopacity in the carotid region on a panoramic radiograph[12,16], the sensitivity of panoramic radiography for this indication improves significantly.

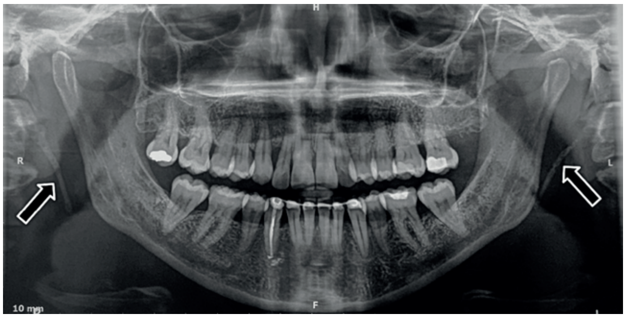


Figure 8. Panoramic radiograph showing calcified stylomandibular ligaments.

Figure 9. Panoramic radiograph showing calculi in the right parotid gland.

The aim of this article is not to promote the systematic use of panoramic radiography as a routine screening method for detecting carotid artery calcifications, but rather to emphasize the important contribution dentists can make to their early detection, potentially helping to save a life through a panoramic radiograph obtained for dental reasons[17]. Accordingly, all structures should be examined carefully when reviewing routine panoramic radiographs, without limiting the examination to the oral cavity, particularly in patients with periodontitis[13,14] or in older patients with risk factors such as smoking, arterial hypertension, diabetes mellitus, obesity or hyperlipidemia[10,20].

Once a calcification has been detected on a panoramic radiograph, the patient must be referred to their primary care physician or cardiologist so that the appropriate tests, such as Doppler ultrasonography, can be performed to confirm or exclude the risk of cerebrovascular disease. When a panoramic radiograph is obtained, it is primarily examined for dental and bone pathology, but it is also essential to assess the other anatomical structures visible on the image, both in the vertebral region and in the soft tissues of the neck. In reality, however, many dentists are not fully aware of these areas when interpreting panoramic radiographs. Nevertheless, with some training and careful examination, calcifications can be detected in approximately 3–15% of patients[9]. These calcifications could indicate an increased risk of stroke[12,15,18]. Furthermore, as artificial intelligence models continue to be developed, the accuracy with which these calcifications are detected on panoramic radiographs will increase in the future[21]. It is therefore essential to reinforce the importance of examining the oropharynx and identifying possible lesions in both undergraduate and postgraduate education[22].

CONCLUSIONS

The management of carotid stenosis is a multidisciplinary process involving the primary care physician, radiologist, cardiologist and vascular surgeon. The dentist can, however, play a key role in this process by detecting calcifications early on panoramic radiographs, thereby contributing to early diagnosis by the physician and helping prevent their possible progression to stroke. The oral healthcare team should also help reduce risk factors shared by oral and cerebrovascular diseases, including smoking, a diet high in sugars and saturated fats, alcohol consumption, obesity and physical inactivity, within the multidisciplinary preventive framework recommended by the Spanish Ministry of Health.

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CASE REPORT

Analysis of potential complications associated with a mandibular dentigerous cyst in close proximity to neural structures: A case report

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ABSTRACT

Introduction: A dentigerous cyst is a benign process of epithelial origin. It is typically characterized as a slow-growing, asymptomatic lesion usually diagnosed after a casual radiological examination. During its growth, it can compromise neighboring anatomical structures that could be injured during enucleation.

The objective is to present a clinical case of a mandibular dentigerous cyst with displacement of the inferior alveolar nerve. Different therapeutic options are evaluated, as well as the management of potential complications.

Methods: We present the case of a 23-year-old male patient who, after a periapical radiograph, revealed a lesion that was subsequently visualized with a panoramic radiograph and CBCT. A presumptive diagnosis of a dentigerous cyst associated with the impaction of a left mandibular canine is established.

Results: After evaluating the different therapeutic options, the permanent mandibular canine was extracted and the capsule enucleated. The patient was referred to the pathologist, who confirmed the diagnosis of a dentigerous cyst. The outcome was favorable, with the only noticeable loss of lip sensation, which disappeared after one month.

Conclusions: In dentistry, it is important to detect the appearance of any lesion in the maxilla or mandible as early as possible to prevent the lesions from becoming large, thus minimizing the occurrence of complications.

KEYWORDS

Dentigerous cyst; Treatment; Complications; Nerve lesions; Pathological fractures.

INTRODUCTION

Dentigerous cysts, also known as follicular, coronodental, or developmental cysts, are benign odontogenic epithelial cysts that arise from developmental abnormalities. Their formation is associated with the accumulation of fluid between the reduced enamel epithelium and the enamel surface of an unerupted tooth[1].

From an epidemiological perspective, they are the second most common odontogenic cysts after radicular cysts, accounting for 14–20% of odontogenic cysts. They occur more frequently in the permanent dentition, in men aged 20–40 years, and in the mandible (70% of cases). The teeth most commonly affected are the maxillary and mandibular third molars, followed by the maxillary canines and mandibular second premolars[2,3].

They are usually asymptomatic and are therefore generally diagnosed on radiographic examinations performed for unrelated reasons; however, accurate diagnosis using cone-beam computed tomography (CBCT) is required for treatment planning[4].

In many cases, this diagnostic examination shows the characteristics of the radiolucent lesion, its unilocular pattern, and its central, lateral, or circumferential relationship to an impacted tooth. Depending on its growth, associated findings may include tooth displacement, root resorption of adjacent teeth, and expansion and thinning of the cortical plates[5,6].

Accordingly, treatment may involve complete enucleation or more conservative techniques such as marsupialization or decompression7,8. The surgeon's experience may be crucial, bearing in mind that mandibular lesions may be closely related to the inferior alveolar nerve or the mental nerve, either of which is generally displaced by the lesion, and that cortical weakening may even result in mandibular fracture.

