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Ilustre Colegio Oficial de Odontólogos y Estomatólogos de la Iª Región

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volumen 19

contents

editorial

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Deputy Director *Científica Dental*

Dear colleagues and readers of *Científica Dental*,

This is the tenth year that *Científica Dental* offers this special supplement in English. It includes the best papers published over 2022 in the categories of best scientific article, best case study and best publication by a new author. A total of six papers are presented, which are the finalists of the aforementioned categories.

The subject matter of the papers, as we always aim for in *Científica Dental*, is up-to-date, varied and of interest for dentistry professionals. Our readers can freely access this issue at the website www.cientificadental.es.

The first prize in the original article category is the study by *Suarez Beke et al.*, which shows a comprehensive and detailed analysis of oral cancer risk, analysing risk factors and the epidemiological trend. In this same category, *Muñoz Cano et al.* are awarded the second prize with a paper on the relationship between socioeconomic level, chronology and eruption sequence in permanent dentition.

As the best case study, *Anitua* is awarded the first prize with an excellent case study on the rehabilitation of a patient with severe bone resorption in maxillary width. *Sánchez-Labrador et al.* receive the second prize with a case study where they successfully show the completion of an autotransplantation of an upper third molar to replace an upper first molar.

The last two papers in this issue belong to the category of best publication by a new author. Particularly noteworthy are the papers by *Santmartí et al.*, who conduct an evaluation of the different therapeutic options in the clinical management of burning mouth syndrome, and that by *Parziale et al.*, who analyse with an extensive review the physical properties of the new silicate-based endodontic sealant cements.

We would once again like to thank our authors for the high quality of the papers they submit, and the trust they place in us to disseminate the papers in *Científica Dental*. We would also like to thank the copy editors and proofreaders, whose work is essential for the production of each issue of this journal, and of course our readers, for whom we offer this issue with the most significant papers published in 2022.

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Original article

Oral cancer. Risk factors and change in epidemiological trend

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SUMMARY

Introduction: Oral cancer continues to be one of the causes of increased morbidity and mortality in the world. With an incidence of approximately 377 thousand cases and a mortality of 177 thousand in 2020, being oral squamous cell carcinoma (OSCC) the most frequent. This neoplasia predominantly affects men and its incidence increases with age. Up to age 80, men have a 40.9% risk of developing cancer and women 27.0%. At age 85, this risk is increased to 49.1% in men and 31.8% in women.

Objective: To know the profile of the patient with oral cancer related to sex and age, and to identify the possible etiopathogenic factors related to the appearance of this neoplastic process.

Material and method: An observational, descriptive and retrospective study is carried out in the Oral and Maxillofacial Surgery Service of the Ramon y Cajal University Hospital in the period between 2004 and 2020. This study has been approved by the research ethics committee of the aforementioned hospital.

Results: Our sample has been made up of 46 men and 40 women. All of them suffer OSCC and have an average age of 66 years ± 14.0 years (66.37; 95% CI). Most of the patients in the sample have been from 60 to 80 years. The most relevant risk factors as predictors of this disease have been tobacco and alcohol. The most common places for oral carcinoma have been the tongue, the jugal mucosa and the floor of the mouth, in women the most frequent localization is in the tongue (57.14% vs 42.85%), the alveolar ridge (54.54% vs 45.45%) and maxillary tuberosity (100% vs 0%).

Conclusions: The profile of the patient suffering from oral cancer is beginning to change toward younger populations, finding it more often in women. The youngest patient with OSCC was 35 years old. Men continue to present more OSCC cases (53.5%), but women are approaching OSCC prevalence, and in some locations, they are already ahead. Risk factors such as tobacco and alcohol are shown to be positive predictors of oral cancer risk.

KEY WORDS

Oral cancer; Oral squamous cell carcinoma; Risk factors; Tobacco; Alcohol.

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- LATINDEX (Regional Online Information System)
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INTRODUCTION

Oral cancer involves all topographic areas of the oral cavity as well as the lip. According to the World Health Organization (WHO) the global incidence is 4 cases per 100,000 inhabitants[1], oral squamous cell carcinoma (OSCC) being the most common cancer of malignant tumours of the oral cavity[2]. representing 90% of cancers of the maxillofacial area. Cancers of the oral[2] cavity and oropharynx are ranked sixth worldwide[4], with Asian countries having the highest incidence of this type of tumours[5]. In Spain, the Spanish Network of Cancer Registries (REDECAN) estimates that approximately 277,394 new cancer cases have been diagnosed in 2020, with values very close to those of 2019. In the case of oral cavity and pharyngeal cancers incidence in Spain (2020) it has been 8.6 thousand cases[6].

Oral and lip carcinoma presents a multifactorial etiology, being considered, among others, abusive alcohol and tobacco habits, areca nut consumption and human papillomavirus (HPV) infection, as risk factors for suffering OSCC3. Other factors that have been proposed as possible OSCC etiology are poor oral hygiene, genetic predisposition, nutritional deficiency, greater genomic alteration and chronic inflammation7. The most frequent OSCC locations are the oropharynx and the oral cavity[8], with the tongue being the most frequent sublocalization in the oral cavity[4].

The objective of this study was to review the profile of the patient presenting oral cancer related to sex and age, and to study the possible etiopathogenic factors related to its appearance.

MATERIAL AND METHOD

An observational, descriptive and retrospective study was carried out on patients with oral cancer treated in the Oral and Maxillofacial Surgery Service of the Ramon y Cajal University Hospital in the period between 2004 and 2020. This study has been approved by the ethics and research committee of the aforementioned hospital. The data processing has been carried out at all times in accordance with the provisions of Law 3/2018 (Protection of Personal Data and Guarantee of Digital Rights Law) and the research team will undertake not to reidentify the patients once the data for the study has been obtained. The fieldwork has consisted in analysing the profile of patients diagnosed with oral cancer in the aforementioned hospital centre, who were older than 18 years and in those who appear to be recorded in their clinical history.

The variables studied were:

- Sex: male-female.
- Age: it will be expressed in decades.
- Tobacco use: Less than or more than 20 cigarettes a day.
- Alcohol consumption: non or occasional drinker, chronic drinker.
- Location of injuries: the following locations, listed in the tenth revision of the International Code of Diseases (ICD-10)9, have been included:
  - Mobile portion of the tongue (C02.0-C02.3, C02.8 and C02.9).
  - Floor of mouth in all its locations (C04.0, C04.1, C04.8 and C04.9).
  - Gums in all its locations (C03.0, C03.1 and CO3.9).
  - Lips in all locations (C00.0-C00.9, C43.0 y C44.0)
  - Jugal mucosa (C06.0).
  - Vestibule (C06-1).
  - Hard palate (C05.0 and C05.9).
  - Retromolar trigone (C06.2).
- Selection of study population:
  - Inclusion / Exclusion Criteria:

Inclusion criteria: Medical records of:

- Medical records from 2004 to 2020.
- Sex (woman or man).
- Patients older than 18 years.
- Patients who have suffered or suffer from a tumour process in the oral cavity.

- Records that reflect the patient's smoking and alcohol habits.

Exclusions criteria: Medical records of:

- Patients younger than 18 years.
- Medical records prior to 2004.
- Patients who have not suffered or suffer from a tumour process in the oral cavity.
- Incomplete medical records regarding our study data.

The statistical analysis has been carried out using the computer application: IBM-SPSS Statistics version 25 (IBM Corp. Released 2017. IBM SPSS Statistics v 25.0 for Windows).

The statistical techniques and tests used were:

1. The descriptive of qualitative variables with frequencies and percentages tables (sex, lesions location).
2. The quantitative variable age, has been described by the usual tools (a) of centrality: Mean and median; and (b) of variability: Observed range, standard deviation, minimum and maximum.
3. Univariate binary logistic regression models were used to analyse the predictive capacity of the factors with respect to the dependent study variable (cancer). The variables are age, sex, tobacco, alcohol.

RESULTS

Our sample consisted of 86 patients, all of them with OSCC. We have reviewed 350 medical histories and excluded 264 histories due to lack of relevant information for our study. The patients of the sample were between 35 years the youngest and 95 years the oldest patient. The majority were between 60 to 80 years and 34% of the sample have been patients < 60 years. The distribution by age range showed a negative asymmetry, with average age of 66 years ± 14.0 years (66.37 years; 95% CI) (Figure 1).

Regarding sex, our results show that there is a higher frequency of oral carcinomas in men with a percentage of 53.5% compared to 46.5% in the case of women (Figure 2).

Data on tobacco and alcohol consumption of the patients in the sample are represented in Figure 3. 90.7% of the patients studied with OSCC smoked more than 20 cigarettes a day and 68.60% were chronic drinkers (Figures 3 and 4).

Analysing, the habits by sex it is observed that of the 46 men in the sample, 43 have smoking habits, that is, 93.5% smoke more than 20 cigarettes/day. Regarding the drinking habit there are 44 (95.7%) chronic drinkers in the case of women we see that of the 40 women in the sample, 35 (87.5%) have a smoking habit of more than 20 cigarettes/day and 15 (37.5%) are chronic drinkers (Figure 5).

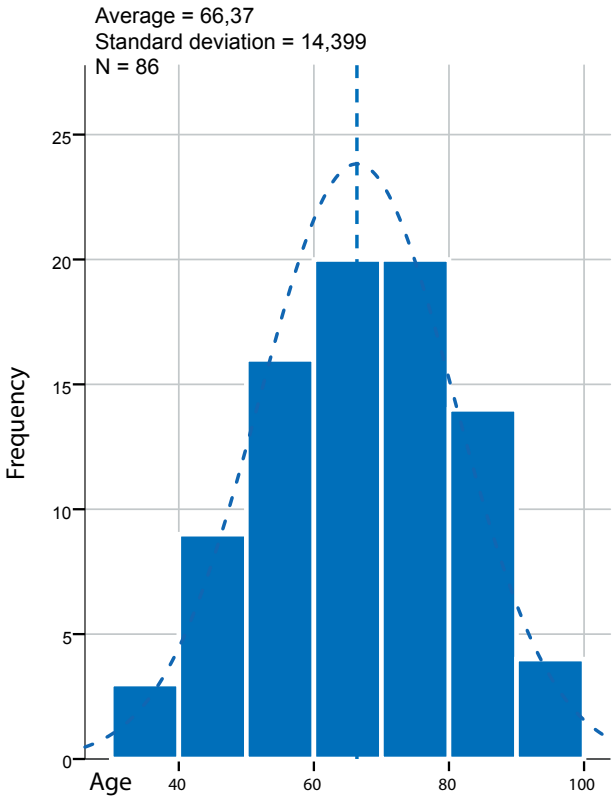

Figure 1. Histogram. Composition according to age.

There are practically no differences between tobacco and alcohol consumption in men.

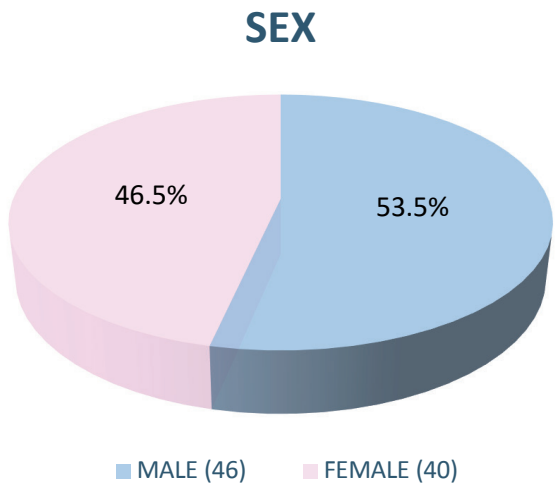

Figure 2. Sector diagram Composition of the sample according to sex. N=86.

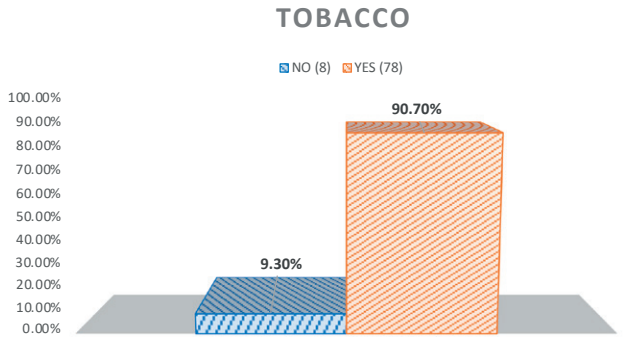

Figure 3. Bar diagram Tobacco consumption

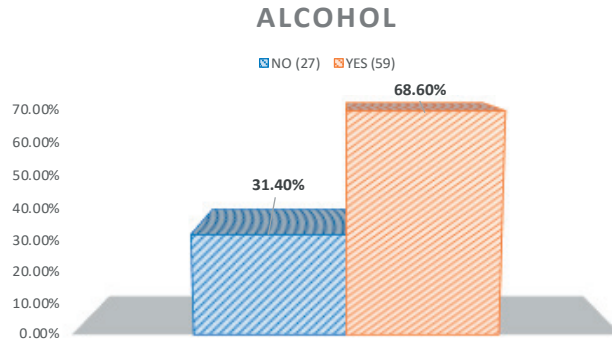

Figure 4. Bar diagram Alcohol consumption

Important differences have been found in women, with a greater consumption of tobacco compared to alcohol. This increase is represented by 50 percentage points more tobacco users than alcohol users among women.

When comparing tobacco consumption between men and women, the difference was only 6 percentage points higher in men.

The most frequent location of OSCC has been in the tongue, where 35 of the 86 cancer cases (40.6%) have been located, followed by the jugal mucosa with 14 cases and floor of the mouth with 13 cases, similar prevalence (16.2% and 15.1% respectively).

Regarding sex and its relationship with the location of the tumour, it has been observed that in most of the localizations the OSCC is more frequent in males, but they are equal in the yugal mucosa and the lip cases and it is already higher in the tongue in women, alveolar ridge and in the tuberosity of the maxilla (Figure 6).

Tobacco appears in our statistical study as a factor with a high predictive capacity for cancer ($p<0.02$). Alcohol alone appears with a lower predictive capacity ($p< 0.05$). The table shows the logistic regression analysis of the tongue in relation to substance use, being the most frequent area of OSCC in this study.

The association of tobacco and alcohol in the same patient is shown as a highly predictive factor ($p< 0.012$).

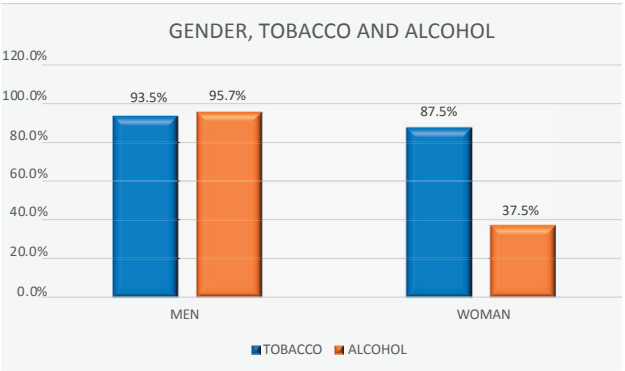

Figure 5. Comparative histogram of gender with substance use (tobacco and alcohol).

DISCUSSION

According to the Spanish Society of Medical Oncology, up to the age of 80 men have a risk of developing a carcinoma of 40.9% and in the case of women, 27.0%. But these figures increase as the population ages and at age 85 they represent values of 49.1% in men and 31.8% and 31.8% in women[6], although we find cases in increasingly younger patients[10,11]. As seen in the sample of this study, although most patients were between 60 to 80 years, we must emphasize that 34% of the sample were patients < 60 years old and the youngest patient was only 35 years old, this being a smoker of more than 20 cigarettes a day and a chronic drinker. This patient developed an OSCC in the floor of the mouth. In this patient, the synergistic effect of both etiopathogenic factors was combined.

The average age of the patients in our study, 66.37 years, is very similar to the data obtained through the Tumour Registry of Madrid (RTMAD) 2019[12] in Madrid public hospitals where the average age was 66.2 years.

Regarding sex, men have presented the highest percentage of OSCC compared to women, although this trend is changing[8,10,13]. These results are very similar to those obtained in the study of cases registered in RTMAD12 where the majority were men with 55% (18,300 cases) compared to 45% (14,677 cases).

It is important to highlight the change in trend, which is reflected in tongue carcinoma, where already in this work is more prevalent in women, also occurs in the tuberosity of the maxilla and alveolar ridge, this data together with the approximation to equalize in frequency in the lip and jugal mucosa locations. Social evolutionism in the incorporation of women into habits that were previously almost exclusive to men is having clear consequences in an increase in prevalence in certain locations, as we have seen.

It is well established in multiple studies that due to tobacco and alcohol consumption there is a greater genetic alteration in the population with these habits that leads to tumour development and growth than in patients who do not have said habits, therefore, the combination of tobacco and alcohol determines an increased risk of developing OSCC. It is known that alcohol increases the permeability of the oral mucosa membrane which gives greater ability to the tobacco toxic chemicals to enter the epithelial membrane and trigger the OSCC[14] mechanisms of genesis. With the limitations of a retrospective study, the high number of patients who smoke and drink in our research could explain this malignant transformation, being smokers of more than 20 cigarettes a day 90.7% and 68.6% chronic drinkers of the sample.

Throughout history, there has been a change of the trend in the profile of patients with oral cancer, both in sex and age. Although statistics show that middle and advanced age men constitute the most frequent profile

Table. Relationship of substance use and lingual cancer.

Factors (n=86)			VD = TONGUE				Logistic Regression					
			No		Yes							
			59%	n=51	41%	n=35	Wald	R^2	P-valor	OR	OR - IC 95%	
Tobacco	No	8	87.5%	7	12.5%	1	2.38	0.040	0.0123	5.41	0.63	46.09
	Yes	78	56.4%	44	43.6%	34						
Alcohol	No	27	40.7%	11	59.3%	16	5.42	0.045	0.020	0.33	0.13	0.84
	Yes	59	67.8%	40	32.2%	19						

of patients with oral cancer, there is a clear increase in women[11,15] and in young people with this disease[16]. This may be due to the change in habits of women regarding tobacco, which has increased considerably as well as the increase in the number of annual deaths of women due to tobacco. 2019-2020 has been the year with the lowest figure in the history of tobacco consumption. If we compare it to 2017 we see a slight decrease of 1.5 percentage points. Even so, the figure remains excessively high with 39.4% of people who have smoked in the last 12 months in 2019 being practically the same between sexes and also at early ages[17]. In addition, alcohol is the most consumed substance in Spain that presents a prevalence of morbidity and mortality in the 20 to 39 age group and is responsible for causing 200 diseases, including cancer[18]. It can be observed that women from 2006 to 2017 have been approaching men regarding drinking habits, especially in the ages between 25 and 64 years[17].

It is important to note that smoking patients are six times more likely to develop oral mucosa cancer according to literature[19]. In the present work we agree with these statements, mainly in the localization in the tongue with a figure of 5.41% times more likely among smokers.

In the case of drinkers, in this study a percentage of 95.7% was found in men and 37.5% in women. These values are higher than the data obtained in alcohol, drugs and other addictions survey in people over 64 years old (Survey on Alcohol, Drugs and other Addictions in the Elderly over 64 years of age "ESDAM")[17] in Spain, where in the last month, 67.7% of men and 30.9% of women are drinkers. This age group presents the characteristic of having a greater daily consumption and less intensive consumption habit, compared to the young population. Consequently, alcohol makes the occurrence of cancer 2.4 times more likely in drinkers than non-drinkers[19], and in this study it appears as a significant factor in the likelihood of developing OSCC.