The aim of this report is to present a case of a mandibular dentigerous cyst whose growth involved the mental and inferior alveolar nerves, and to analyze the treatment approach, potential complications, and their subsequent management.

CASE REPORT

A 23-year-old man with no relevant medical history was referred by his dentist to the Oral Surgery Service at the Faculty of Dentistry, Universidad Complutense, after a periapical radiograph obtained for unrelated reasons revealed a partially visualized radiolucency in the apical region of the left mandibular premolars and primary canine (Figure 1).

During history taking, no relevant medical or surgical history was reported. The patient had no known drug allergies, reported no tobacco, alcohol, or recreational drug use, and was asymptomatic.

Extraoral examination revealed no deformity or lymphadenopathy. Intraoral examination showed that the permanent left mandibular canine was absent and the primary canine was retained. The appearance and color of the oral mucosa were normal, except for a small sinus tract overlying the apex of the primary canine. The premolars and molars showed no associated pathology, retained pulp vitality, and exhibited no mobility.

Following these findings, a CBCT examination of the entire mandible was requested. The panoramic reconstructions revealed a well-defined radiolucent lesion with an almost complete sclerotic rim, extending mesiodistally from the distal aspect of the primary

Figure 1. Periapical radiograph: note the apical lesion associated with the primary canine (73) and the partially visualized radiolucency in the apical region of the second premolar (35).

canine to the apex of the first molar, reaching the inferior border of the mandible and encompassing an impacted mandibular canine (Figure 2).

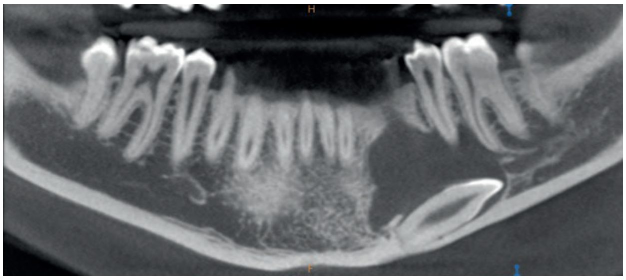

Figure 2. Panoramic CBCT reconstruction showing the radiolucent lesion associated with the impacted mandibular canine.

The cross-sectional CBCT images showed no cortical expansion, preservation of the lingual cortex, and slight perforation of the buccal cortex at the level of the second premolar (Figures 3A and 3B). The Following these findings, the patient was informed of the different treatment options and their advantages and disadvantages and elected to undergo enucleation. The patient was asked to sign an informed consent form describing the procedure and the potential intraoperative and postoperative risks. Endodontic treatment of the primary canine before surgery was considered, while the vital premolars involved in the lesion were to be monitored.

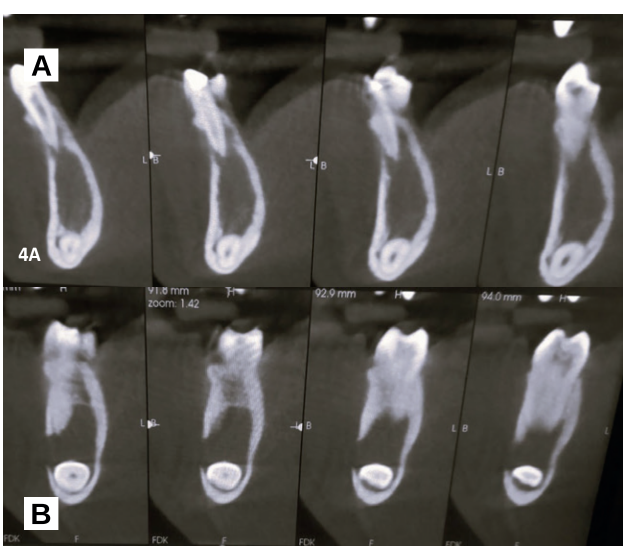

Figure 3. Cross-sectional CBCT images. 3A: Radiolucent lesion extending to the inferior border of the mandible, with preservation of both cortices. 3B: Buccal cortical perforation at the level of the second premolar.

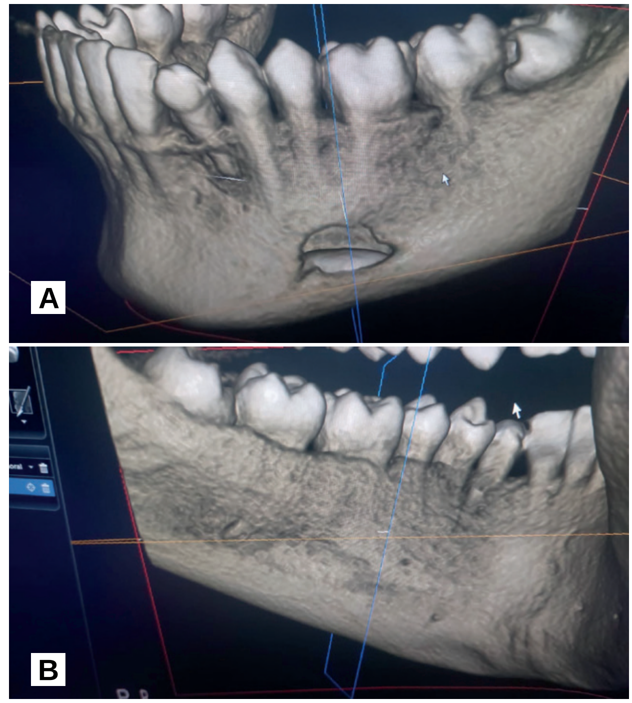

Figure 4. 3D reconstruction. 4A: Perforation of the mandibular buccal cortex. 4B: Preservation of the mandibular lingual cortex.

Surgical treatment was performed under sedation combined with local anesthesia administered via inferior alveolar, lingual, and mental nerve blocks. A buccal approach was used with a Neumann incision (a scalloped, marginal, full-thickness intrasulcular incision with vertical releasing incisions at the mesial aspect of the lateral incisor and the distal aspect of the first molar) followed by elevation of a mucoperiosteal flap and exposure of the mental foramen. An ostectomy was then performed to obtain the widest possible exposure of the lesion. The mandibular canine was visualized adjacent to the cyst capsule and was extracted with the mental nerve under direct visualization to facilitate complete and careful enucleation. After removal of the cyst capsule, the residual cavity was carefully curetted. Curettage was avoided along the inferior border of the mandible to prevent injury to the inferior alveolar nerve. Once the procedure had been completed, the mucoperiosteal flap was repositioned and a watertight closure was achieved using 4-0 monofilament sutures (Figures 5–12).

Figure 5. Complete Neumann incision with vertical releasing incisions at the mesial aspect of the lateral incisor and the distal aspect of the first molar.

Figure 6. Mucoperiosteal flap elevation.

Figure 7. Identification of the mental nerve and visualization of the cyst capsule and impacted tooth.

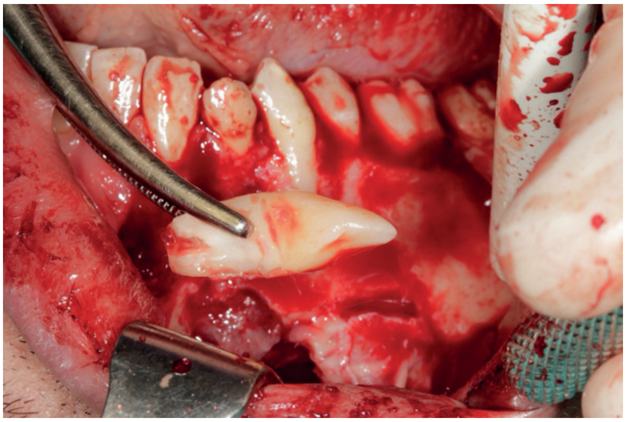

Figure 8. Extraction of mandibular canine.

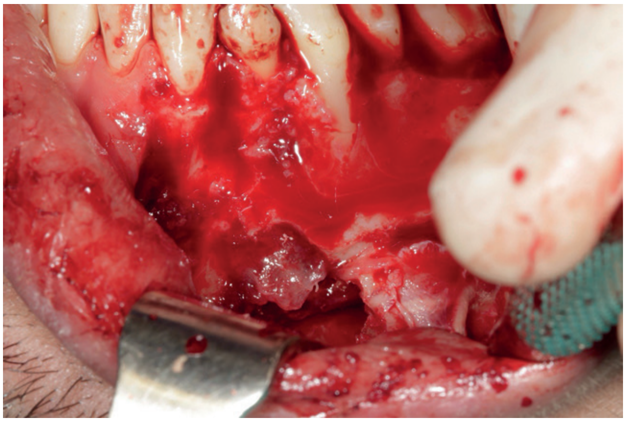

Figure 9. Cyst capsule isolated for meticulous enucleation.

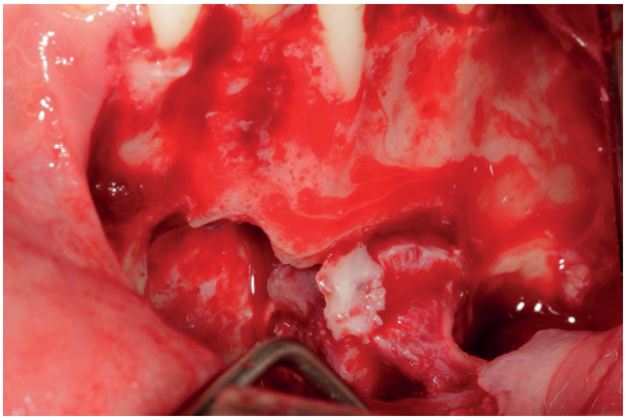

Figure 10. Residual cavity.

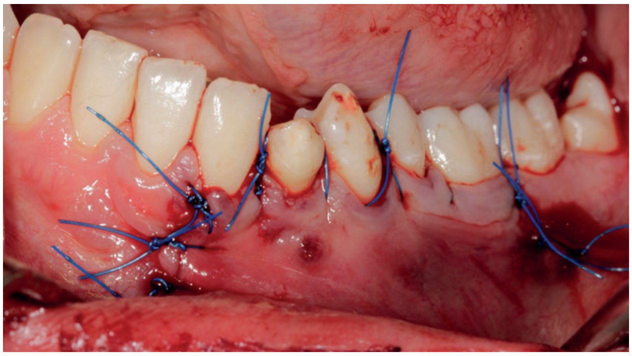

Figure 11. Repositioning of the mucoperiosteal flap and suturing.

Figure 12. Macroscopic view of the canine.

The specimen was placed in 10% formalin and submitted for histopathological examination. The following findings were reported:

- Macroscopic description: Two irregular, membranous, brownish fragments with blackish areas were submitted, measuring 1 × 1.2 × 0.5 cm in aggregate. The larger fragment was sectioned, and both fragments were submitted in their entirety.
- Microscopic description: Examination revealed a cystic lesion with a well-defined, thick fibrocellular connective tissue wall containing scattered vascular structures and foci of chronic lymphoplasmacytic inflammation, hemorrhage, and hemosiderin deposits. Foci of mixed inflammation with numerous foamy macrophages were also observed. In one of the fragments, a thin, nonkeratinized stratified epithelial lining was identified, with focal detachment. A peripheral shell of vital trabecular bone was observed (Figures 13 and 14). The definitive diagnosis was a dentigerous cyst with chronic inflammation.