While anti-smoking laws and tobacco and alcohol cessation implementations are providing encouraging data, other habits are emerging such as the increase of e-cigarettes, hookahs and smokeless tobacco among young people. The cause of this increase could be poor awareness and lack of information about the harmful effects of this type of tobacco. In addition, it has been possible to observe the evolutionary process from 2017 to 2020 that has had an upward trend, going from

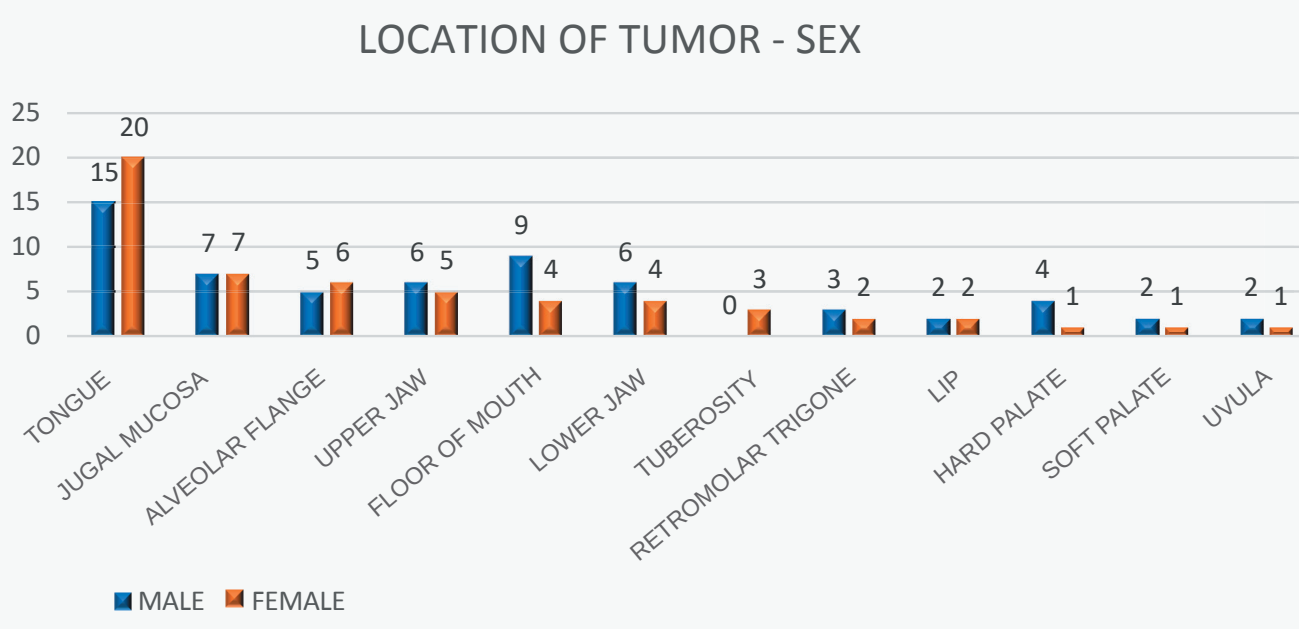

Figure 6. Histogram. Relationship of tumour location and the sex of the sample (n=86).

8.8% to 10.5% and being very frequent in women the use of e-cigarettes in the age group of 45-54 years[20].

It is worth noting the change in trend regarding the involvement of women in the prevalence of cancer, in this study in the case of the tongue, alveolar ridge and in the tuberosity of the maxilla, women have suffered more frequently OSCC, being the tongue the area where more cases of this neoplasm have occurred. We agree with the study carried out by Sundermann et al.,[11] which analysed risk factors, tumour location and sex, resulting in a higher rate of OSCC cases in the tongue and jaw in women. The global study conducted by Ng et al.,[21] analysing tongue cancer in relation to age and sex, concluded that tongue cancer had increased over the age of 40 years in the 22 countries analysed, he especially observed an increase in younger white women, but he could not globally determine the frequency between genders. Although the study was carried out until 2012 in some countries, it was already marking the future evolution of lingual OSCC in women.

CONCLUSIONS

- The general data of this study show that oral cancer is more prevalent in men (53.5%), but there are locations such as the tongue, alveolar ridge and maxillary tuberosity where it appears most frequently in women.
- The appearance of patients with OSCC in the 30s age, and finding 34% of patients with OSCC under 60 years of age, should alert us to the importance of performing a thorough oral examination in all patients, regardless of their age.
- Tobacco alone, and especially the synergy of tobacco and alcohol, may be positive predictors of oral carcinoma risk.

LIMITATIONS

This work is part of a larger study that involves a follow-up, but has been carried out in the middle of COVID-19 and the stay in the hospital was limited.

We have found that the medical records do not show information about the oral treatments that the patient has had, nor the traumatic factors associated with poorly adjusted prosthesis or other chronic irritant or inflammatory factors. this could be very useful when analysing the etiopathogenic factors associated with oral cancer.

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Original article

Relationship between the socioeconomic status and the chronology and eruption sequence of permanent dentition

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SUMMARY

Objective: Relate the eruption process in permanent dentition with the socioeconomic status.

Methods: An epidemiologic, descriptive and cross-sectional study was carried out in the Spanish population, participating 725 children between 4 and 14 years of age, the selection was opportunistic recording in a database the socioeconomic status of the progenitors, the chronology and emergence sequence of each of the permanent teeth.

Results: Regarding the socioeconomic status, 38.62% were Level I, 40.83% Level II, 15.86% Level III, 4.14% Level IV and 0.55% Level V. The first tooth to appear in the maxilla was the first molar (74.34-76.41%), while in the mandible it was the central incisor (78.9-82.76%) with statistically significant differences (p-χ^2<0,001).

Conclusions: TThe medical care and nutrition of the patients will depend on the socioeconomic status, but at the dental level there were no statistically significant differences regarding the chronology and eruption sequence.

KEY WORDS

Sequence; Chronology; Dentition; Permanent; Socioeconomic; Spain.

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INTRODUCTION

The eruption is a physiological and dynamic process that starts with the formation of the tooth germ, which moves from its crypt in the bone until it emerges in the oral cavity and occludes with its antagonist[1-3]. This process begins around the age of 6, when the first permanent molar erupts, going from an exclusively temporary to mixed dentition, ending around the age of 12 when the permanent second molar emerge[4].

Among the systemic and local factors that can alter both the chronology and the eruption sequence of permanent dentition, are:[4.5] sex, age, origin, genetics, bone-dental discrepancy, premature loss of temporary teeth, skeletal development, socioeconomic status and environmental factors[5-9]. Because of all these factors, establishing a specific age for the emergence is complex. However, it is possible to establish age ranges or averages for the eruption, in order to have a guide for the diagnosis and treatment in paediatric dentistry and orthodontics[10].

As for the emergence sequence, it seems that it is a key element for the correct tooth eruption. We consider this as the place occupied by the tooth in the arch[11]. Moron et al.[1] consider the sequence norm stricter than that of the chronology while San Miguel Penton et al. state that, even if the emergence order does not follow the norm, it may be favourable[11]. The most propitious sequence at the maxillary level is: 6-1-2-4-5-3-7 and in the mandible: 1-6-2-3-4-5-7[12].

In Spain, the chronology and sequence studies in permanent dentition are scarce, and the last record corresponds to 2013, hence the interest in collecting updated data[12]. In addition, one of the least studied influencing factors is the socioeconomic status, closely related to the individual nutritional level and the growth and development of oral tissues, especially dental[13]. Domingo et al. determined how the lower social classes would have poorer health and less opportunity to high-quality health care, worse nutrition, and less physical activity and delayed tooth eruption[14].

Based on this, the main objective was to investigate and relate the chronology and sequence of tooth eruption with socioeconomic status.

METHODS

A cross-sectional descriptive epidemiological study was carried out between November 2020 and September 2021. 733 children from the Community of Madrid (Spain) between 4 and 14 years of age participated. The population was randomly selected, all went to the Dental Clinic of the European University of Madrid and two private clinics. To determine the sample power, a calculation was made with a standard deviation of 0.5 years, taking into account the age and gender ranges; the minimum number of participants was 620.

The study was carried out in accordance with the Declaration of Helsinki and with the prior approval by the Research Committee of the European University of Madrid and the Ethics Committee of the Community of Madrid of the Medicines Research. At the beginning, parents or legal guardians were informed of the procedure and signed an informed consent for both the study and for the preventive measures due to the Covid-19 pandemic.

The children included enjoyed a good general health. 8 patients were excluded due to dental agenesis, supernumerary teeth and systemic diseases.

A first dental examination was carried out by two researchers. Previously, the patient's clinical history was reviewed, recording data regarding the date of the visit, age in years and months, origin, sex and socioeconomic status. It was determined as shown below[14]:

I. Directors of public administration and of companies with 10 or more employees. Professions associated with second or third cycle university degrees.

II. Managers of companies with less than 10 employees. Professions associated with a first university cycle. Support technicians and professionals. Artists and athletes.

III. Administrative and professional staff to support administrative and financial management. Personal services and security workers. Self-employed. Manual work supervisors.

IV. Skilled and semi-skilled manual workers.

V. Unskilled workers.

The researchers recorded the emerged teeth and their sequence under a light source of the dental chair and an intraoral mirror. A tooth was considered to have erupted when any part of its crown had pierced the gingival mucosa according to the criteria established by Carr et al.15 Third molars were excluded from the study. The sequence was recorded according to the eruption of each piece. In those participants with complete permanent dentition, the most common eruption sequence according to the literature was taken into account[12].

One week after the first examination, 20% of the sample was re-examined by both researchers. First, the principal investigator performed the examination again and recorded both the sequence and the erupted teeth at that time. Then the second investigator carried out the same procedure recording everything in two different Excel sheets (Microsoft Corp., Redmond, WA, USA). It was considered that one tooth would have erupted when any part of its crown was seen through the gingival mucosa. Intra-observer and inter-observer concordance tests were carried out with a kappa value always above 0.95. It was observed that the concordance was almost perfect, being perfect for several of the teeth.

DATA ANALYSIS

Regarding the quantitative variables, the descriptive statistic was carried out by numerical summaries, and the qualitative with frequency and contingency tables. Subsequently, the chi-square test and Fisher's exact test were applied.

For the measurement of a factor using logistic regression feedback models, the Wald test, the ROC curve and AUC (Area under the ROC Curve) were applied. The t-test and Wilcoxon test were used for the comparison of two samples, the Welch t-test was required in cases that did not assume the sample's normalcy.

The homoscedasticity of the sample was studied by the Levene test and a normality was found in those samples large enough according to the central limit theorem. To compare the averages of two groups, different tests were used according to the homoscedasticity; if this was low, we used the Kruskal-Wallis test, if it was average we used the Welch's ANOVA test and if it was high the ANOVA test.