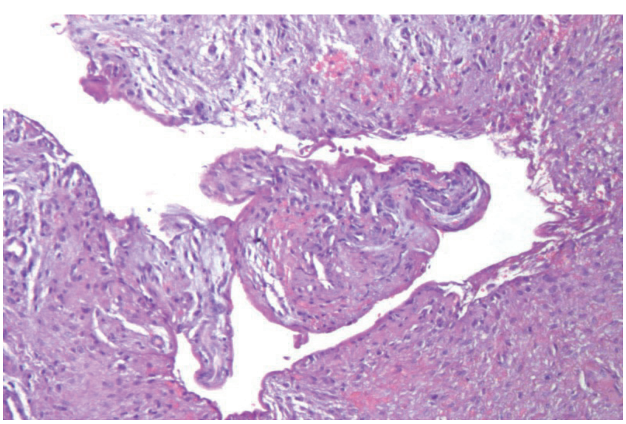

Figure 13. Histological section stained with hematoxylin and eosin. Fibrocellular connective tissue capsule, partially lined by a thin band of nonkeratinized epithelium, with an empty cystic space (Profs. Aguirre and Lafuente. SDPOMF).

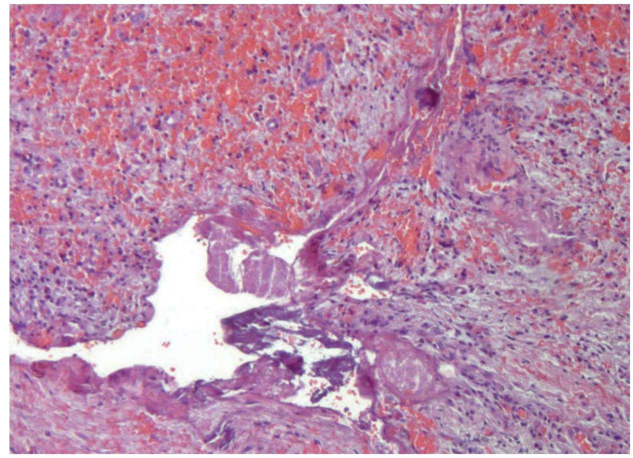

Figure 14. Histological section stained with hematoxylin and eosin. Areas of hemorrhage and partial lining by thin, nonkeratinized epithelium (Profs. Aguirre and Lafuente. SDPOMF).

After surgery, detailed postoperative instructions were provided and pharmacological treatment was initiated with amoxicillin 750 mg (one dose every 8 hours for 8 days), prednisone 30 mg (one dose every 24 hours for 6 days), and, as rescue analgesia, metamizole magnesium 575 mg (one dose every 8 hours as required by the patient).

Postoperative check-ups were carried out at 2 and 7 days to review the surgical wound, and the Weber test (two-point discrimination test) was performed to assess sensation in one half of the lip; this showed a small area of sensory loss (Figure 15). The sutures were removed at 15 days, and the patient was clinically reviewed at one month, when both sensory recovery and the absence of complications were observed (Figure 16).

Figure 15. Weber test: areas of loss of lip sensation in the immediate postoperative period.

Figure 16. Weber test at the one-month follow-up, showing recovery of lip sensation.

The patient remains under follow-up, with no complications to date. A radiographic follow-up examination was performed at three months and showed signs of remineralization (Figure 17).

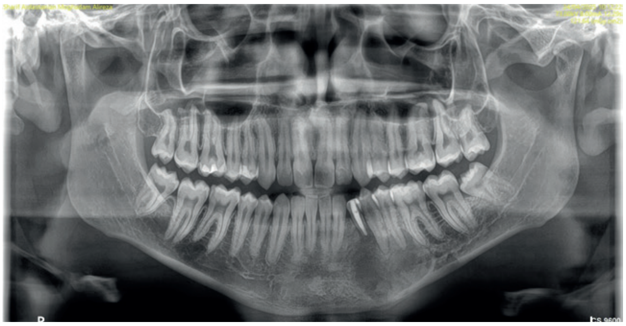

Figure 17. Panoramic radiograph at three months postoperatively, showing signs of remineralization.

DISCUSSION

Dentigerous cysts are benign developmental odontogenic cysts that result from the accumulation of fluid between the reduced enamel epithelium and the crown of an unerupted tooth and are associated with impacted teeth. A recent study by Sun et al.[9] of 2,872 impacted teeth found a frequency of 22.55% for dentigerous cysts associated with canines, a much higher figure than the 6% observed in association with third molars.

As Karabas et al.[10] point out, there is a slight male predilection, and most cases remain asymptomatic and are detected incidentally on radiographic examination, as in the present case.

Their appearance as a well-defined unilocular radiolucent lesion associated with the crown of an impacted tooth is readily detectable on panoramic radiography, although CBCT provides greater precision in characterizing the lesion and assists with the presumptive diagnosis and treatment planning[11].

Lesion size appears to be a predictive factor for possible provisional diagnoses. In their study of 153 cases of unilocular radiolucent lesions, Atarbashi-Moghadam et al.[12] considered that lesions larger than 2.0 cm were 5.5 times more likely than smaller lesions to be diagnosed as lesions not suggestive of dentigerous cysts. The present case meets these characteristics, which is why the patient was informed beforehand of some possible differential diagnoses, in agreement with Austin et al.[13], who state that the differential diagnosis should include at least unicystic ameloblastoma and odontogenic keratocyst.

Another aspect to consider is the approach to be taken with the teeth involved in the cystic lesion. According to Zhao et al.[14] and Diarra et al.[15], in the presence of large cysts, it is essential to carry out an accurate assessment of pulp vitality or blood supply, both in teeth involved in the cystic lesion and in those that may lie within the surgical field.

The response of the pulp to trauma may vary, so that in some cases the pulp remains completely normal, with no adverse effects, whereas in other cases it becomes necrotic. Pulp necrosis may occur as a sequela of trauma and may promote the development of a periapical lesion due to microbial infection. Some studies, as noted by Niu et al.[16], have shown that, in some cases, no pulpal infection occurred after enucleation, even in vital teeth that had not undergone root canal treatment and were affected by developmental odontogenic cystic lesions.