The relationship between the numerical variables was carried out using the coefficient and the Spearman correlation test. The results were considered significant for *p* values below 0.05.

To perform the analysis the statistical software R (version 4.1.1) was used using the RStudio environment (RStudio Inc., Boston, MA, USA).

RESULTS

Data were recorded from 725 individuals (367 girls and 358 boys). 93.1% of the sample was of Caucasian origin and the remaining 6.9% was of Hispanic origin. Regarding the socioeconomic status, 38.62% belonged to a level I, 40.83% to level II, 15.86% to a level III, 4.14% to a level IV and 0.55% to a level V.

Statistically significant differences were found between socioeconomic status and patient origin: Caucasian subjects had better socioeconomic status. No significance was observed in the distribution of socioeconomic status regarding gender and age. (Table 1, Figure).

The eruption symmetry was presented in 41.38%, being significantly higher the percentage of subjects without symmetry (68.62%) (p-χ^2<0.001). The presence of symmetry in the upper arch was significantly related to that of the lower arch (p-χ^2<0.001), being present in 67.87% of the children. Asymmetry in the upper and lower arch simultaneously was found in 71.38%

of the sample. No significant results were found in the relationship between sex and eruption symmetry (p-χ^2=0.582) or between race and symmetry (p-χ^2=0.5901). There was also no significance between eruption symmetry and socioeconomic status (p-χ^2=0.9257) (Table 2).

A univariate logistic regression model was carried out, finding that sex, race and socioeconomic status were not predictors of eruption symmetry (p-Wald>0.05 in all analyses). On the other hand, age was found to behave as a significant predictor variable, p-Wald=0, OR (*odds ratio*)=1.02718806.

The first permanent tooth to appear in the maxilla was the first molar (74.34-76.41%) and in the mandible the central incisor (78.9-82.76%), with statistically significant differences (p-χ2<0.001). The symmetry and emergence of the first tooth was analysed, there was only a significant relationship between symmetry and the fourth quadrant (p-fisher=0.003391), since when erupting there was asymmetry in 80.95% of the cases.

When analysing the relationship between the eruption of the first tooth and the study variables, the socioeconomic status did not show statistically significant differences in any quadrant (p-Fisher>0.05 in all cases). With respect to sex and race, the data were significant for gender and lower-right hemiarch and race and upper left hemiarch. In girls the first tooth

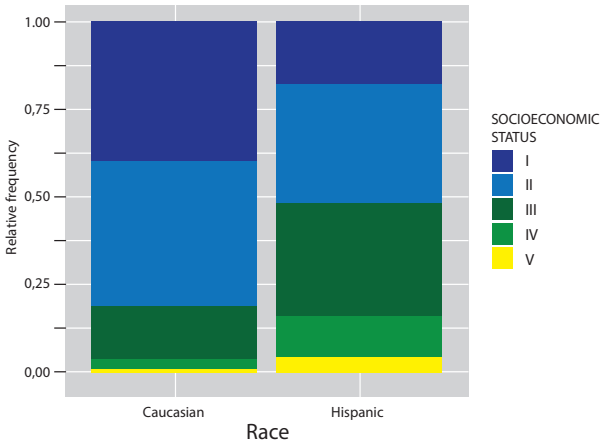

Figure. Bar graph of socioeconomic status according to race.

Table 1. Descriptive and comparative statistics: race, gender, age and socioeconomic status.

		Origin		Socioeconomic status					Age (months)	
		C	**H**	**I**	**II**	**III**	**IV**	**V**	**Medium**	**SD⁺**
Gender*	***Significance***	*p-χ^2=1*		*p-χ^2=0.1854*					*p-test=0.9159*	
	F	342	25	150	145	55	13	4	115	36.7
	M	333	25	130	151	60	17	0	115	37.2
Race	***Significance***			***p-χ^2<0.001***					***PTWelch<0.001***	
	C			271	279	99	24	2	117	36.8
	H			9	17	16	6	2	91.9	31.1
Socioeconomic status	***Significance***								***p-Kruskal-Wallis=0.174***	
	I								117	36.7
	II								116	38.2
	III								114	34.5
	IV								102	34.3
	V								92.2	33.1

Gender F (female), M (male). +SD. Standard Deviation. Origin C (Caucasian), H (Hispanic).*

to erupt in the fourth quadrant was the central incisor (98.01%) (p-Fisher=0.04563), and in Caucasian boys the emergence in the second quadrant was the first permanent molar (98.65%) (p-Fisher=0.01365).

The eruption symmetry and sex were predictive variables regarding the emergence of the first tooth in the lower-right hemiarch (p-Wald=0.007 and p-Wald=0.046, respectively), and the race in the first and second quadrant (maxillary arch) (p-Wald<0.05). Age was a predictive p-wald<0.05 in all quadrants.

Sex was found to be significant in the eruption of the 17, 33, 42 and 43 teeth since the probability of eruption was higher in boys regarding tooth 46 whose probability was higher in girls (Table 3).

DISCUSSION

Knowing the chronology and eruption sequence of permanent dentition is essential as an improvement in treatment planning at both preventive paediatric dentistry or orthodontic level[16]. In this regard, Veloso et al. associated the eruption sequence and motor laterality function[17].

Current changes in the emergence chronology are relevant for forensic dentistry. Several authors insist on the differences in chronological and sequential level of the eruption according to race or geographical area[12,18]. Schmeling et al. highlighted the influence of the various ethnic groups in the procedures that existed for estimating the age of the patient and the difficulty that appeared in cases in which the population of the studied subject had no reference[19] studies.

According to Nassif and Sfeir, premolars and second molars emerge at an early stage in Lebanese children compared to established standards[20]. Therefore, knowing the eruptive population characteristics is relevant at forensic level regarding identification cases in war conflicts, migratory movements, refugee flows or accidents of any type[3,21].

Regarding sex, several authors indicate that in girls the emergence is at an earlier stage, due to hormonal causes[20-26]. Saenz Martinez et al. observed this characteristic, except for tooth 46[4]. In our research, teeth 17, 33, 42 and 43 are more likely to emerge in boys compared to girls, while teeth 46 emerge earlier in girls. According to Vithanaarachchi et al., the exception lies in the central incisors[27]. However, Oz and Kirzioglu note that the eruption in girls is earliest at age 5, but in groups of 6-8 years and 10-12 years there would be no statistically significant differences regarding sex[28]. Almeida et al., in their research, also corroborated the earliest eruption in girls than boys, the upper teeth erupting between 4.3 and 4.4 months before and the lower teeth between 3.0 and 3.729. Valenzuela et al.

Table 2. Descriptive and comparative statistics: Emergence symmetry/ asymmetry of permanent dentition and its relationship with socioeconomic status. Contingency table and chi-square test.

SOCIOECONOMIC STATUS	Asymmetry	Symmetry	*P- value Chi-square test*
I	160 (57.14%)	120 (42.86%)	*0.9257*
II	174 (58.78%)	122 (41.22%)	
III	70 (60.87%)	45 (36.67%)	
IV	19 (63.33%)	11 (36.67%)	
V	2 (50%)	2 (50%)	

Table 3. Odds Ratio values for permanent dentition with the exception of wisdom teeth.

	17	16	15	14	13	12	11
GENDER (OR)							
Boy	1	1	1	1	1	1	1
Girl	0.4583*	1.1273	0.7668	0.5889	0.8077	1.4132	0.4315
AGE (OR)							
	1.1551*	1.1938*	1.1283*	1.1445*	1.1443*	1.2641*	1.3001*
SOCIOECONOMIC STATUS (OR)							
I	1	1	1	1	1	1	1
II	0.5262	2.1119	1.2685	1.1671	1.2529	2.4956	1.3028
III	1.2101	0.9877	1.7045	1.6108	1.7591	3.9561*	3.1322
IV	3.4019	0.3129	1.3332	1.6238	2.147	1.2506	1.3055
V	0	14.053	0	0	0	18.0565	103.8389
	21	**22**	**23**	**24**	**25**	**26**	**27**
GENDER (OR)							
Boy	1	1	1	1	1	1	1
Girl	0.4287	0.7575	0.6669	0.6551	0.9506	0.8288	0.7554
AGE (OR)							
	1.2709*	1.3011*	1.1338*	1.1425*	1.1327*	1.2061*	1.1543*
SOCIOECONOMIC STATUS (OR)							
I	1	1	1	1	1	1	1
II	1.3918	2.0862	1.1107	0.8843	1.4473	1.8206	0.518
III	2.8589	2.3306	1.0708	1.7789	4.0371*	1.2661	1.1352
IV	0.9667	2.7071	1.2539	0.7496	0.5903	0.4918	3.3374
V	96.8475	12.8522	0	10.948	0	24.8599	0
	31	**32**	**33**	**34**	**35**	**36**	**37**
GENDER (OR)							
Boy	1	1	1	1	1	1	1
Girl	1.274	1.1336	0.4498*	0.7344	0.9918	2.1176	0.7346
AGE (OR)							
	1.1661*	1.2947*	1.151*	1.151*	1.1526*	1.2524*	1.1559*
SOCIOECONOMIC STATUS (OR)							
I	1	1	1	1	1	1	1
II	0.7321	2.9717*	1.5214	1.6571	1.147	0.667	1.2896
III	0.7861	3.3237	1.2914	2.1154	2.3609	1.046	1.6731
IV	0.0685*	3.3508	0.7203	2.0424	0.8316	0.2432	1.868
V	5.19×10^{8}	1245.1041	0	0	0	24.7364	0
	47	**46**	**45**	**44**	**43**	**42**	**41**
GENDER (OR)							
Boy	1	1	1	1	1	1	1
Girl	0.6078	3.9453*	0.7618	0.9834	0.4923	0.396*	0.7177
AGE (OR)							
	1.1371	1.2514*	1.1376*	1.1502*	1.1566*	1.2463*	1.1788*
SOCIOECONOMIC STATUS (OR)							
I	1	1	1	1	1	1	1
II	1.0605	0.578	1.5339	1.0791	0.901	1.2325	0.9213
III	2.9011*	0.4499	2.0757	1.041	1.3147	1.6726	1.0739
IV	5.4031	0.1819	3.238	1.2938	0.6241	4.7702	0.2072
V	0	19.2096	0	0	0	142.4275	1.19×10^{9}

**p-value <0.05*

Permanent dentition teeth: 17 (2nd upper right molar); 16 (1er upper right molar); 15 (2nd upper right premolar); 14 (1st upper right premolar; 13 (upper right canine); 12 (upper right lateral incisor); 11 (upper right central incisor); 21 (upper left central incisor); 22 (upper left central incisor); 23 (left upper canine); 24 (1st left upper premolar); 25 (2nd left upper premolar); 26 (1st left upper molar); 27 (2nd left upper molar); 37 (2nd left lower molar); 36 (1st left lower molar); 35 (2nd left lower premolar); 34 (1st lower left premolar); 33 (lower left canine); 32 (lower left lateral incisor); 31 (lower left central incisor); 41 (lower right central incisor); 42 (lower right lateral incisor); 43 (lower right canine); 44 (1st lower right premolar); 45 (2nd lower right premolar); 46 (1st lower right molar); 47 (2nd lower right molar).

also observed an earlier eruption in girls compared to that of boys, as did Gonzalez et al.[30,31] Plasencia et al., in their study in Spain, and Dahiya et al., in India, highlighted the same eruption pattern, being this earlier in females than in males[32,33].

Regarding the socioeconomic status, there is no consensus, since early emergence is associated with children with higher socioeconomic levels or the opposite[34.35]. In our study, we found no significance between symmetry, eruption chronology and socioeconomic status. According to Clements et al., at a higher socioeconomic status better medical care, better nutrition and earlier emergence of permanent teeth, except for the second premolar, since the latter is more susceptible to caries and, therefore, to present an earlier exfoliation and a later eruption of its successor[34]. On the contrary, Dimaisip-Nabuab et al. believe that a lower socioeconomic status and worse nutrition favour the presence of untreated caries pathology and delayed eruption[3]6. Phillips et al. suggested that a high socioeconomic status could play an important role in the calcification of permanent teeth influencing x-rays vision used to detect the age of the individual[37].

In relation to the sequence the first tooth to emerge when the purchasing level is higher, are the mandible incisors, while in population with less resources the first mandible molars[35] erupt first. In our research, no statistically significant differences were found in this regard, observing how in the first quadrant the probability of the lateral incisor emerging was approximately four times greater for individuals of social class III. The same would occur in the second quadrant with the second premolar. At the third quadrant level, the probability of the lateral incisor appearing was multiplied by three for social class II and by fifteen for the central incisor appearing for social class IV. Finally, at the fourth quadrant level the piece 46 would have a probability of emerging three times higher for the social class III. Colomé et al. emphasize in their study that the first tooth to emerge is also the lower central incisor, followed by the first lower molar[38]. However, Valenzuela et al. determined that the first tooth to erupt in its structure was the first molar both upper and lower[30].

Regarding the racial factor, in our study the chronology of eruption of the permanent dentition was faster in those individuals of Hispanic origin than in those of Caucasian origin and the probability of symmetry was multiplied by 2.5 for individuals of Hispanic origin. In addition, there was a significant relationship in the second quadrant with the origin of the child, that is, the first tooth to erupt predominated more in individuals of Hispanic origin than in those of Caucasian origin. Debrot, in his research, also concludes that the teeth emerged earlier in black race than in white[39] race, just like Mugonzibwa[40], Kutesa[41] and Hassanali[42] that pointed out that the eruption in African and African American children was faster than that of Asians and Caucasians. Coinciding with our results, Steggerda et al. concluded that there were differences in the eruption times according to the races, erupting before in the Navajo race, then in the black race, then in the Mayan race and finally in the white race[43]. Colomé et al. observed that the eruption chronology of the population of southeastern Mexico was late with respect to that reported in Anglo-Saxon studies and early with respect to the population of central Mexico[38].

In reference to the limitations of our research, it should be noted that a larger sample with individuals with a lower socioeconomic status would enrich the obtained results. Since it is not a longitudinal study, it is not possible to determine if there are changes regarding the eruption and sequence in the same patient. However, we highlight as strengths the diversity of results regarding sex and the chronology and sequence, noting that, today, establishing a strict norm in terms of these variables is complex, since the eruption chronology and sequence depend on multiple factors. Therefore, future studies will be necessary to endorse the obtained results.

In conclusion, regarding gender, significance was observed for some teeth in males and in girls only a significance in the emergence of the lower right first molar. Regarding the socioeconomic status, this does not influence the chronology or the eruption sequence of permanent dentition.

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Clinical case

Block grafting in combination with the two-stage split technique for the rehabilitation of a case of severe bone resorption of the maxilla in width

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SUMMARY

The use of different surgical techniques to achieve the resolution of the most complex atrophy cases is of vital importance. Increasingly, we have cases with edentulism of longer duration in our practice that require implant treatment with fixed prosthesis, which is a challenge when planning and carrying out treatments. To do this, we can use different techniques that allow us to gain width and height, as well as implants of different lengths and diameters that allow us to adapt to each situation. In the present clinical case, we show a rehabilitation that combines different surgical techniques to achieve the desired result.

KEY WORDS

Dental implant; Block grafting; Split technique.

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INTRODUCTION

More and more frequently, patients with long-term edentulism, wearing complete prosthesis come for dental consultation requesting implantology treatment. The digital age, social networks and patient access to clinical information in dentistry, means that the latest advances in rehabilitation of extremely atrophic maxillary and mandible reach the patients and they demand a solution to their situation, they thought it could not be corrected in any other way than with removable dentures[1-4]. Therefore, patients sometimes request implantology treatments in cases of great complexity that make us have to use all the surgical and prosthetic tools at our disposal to solve them[5]. When we face a severe resorption in a horizontal sense, both in the maxilla and in the mandible, there are different techniques that help us to recover the lost bone volume to later insert dental implants[6-7]. Each of the techniques has its indications and may, sometimes, in the same patient, need several of these techniques to achieve a regeneration of the lost bone volume, since there are substantial variations in the quality and quantity of bone volume within the same arch of the same patient, as well as areas where in addition to width the bone plates have been completely or partially lost, which changes the approach of the technique to employ[6-9].

In general, when there is a reduced bone width (below 3 mm of residual crest) that does not allow direct insertion of the implant we can opt for an expansion or split crest, in one or two phases, as long as the two bone plates are available and there is a bone particulate between them that allows the separation between them by inserting the definitive implant or the expander implant[10-14]. When one of the two bone plates is absent, in that case, the recommendation will be to use block grafts or guided bone regenerations[13-14]. Both techniques are widely documented[15], and the selection between one procedure and the other is mainly based on the availability of autologous bone to perform block surgery, and the ability of the operator to perform the technique, since the use of blocks requires a greater learning curve and can lead to more complications in obtaining, manipulating and healing, since it is a technique of greater technical difficulty. In spite of all this, if careful protocols are used to obtain the graft, and a careful positioning technique is performed, paying special attention to soft tissues, nowadays, it can be performed without greater rate of complications than the bone regeneration technique, especially when the intraoral area is used as the donor zone and the obtained bone is maximized by dividing the block as described by Khoury[16-18].

In the following clinical case, a situation is shown where different procedures have been necessary to rehabilitate the maxilla with extreme bone loss in width, depending on each of the areas to be treated, individualizing the type of treatment according to the characteristics of the remaining bone recess.

CLINICAL CASE

We present the clinical case of a 56-year-old female patient, who has been wearing an upper complete removable prosthesis and a lower partial prosthesis for more than 20 years. She comes for consultation requesting implant rehabilitation to replace her current prosthesis to improve her masticatory function. In the intraoral examination we can observe that the prosthesis meets quite satisfactorily the aesthetic requirements of the patient, but according to her, they move when chewing. When removing the prosthesis, a maxillary edentulous ridge with an evident centripetal resorption that has left the starting situation close to that of a skeletal class III (Figures 1 and 2).

To start the diagnostic phase, a panoramic radiograph is performed that gives us an idea of the general condition of both jaws to start the treatment plan. It shows that there is apparently some height in the maxillary ridge both anterior and posterior and a low dental nerve in the jaw that allows us to have a greater residual bone crest available for the insertion of the implants (Figure 3).

Subsequently, we proceed to perform a dental cone beam that offers a more accurate view of the type of

Figures 1-2. When removing the prosthesis, we can see how the maxilla has suffered a resorption from the outside to the inside remaining more compressed transversely than the jaw.

implant rehabilitation that can be proposed. In the sections corresponding to the upper maxilla, there are areas where the direct insertion of the implants can be performed such as those corresponding to 16 and the central incisor zone of this quadrant (Figures 4-5) or in the second quadrant the area of the 27. On the other hand, in the area corresponding to teeth 21 and 23 there is a significant horizontal atrophy, with a residual bone width of approximately 3.5 mm in the

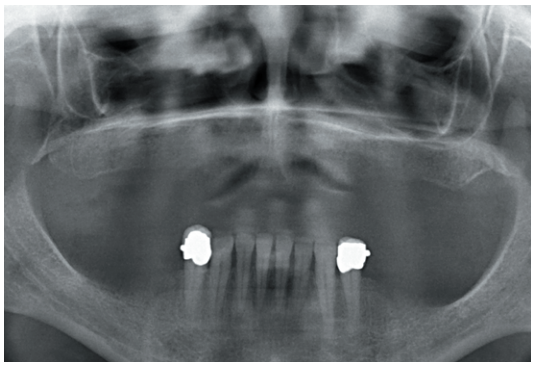


Figure 3. Initial panoramic X-ray showing the approximate maxillary and mandibular bone ridge heights for a first diagnostic impression.