In case of doubt, it is recommended that root canal treatment not be performed on involved vital teeth and that follow-up be carried out over a prolonged period, making every effort to preserve their vitality[17].

After this initial assessment, the size of the lesion and its relationship to surrounding anatomical structures may determine the choice of surgical treatment. The choice between enucleation, marsupialization, and decompression will often depend on the risk of intraoperative complications, as assessed by the surgeon; the surgeon's experience will therefore be crucial.

In the present case, based on our experience, the main risk was injury to the mental and inferior alveolar nerves, given the very close relationship of the impacted tooth and the cyst capsule to these nerves.

In a review of 70 articles on displacement of the mandibular canal, Mortazavi et al.[18] found dentigerous cysts to be one of the main causes.

This close relationship, among other factors, has led to the wider use of techniques such as decompression or marsupialization to prevent injury[19-21]. Marsupialization is increasingly recommended in very young patients with mixed dentition when the aim is to promote eruption of the involved tooth and reduce the bone damage caused by ostectomy[22]. In a recent systematic review of dentigerous cysts in pediatric patients, Cobo-Vázquez et al.[23] found that outcomes with marsupialization or decompression were highly predictable and that these techniques facilitated eruption of the involved tooth in 83% and 100% of cases, respectively.

Despite these results, because the patient in the present case was not pediatric and the canine had been displaced toward the inferior border of the mandible, cyst enucleation and extraction of the impacted canine were chosen.

In the immediate postoperative period, as the patient had been informed before surgery, he had a small area of loss of sensation. In a study of 249 patients, Lee et al.[24] found that 15.26% developed inferior alveolar nerve paresthesia, showing that surgical manipulation itself almost inevitably entails some loss of sensation, which would initially be expected to be temporary.

During this period, patients may experience various neurosensory disturbances, including hypoesthesia, hyperesthesia, paresthesia, and anesthesia. These may range from minimal impairment to severe conditions and may affect the patient's quality of life. Therefore, although there is still no standardized protocol for managing patients with paresthesia caused by nerve injury, dentists should at least be familiar with pharmacological treatments such as B vitamins and with laser therapy, as well as other approaches such as acupuncture, electrical stimulation, physical therapy, and moist heat[25-27].

According to the study of refractory hypoesthesia by Hasegawa et al.[28], vitamin B12 should be administered early in all cases of hypoesthesia because it may help restore axonal transport and is effective in treating neuralgia caused by traumatic nerve compression.

Likewise, laser photobiomodulation, or low-level laser therapy, has become an increasingly used adjunctive treatment.

Brito et al.[29] report that this nonthermal light therapy helps modulate tissue metabolism using red or infrared light delivered by lasers or light-emitting diodes (LEDs), promoting sensory recovery after nerve injuries.

Another complication that may occur during surgical treatment is mandibular fracture. These pathological fractures are uncommon, accounting for approximately 2% of mandibular fractures, and occur most often in the mandibular angle and body[30-31].

In the previously cited study of 249 patients with cystic lesions by Lee et al.[24], four pathological fractures occurred, representing 1.60%.

Authors such as Bazin et al.[32] suggest placing fixation plates to prevent these fractures. No plate was placed in the present case because CBCT showed that, despite the large size of the lesion, the lingual cortex was completely preserved. The patient was therefore advised only to follow a soft diet for at least four weeks and avoid high-impact sports.

Finally, once the histopathological diagnosis has been confirmed, clinical and radiographic follow-up is important to confirm the absence of symptoms and remineralization at the lesion site after enucleation.

The risk of neoplastic transformation arising from odontogenic cysts is below 3%, with chronic inflammation being a key factor. In their systematic review, Sulistyani et al.[33] consider that the inflammatory process can trigger genetic instability in cells through the formation of reactive oxygen species. It also induces apoptosis, cytokine production, and keratinization of the cystic epithelium and may cause alterations in DNA, proteins, and cell membranes, thereby promoting the transformation of normal cells into neoplastic cells.

CONCLUSIONS

It is important to detect any lesion in the maxilla or mandible as early as possible to prevent it from becoming large.

Early diagnosis, together with a precise surgical approach, will minimize risks and prevent complications such as root resorption, damage to neurovascular structures, or pathological fractures.

Follow-up is important to confirm resolution through clinical and radiographic examinations.

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ORIGINAL ARTICLE

Influence of a cyanoacrylate-based adhesive on pain and healing at the palatal donor site after connective tissue graft harvesting: preliminary results of a multicenter randomised clinical trial

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ABSTRACT

Introduction: The use of cyanoacrylate has been proposed as an alternative in clot stabilization in the palatal donor site after harvesting connective tissue grafts. The main advantages are the reduction of postoperative pain perception and improved wound healing.

Methods: Preliminary results of a randomized clinical study are reported. 20 patients were divided into two groups: one in which sutures were used (control group and another where a cyanoacrylate-based tissue adhesive was applied (test group). Variables such as postoperative pain, healing, analgesic consumption, and patient willingness to undergo a similar procedure were compared.

Results: The cyanoacrylate group experienced less pain during the 14-day postoperative period compared to the control group, reflected in lower scores on the visual analogue scale. Furthermore, patients in the test group consumed fewer analgesics and showed a greater willingness to repeat the procedure, suggesting a better postoperative experience. As for healing, no differences were found between the two groups according to the modified early wound healing index assessed at 7 and 14 days.

Conclusions: Preliminary results suggest that cyanoacrylate is an effective alternative to sutures, with clear advantages in terms of pain reduction and patient comfort.

KEYWORDS

Cyanoacrylate; Connective tissue graft; Postoperative complications; Wound healing.