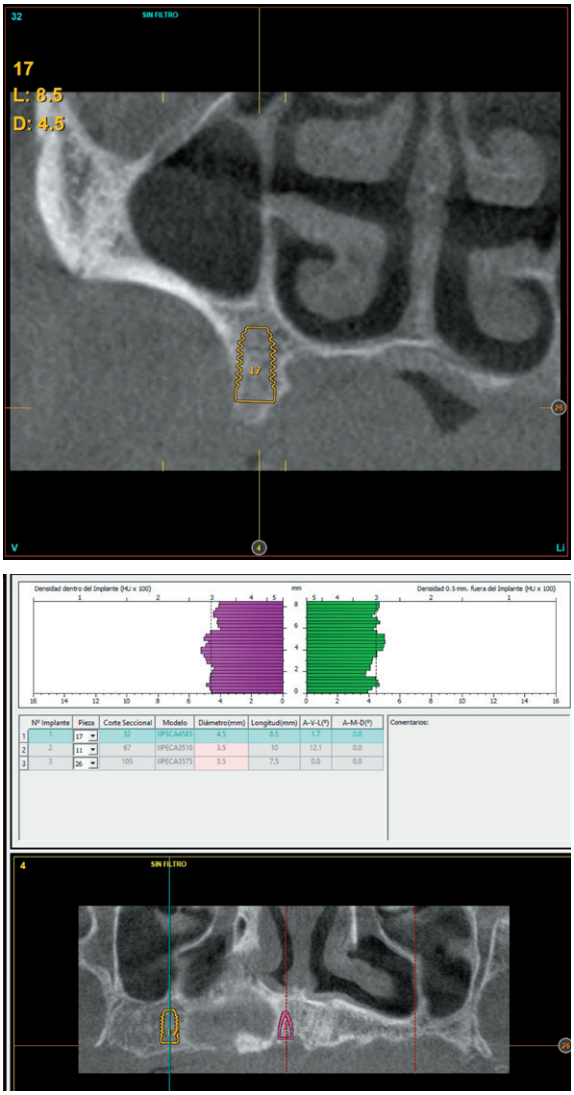


Figure 4. Planning view in the 16 area, where there is sufficient bone volume in width and height for the direct insertion of an implant in this position.

middle zone of the crest, with an enlargement in the most basal area of the same and conservation of both corticals. This leads to choose a split crest technique, in this case in two phases to achieve a greater final width and correct the inclination of the final implant as much as possible to achieve adequate aesthetics in the final prosthesis (Figure 6).

In the areas corresponding to teeth 11 and 13 the horizontal atrophy is even more marked. There is no trabecular bone separating the two corticals (vestibular and palatine) and the width is less than 2mm in some areas which is why block grafts are planned in this area. Short implants are planned in the mandible by direct insertion, and the area

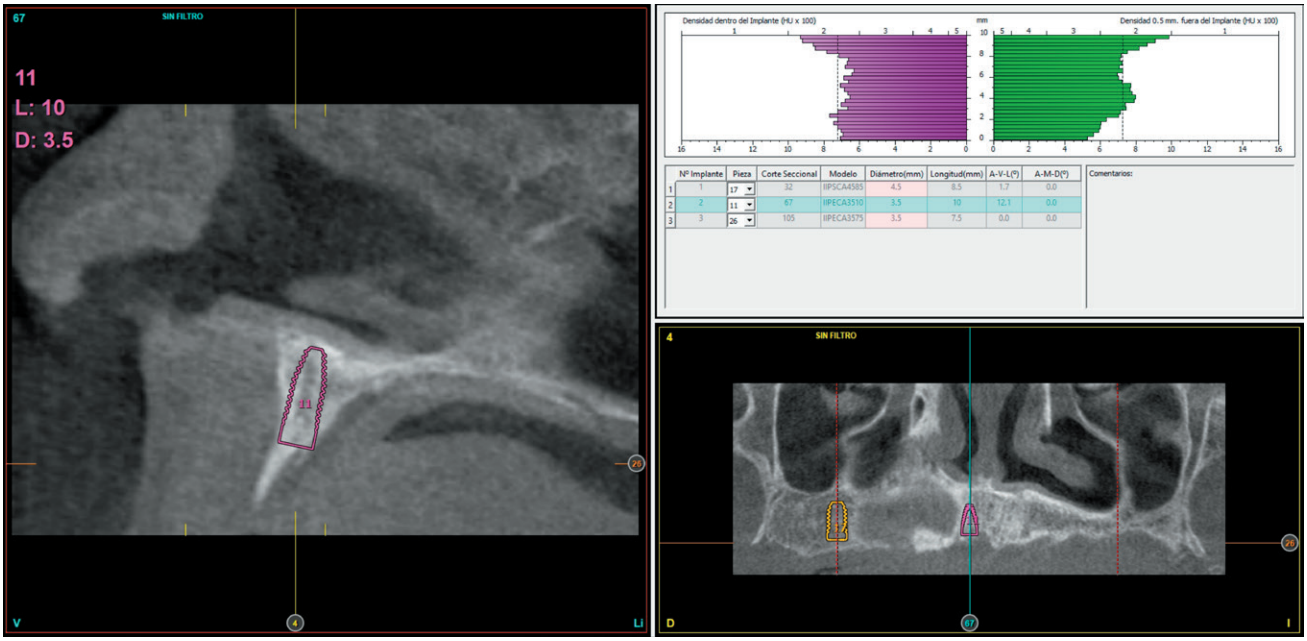


Figure 5. Area corresponding to the location of the 11 where direct insertion of the implant is also possible.

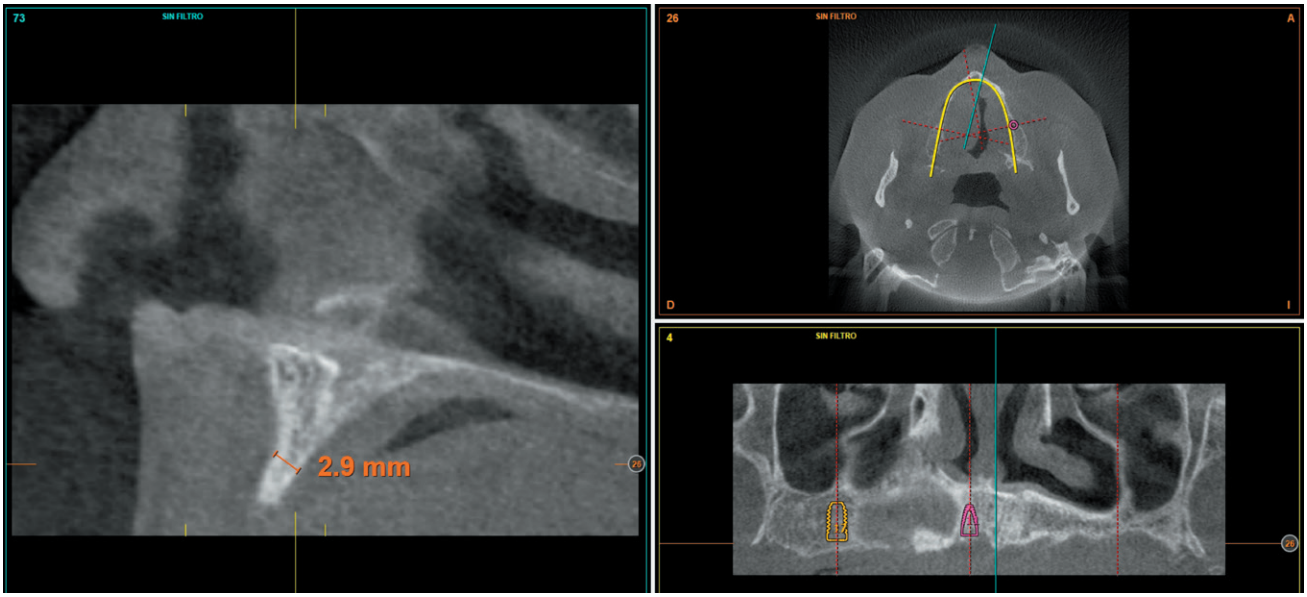
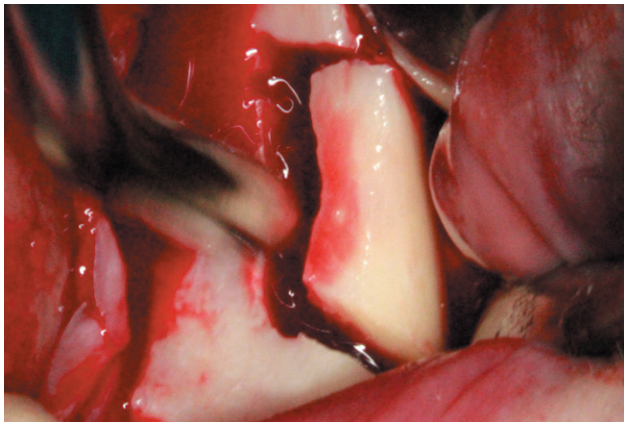


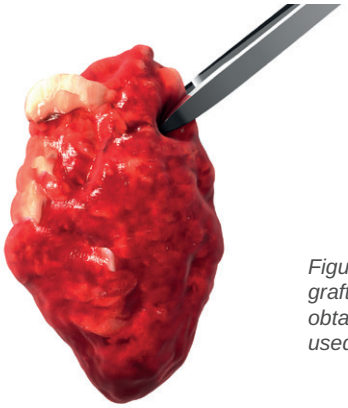
Figure 6. One of the areas of maximum horizontal atrophy (corresponding to dental positions 11 and 13) where the placement of block grafts is planned.

corresponding to the mandibular branch will be the donor area for the block grafts.

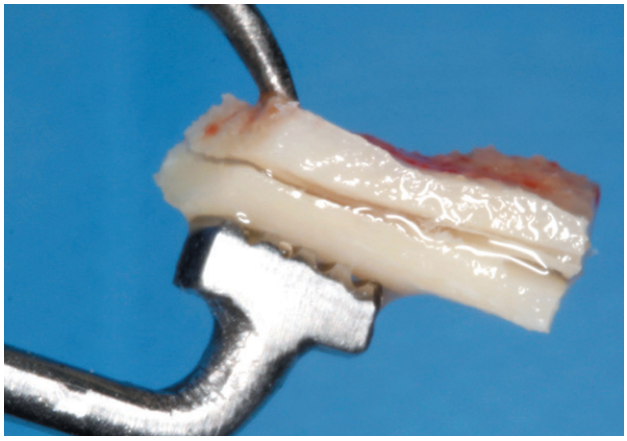
Once the case is planned, the insertion of the lower and upper implants and the different techniques of bone volume increase described is performed. It starts with mandibular surgery to obtain autologous bone obtained from miling that will be preserved during the whole surgery in PRGF-Endoret fraction 2 without activation, to be used in the maxilla where it will be necessary for the grafts in block, according to the technique described by our study group[19] (Figures 7 and 8). Once the block graft is obtained it will be divided and maintained in PRGF-Endoret fraction 2 without activation, to maintain its hydration and cell viability until its placement according to the technique described by Khoury where the cortical of the block graft is used as a formwork (Figures 9 and 10)[20].