INTRODUCTION

Periodontal plastic surgery is the treatment of choice for gingival recessions and mucogingival defects[1,2]. Connective tissue grafts (CTGs) are currently considered the gold standard for soft-tissue reconstruction because of their long-term stability and biocompatibility[2]. The technique most commonly used to harvest a CTG is that described by Zucchelli et al.[3], which consists of harvesting a free gingival graft that is then de-epithelialised extraorally. Other methods of harvesting these grafts are available, such as the single-incision technique[4], which are intended to minimise morbidity at the donor site. However, CTG harvesting always involves a donor site, usually on the palate, increasing the complexity of the procedure and patient discomfort during the postoperative period. During healing, this may lead to complications such as bleeding, pain, infection, or necrosis, mostly associated with failure to form a stable blood clot[5-8]. In addition to sutures, various haemostatic and wound-healing agents have been used to achieve this stabilisation, including cyanoacrylate-based adhesives[8]. The main properties of these tissue adhesives include their excellent haemostatic capacity, rapid adhesion to tissues, and potential bacteriostatic properties[8]. Previous studies indicate that the use of these agents to promote healing at the palatal donor site after CTG harvesting using different techniques is promising[9,10]. However, the literature on healing and tissue response at the palatal donor site after CTG harvesting using the single-incision technique remains limited. Therefore, the aim of the present study was to evaluate and compare the use of sutures and cyanoacrylate at the palatal donor site after CTG harvesting.

MATERIALS AND METHODS

Study design

The present study was designed as a multicentre randomised controlled clinical trial. The research protocol was approved by the Ethics Committee of Hospital Clínico San Carlos in Madrid (23/744-EC_X), in accordance with the CONSORT guidelines, and was registered at ClinicalTrials.gov (NCT06116539). The study protocol complied with the 1975 Declaration of Helsinki. A sample size of 40 patients was calculated using G*Power® software (Heinrich Heine University Düsseldorf, Germany). The patients were divided into two groups. In the control group, the clot was stabilised using sutures, whereas in the test group, a cyanoacrylate-based tissue adhesive was used (PeriAcryl 90 HV; Glustitch, Delta, Canada). All patients were informed about and understood the aims of the study; they participated voluntarily after providing both verbal and written informed consent. The study was conducted at two private centres between January and September 2024. To be included in the sample, patients had to be candidates for mucogingival treatment requiring a CTG around teeth or implants. No age limit was set. Patients were excluded if they had systemic conditions or healing problems, were receiving bisphosphonate therapy, smoked more than 10 cigarettes per day, had previously undergone palatal graft harvesting at the same site, or had any contraindication to surgery.

Procedure

All procedures were performed by two calibrated operators (IFB, JLM). Once the patient had agreed to participate in the study and signed the informed consent form, they were randomly assigned to one of the groups. The randomisation sequence was computer-generated before the start of the study, and each participant was assigned to a group according to the order of enrolment.

Planning: sociodemographic data and general patient characteristics (age, sex, smoking status, systemic health, and medication) were recorded at the first visit.

Surgical technique: The subepithelial connective tissue graft was harvested using the single-incision technique described by Hürzeler et al. in 1999[4]. The first incision was made at full thickness, perpendicular to the palate and at least 2 mm from the probing depth on the palatal aspect of the adjacent teeth. A partial-thickness incision was then made parallel to the palatal epithelium to avoid fenestrations. The graft was harvested by means of a second partial-thickness incision parallel to the bone. In the control group, the clot was stabilised using 4-0 non-resorbable monofilament nylon sutures (Aragó, Barcelona, Spain), with double tooth-supported sutures[4]. In the test group, a cyanoacrylate-based tissue adhesive (PeriAcryl 90 HV; Glustitch, Delta, Canada) was applied according to the manufacturer's instructions. The protocol followed in the test group is shown in Figures 1, 2, and 3.

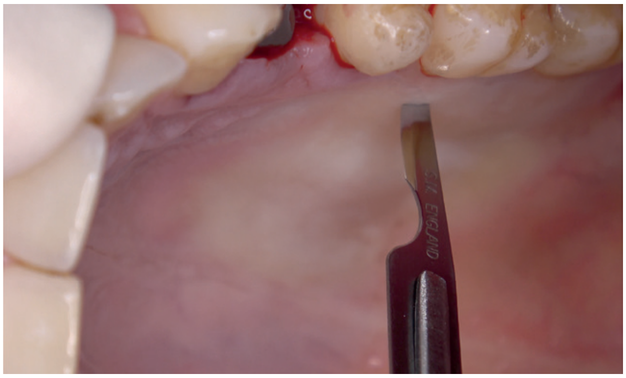

Figure 1. Initial incision for harvesting a connective tissue graft using the single-incision technique.

Postoperative Care: Ibuprofen 600 mg was prescribed every 8 hours for the first 3 postoperative days. Thereafter, patients were advised to take it as needed. A 0.12% chlorhexidine mouthwash (Perio-Aid, Dentaid) was also prescribed for the first 2 weeks. Patients were scheduled at 7 and 14 days after surgery for removal of the palatal sutures and examination of the donor site.

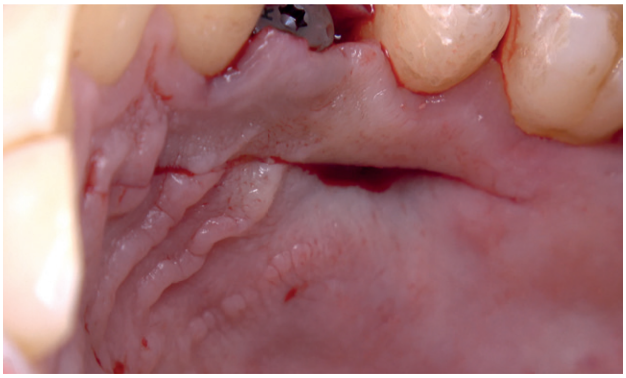

Figure 2. Palatal appearance after harvesting a connective tissue graft using the single-incision technique.

Variables

Pain perceived by the patient was assessed using a visual analogue scale (VAS) on days 1, 2, 3, 4, 5, 6, 7, and 14. Healing of the donor site was visually assessed at 7 and 14 days using the modified Early Wound Healing Index (MEHI)[11], which distinguishes the following five grades:

1. Complete flap closure with no fibrin line on the palate.
2. Complete flap closure with a fibrin line on the palate.
3. Complete flap closure with small fibrin clots on the palate.
4. Incomplete flap closure with partial necrosis of the palate involving less than 50% of the flap.
5. Incomplete flap closure with complete necrosis of the palatal tissue involving more than 50% of the flap.

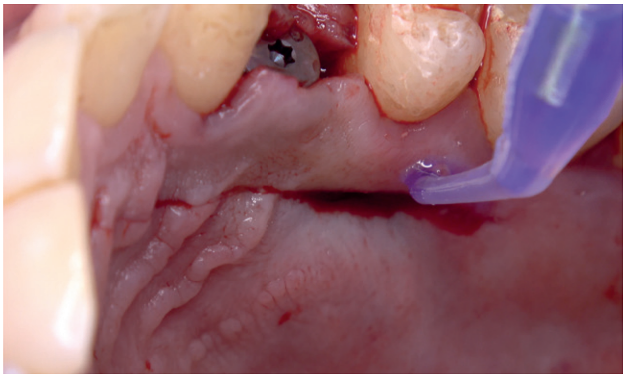

Figure 3. Application of cyanoacrylate in the test group (TG).

Analgesic consumption and the occurrence of complications, such as bleeding or infection, were also recorded. Lastly, the patients' willingness to undergo a second procedure requiring the use of palatal connective tissue grafts was assessed using an ordinal scale designed specifically for this study. The patients answered the following question: "Would you undergo this surgical procedure again, if necessary?" The response options were "Yes", "Maybe", and "Under no circumstances".

Statistical analysis

The data collected during the study were analysed by calculating means and standard deviations (SD) using specialised statistical software (SPSS version 28.0, IBM Corp., Armonk, NY, USA).

RESULTS

Preliminary results are presented for 20 patients who had completed the study to date, of whom 10 were in the control group (CG) and 10 were in the test group (TG). The demographics and general characteristics of the participants are listed in Table 1. The mean age was slightly higher in the control group (44.9 years) compared with the test group (42 years). The proportion of men and women was equal in both groups (40% men, 60% women). With regard to smoking, 10% of the patients in the control group were smokers, compared with 40% in the test group.

1.4 in the test group. This trend continued throughout the 14 days, with residual pain being almost absent in the test group (0.2), compared with 0.8 in the control group. These results are shown graphically in Figure 4.

Donor site healing

Healing was assessed using the MEHI on days 7 and 14, and the results are presented in Table 4. At 7 days, both groups had similar results (3.6 in both cases), indicating comparable initial healing. However, at 14 days, the control group showed faster improvement, with a MEHI score of 1.7 compared with 2.0 in the test group.

Analgesic consumption and postoperative complications

Analgesic consumption was lower in the test group. As shown in Table 5, patients in the control group consumed a mean of 3.7 doses of analgesics from the third postoperative day onwards, whereas consumption was lower in the test group, with a mean of 1.1 doses.

Table 1. Participant data.

Group	Participants	Mean age (SD)	% men	% women	% smokers	% non-smokers
CG	10	44,9 (15,42)	40,0	60,0	10,0	90,0
TG	10	42,0 (13,32)	40,0	60,0	40,0	60,0
Total	20	43,45 (14,1)	40	60	25	75

SD: Standard deviation. CG: Control group. TG: Test group.

Graft dimensions

With regard to the dimensions of the CTGs harvested, Table 2 shows that the mean area was slightly larger in the control group (86.88 mm²) than in the test group (81.9 mm²).

Pain assessment

Pain perceived by the patients was assessed using the VAS during the first 14 postoperative days. The results, shown in Table 3, indicate that patients in the test group reported less pain than those in the control group throughout the follow-up period. On day 1, the mean pain score was 4.1 in the control group and only

No postoperative complications were recorded in either group during the 14 days following the procedure.

Table 2. Mean area of the connective tissue grafts (mm²).

Group	Mean area (SD)
CG	86,88 (33,51)
TG	81,9 (43,68)
Total	84,26 (38,21)

SD: Standard deviation. CG: Control group. TG: Test group.

Table 3. Mean VAS scores (standard deviation) during the first 14 days.

	VAS 1	VAS 2	VAS 3	VAS 4	VAS 5	VAS 6	VAS 7	VAS 14
CG	4,1 (2,51)	4,55 (2,43)	4,2 (2,16)	3,8 (2,14)	3,15 (2,18)	2,2 (1,98)	1,9 (2,02)	0,8 (1,13)
TG	1,4 (1,17)	1,0 (0,7)	1,0 (0,78)	0,95 (0,72)	0,9 (0,65)	0,8 (0,58)	0,75 (0,54)	0,2 (0,42)
Total	2,75 (2,35)	2,77 (2,52)	2,6 (2,28)	2,37 (2,13)	2,02 (1,94)	1,5 (1,59)	1,32 (1,55)	0,5 (0,88)

VAS: Visual analogue scale. CG: Control group. TG: Test group.

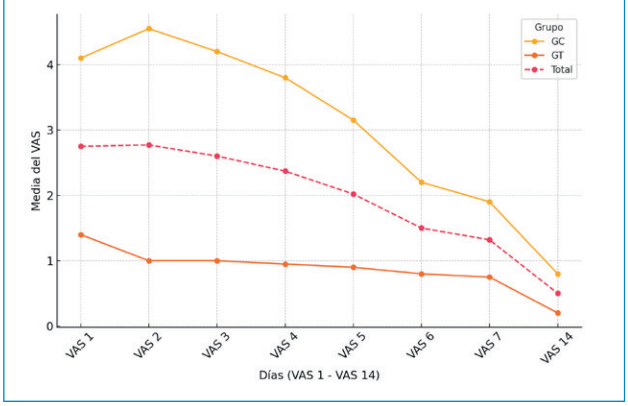

Figure 4. Comparison of VAS scores between the control, test, and total groups.