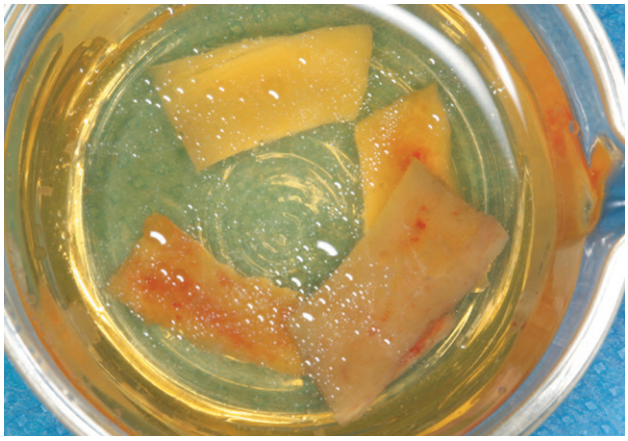
Once the mandibular surgery is finished, the opening of the upper flap is performed, where the great atrophy in horizontal direction that exists in certain locations is noted, as described above, that require performing block grafts (Figures 11 and 12). We proceed to perform the Split technique in two phases (Figure 13) with the insertion of the transitional implants and the insertion of the implants that could be placed directly. Once the insertion of all the implants is completed, the corticals of the grafts are fixed in block, trying to adapt them to the residual morphology as best as possible, avoiding edges that can damage the soft tissue. Once fixed, the gaps are filled mainly with autologous particulated bone obtained from the milling of the lower implants, as well as bone obtained from scraping the mandibular branch (Figures 14-18).





Figures 7-8. Obtaining the block graft and collecting the particle graft obtained from milling ready to be used as a particle graft.

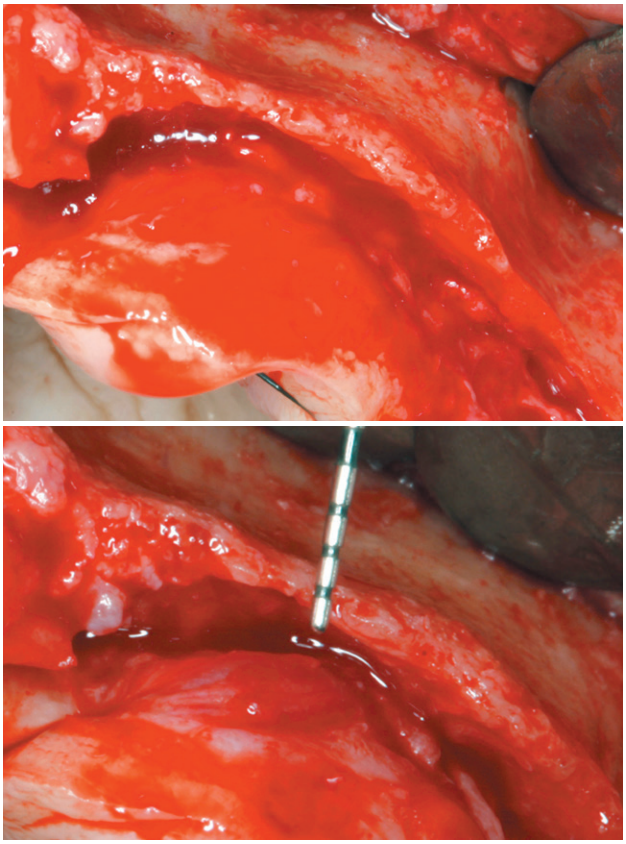




Figures 9-10. Block graft division and conservation in PRGF-Endoret.

Four months after the initial regeneration of the maxilla surgery a new dental cone-beam is performed, in which the next surgery phase is planned based on the bone gain that has been achieved with the block grafts and the Split technique in two phases. In the images we can see how in the maximum atrophy areas, where the blocks are placed a width has been achieved that triples the initial width (Figures 19 and 20). At the flap opening it is seen as the planification CT images correspond to reality, and also that the area treated by Split in two phases has achieved a crest width that now allows the removal of the transitional implants and the insertion of the new implants in this position, with a better starting and axis situation for the subsequent construction of the prosthesis (Figures 21-22). The implants are inserted and a temporary prosthesis of progressive load is made supported on the implants placed in the first surgical phase. In this way, the patient can have a fixed prosthesis on implants that will serve to shape the provisional ones in terms of aesthetics and function before the final prosthesis (Figures 23-24).

After four months the loading of the inserted implants in this second surgical phase is carried out. Again, a second



Figures 11-12. Residual bone crest status in the area of greatest atrophy, we can observe how there is bone volume with less than 2 mm width.

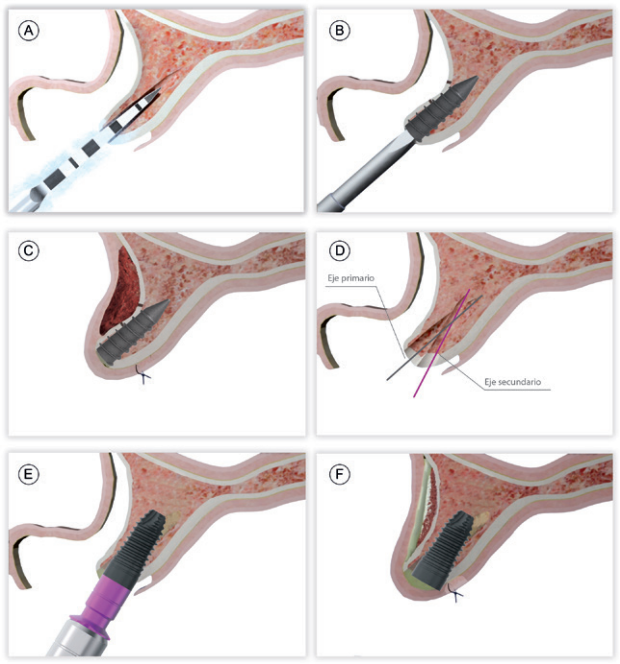


Figure 13. Steps for the two-phase split technique.
A and B) Start of the drilling with the correct axis according to the bone recess.
C) Insertion of the transitional implant.
D) Vestibular overcorrection once the transitional implant is inserted.
E) Removal of the transitional implant and new drilling axis.
F) Insertion of the definitive implant.

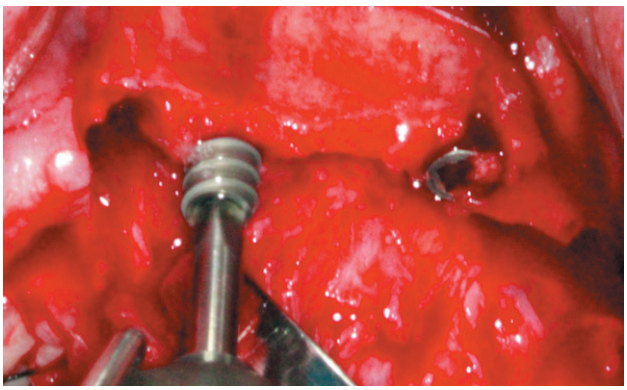
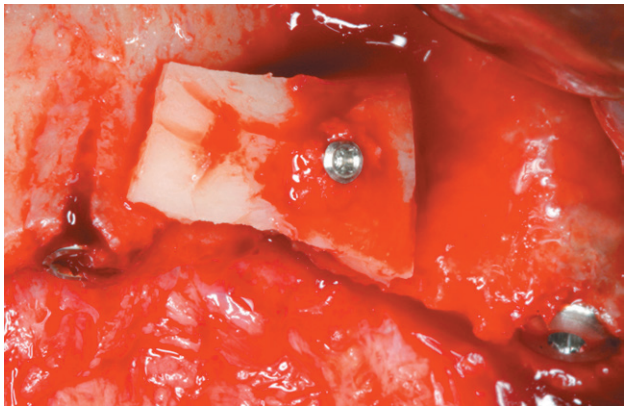
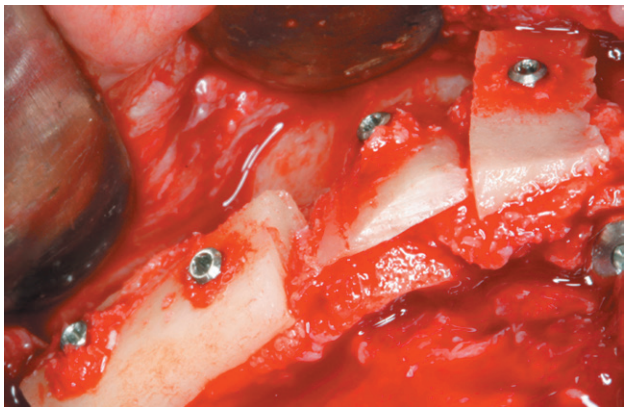
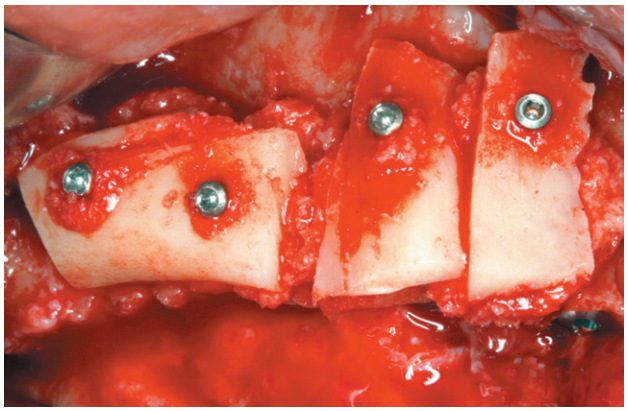


Figure 14. Insertion of the transitional implants by the split crest technique and the rest of the implants directly.

provisional prosthesis of progressive loading is chosen, elaborated in the same way as the previous ones. three months after the occlusion is prepared for the manufacture of the final prosthesis, so the prosthesis is transformed into a metal-ceramic prosthesis, screwed on transepithelial made by CAD-CAM (Figures 25-26). The patient has recovered the requested function, as







Figures 15-17. Filling of the gaps between the corticals of the graft and the original autologous bone using bone obtained from drilling embedded in PRGF-Endoret fraction 2. Part of the bone can also be obtained by scraping the mandibular branch with a bone scraper.