Table 4. Mean MEHI scores (standard deviation) on days 7 and 14.

	MEHI 7	MEHI 14
CG	3,6 (1,17)	1,7 (0,82)
TG	3,6 (1,34)	2,0 (0,94)
Total	3,6 (1,22)	1,85 (0,88)

MEHI: modified Early Wound Healing Index. CG: Control group. TG: Test group.

Motivation to repeat the procedure

Regarding the patients' willingness to undergo a second procedure requiring palatal graft harvesting, the data

Table 5. Mean analgesic consumption (standard deviation) from the third day onwards.

	Analgesics
CG	3,7 (4,2)
TG	1,1 (1,5)
Total	2,4 (3,36)

CG: Control group. TG: Test group.

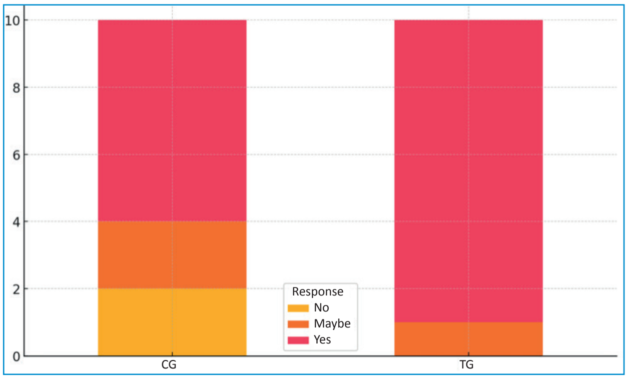

Figure 5. Distribution of responses to the question about repeating the procedure. The X-axis represents the control group (CG) and test group (TG). The number of responses is plotted on the Y-axis.

in Figure 5 show that patients in the test group would be more willing to repeat the procedure than those in the control group.

DISCUSSION

The preliminary results of the present study confirm some of the trends reported in the literature regarding the use of cyanoacrylate to stabilise the clot at the palatal donor site, particularly in relation to reduced postoperative pain and analgesic consumption.

With regard to postoperative pain, patients in the cyanoacrylate group consistently reported lower pain levels than those in the suture group, in agreement with the results of similar studies[9,10,12-15,18]. Similar results were also found in studies in which free gingival grafts were harvested, with better outcomes in the cyanoacrylate group than in the suture group, as described by Karimi et al.[19]. These studies also reported that cyanoacrylate was effective in reducing pain during the early postoperative days. This is consistent with our data, in which the cyanoacrylate group showed a reduction in VAS scores from the first day onwards. This finding may be explained by the haemostatic and bacteriostatic properties of cyanoacrylate, which create a protective barrier and minimise exposure of the wound to oral irritants, as suggested by Tavelli et al.[10,12]. It is noteworthy that, in the present study, pain in the cyanoacrylate group was much lower not only during the first few days but also throughout the two-week period. This could indicate a more comfortable healing process for the patient, as has also been suggested in previous reviews[16]. This may be explained by the lower level of inflammation and more uniform distribution of neutrophils, lymphocytes, histiocytes, and eosinophils reported with cyanoacrylate-based adhesives[17]. These results support the use of haemostatic agents in this type of procedure, as concluded in the systematic review by Oliveira et al.[20], in which all the agents studied produced better outcomes than spontaneous healing.

The lower analgesic consumption observed in the cyanoacrylate group in our study is also consistent with the existing literature[10,12,13,18,19]. Tavelli et al. (2018)[12], Yilmaz et al. (2022)[18] and Parlak et al. (2023)[15] reported a significant reduction in analgesic consumption in the cyanoacrylate groups compared with the suture groups, reflecting lower postoperative morbidity. In this trial, patients in the suture group consumed more than three times as many analgesics as those in the cyanoacrylate group, supporting the hypothesis that the reduced inflammation and wound protection provided by the tissue adhesive contribute to a more comfortable postoperative period.

With regard to healing, our study showed minimal differences between the two groups according to the MEHI, with results similar to those obtained by Castro-Gaspar et al. (2022)[14]; Stavropoulou et al. (2018)[9]; and Yilmaz et al. (2022)[18]. This finding contrasts slightly with some previous studies, such as that of Tavelli et al. (2018)[12], which reported faster and more effective healing in the groups treated with cyanoacrylate. However, the difference may not be as marked in our preliminary results because of the sample size or the evaluation period, which was limited to two weeks. In any case, the MEHI values at 7 and 14 days were similar in both groups, suggesting that cyanoacrylate does not compromise initial wound healing.

Patients in the cyanoacrylate group were considerably more willing to undergo a similar procedure again than those in the suture group. This result has also been reported in studies such as that by Basma et al. (2022)[13], in which patients treated with cyanoacrylate showed greater overall satisfaction and less perceived discomfort. Regarding complications such as bleeding and infection, no differences between the groups were observed in this preliminary assessment. This is also consistent with the studies cited above, in which cyanoacrylate was shown to be as safe as sutures in terms of complications[9,13,14,18].

CONCLUSION

The preliminary results of the present study support the effectiveness of cyanoacrylate as an alternative to sutures for stabilising the clot at the palatal donor site after connective tissue graft harvesting. The benefits observed include reduced postoperative pain and analgesic consumption, with healing comparable to that achieved with sutures. These findings are consistent with the literature reviewed and suggest that cyanoacrylate may be a valid option for improving patients' postoperative experience, although further studies with larger sample sizes will be required to confirm these long-term results.

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