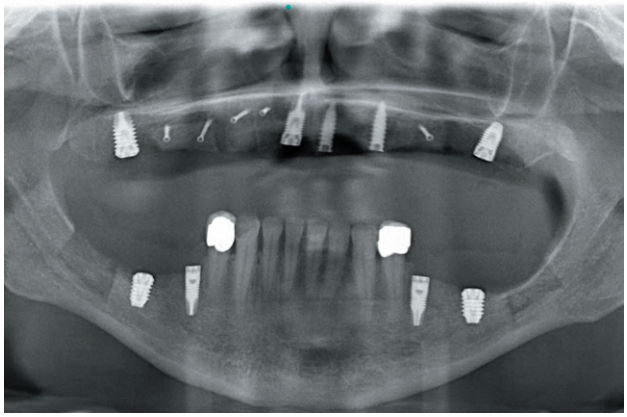
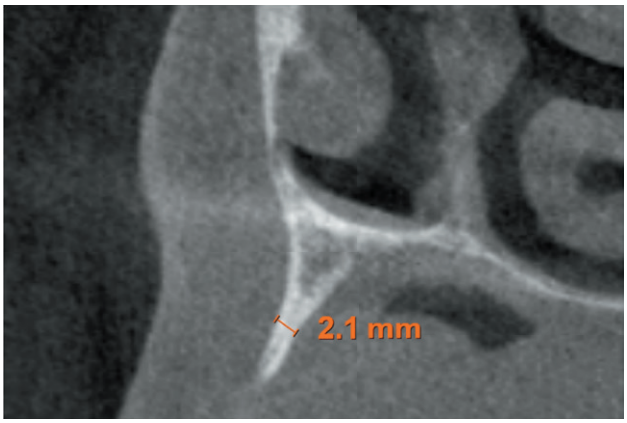
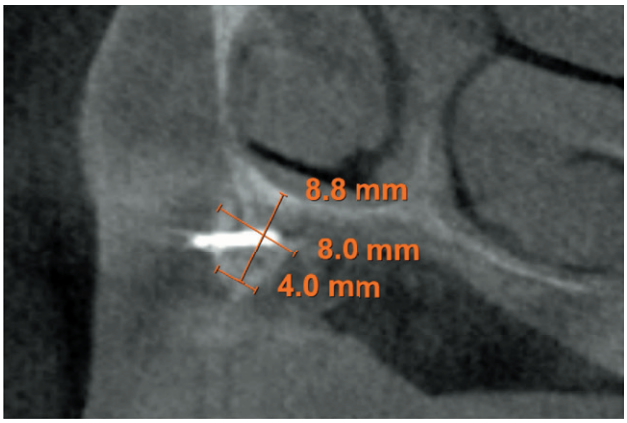


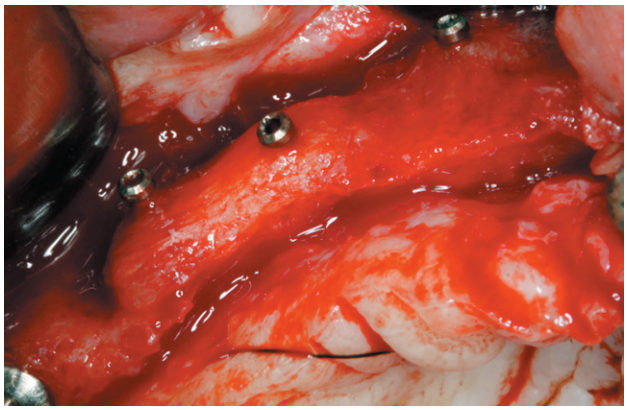
Figure 18. Post-operative radiograph showing the lower implants, the donor areas of both mandibular branches, the upper implants that have been inserted directly and the Split areas and placement of the transitional implants. It also shows the osteosynthesis screws of the block grafts.





Figures 19-20. Images before and after the regeneration carried out with the blocks. It is observed how it has been possible to reconstruct the maxilla crest to insert the dental implants and a gain in width of 8 mm has been generated in the middle zone of the crest.

well as the correction of the occlusion of the complete prosthesis, which presented a right lateral cross bite with decrease in the vertical dimension at the beginning of the treatment. The patient comes to her review and the treatment remains stable as shown in the images taken after 10 years of follow-up (Figures 27-28).



Figures 21-22. Images of the treated area with block grafts and crest expansion by transitional implants. The excellent situation for the insertion of the implants is observed.

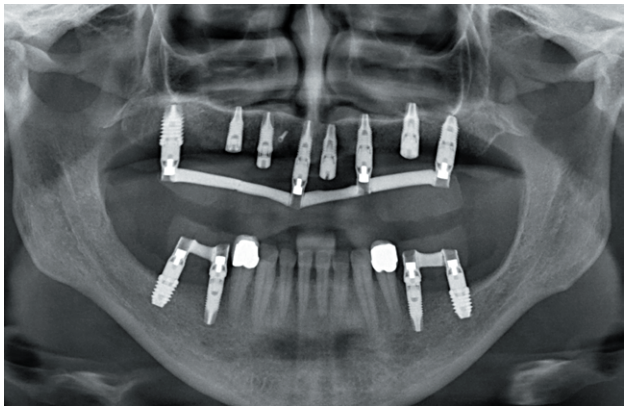


Figure 23. Radiological image after the insertion of the implants and the preparation of the progressive load prosthesis by articulated bars supported on the initial implants.

Figure 24. Provisional loading prosthesis after insertion of the implants in the previously regenerated areas.

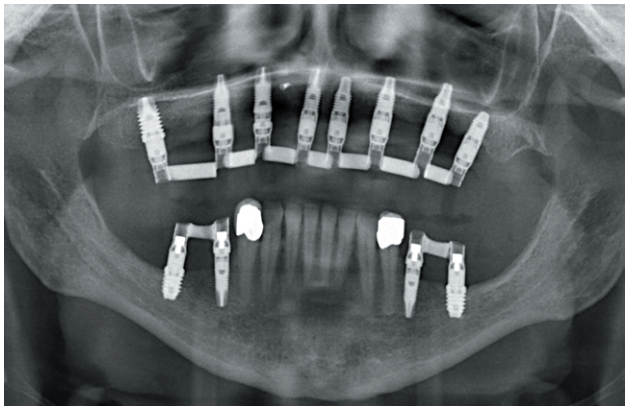


Figure 25. X-Ray image of the patient with the second progressive loading prosthesis.

Figure 26. Clinical image of the patient with the prosthesis in place.

DISCUSSION

The regeneration technique of horizontal atrophies with grafts in block and particulate bone as described by Khoury in 2007[21], presents predictable results in multiple publications in which autologous bone has been used, such as the case that has been studied, as well as with the fusion of autologous bone and biomaterials in cases where the availability of the patient's bone is not enough[20].

The PRGF-Endoret with the particulate bone mixture maintains the viability of the cells until the moment of their use in the block grafting attached to the particle graft technique, and improves the manageability properties of the same, at the same time it increases the ostoinductive potential by increasing the cellular signals contained in the platelet growth factors[22-25]. The use of ultrasound to obtain the block graft and the need for a smaller amount of depth of the same, since it will later be divided to be used in different fragments makes the necessary donor block volume smaller and, therefore, the volume of the donor block is lower, so the risk of nerve injury is also minimized by leaving a layer of bone under the extracted graft and separating the donor area of the dental nerve path[16.18].

Similarly, the Split technique in two phases, with the use of a transitional expander implant maintains the space of the separation between the vestibular and palatal corticals so that a new bone bridge is formed between both. This increases the width of the residual crest to then be permanently replaced by another implant with the correction of the insertion axis that would give us a conventional Split technique. These advantages have been reported in the technique described by our study group with good results[14-26]. This type of procedure, in complex cases such as the one addressed in this clinical case, where different surgeries are going to be performed does not increase the morbidity in the patient and guarantees an improvement in the long-term result, by achieving greater bone volume around the definitive implant[27,28].

CONCLUSIONS

Complex cases require multidisciplinary approaches in which different surgical techniques can be implemented and achieve a successful result. The selection of the correct surgical technique and being able to perform it with the least possible trauma in the patient minimizes the risks of surgery and improves the obtained results.

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Clinical case

Upper third molar autotransplant to replace a superior first molar: about a clinical case

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SUMMARY

Introduction: The development of dental implants has led to lower frequency of autotransplants, despite their high success rates and being a therapeutic alternative that allows the realization of natural, functional and aesthetic rehabilitations.

Clinical case: we present the case of a 28-year-old male who came for consultation due to the presence of some radicular remains located on the left upper first molar. A dental autotransplant was carried out, the donor tooth being the third upper left molar, which was transplanted to the alveolus of the first molar, showing good clinical and diagnostic evolution.

Discussion: There are different therapeutic alternatives to replace missing teeth, within which autotransplants are found, with high success rates in teeth with open and closed apex. The most frequently transplanted teeth are the third molars, as shown in the present case, suggesting as one more option, that professionals and patients should take into account.

Conclusions: Although autotransplants have more limited indications, they have a lower cost for patients, and a simpler restoration for the professional. In addition, they sustain micromovements, achieving occlusion harmony in relation to the adjacent teeth, presenting a high success rate.

KEY WORDS

Autotransplant; Dental transplant.

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Ilustre Colegio Oficial de Odontólogos y Estomatólogos de la Iª Región

INTRODUCTION

The most common therapeutic options for restoring missing teeth are fixed dental supported prosthesis, dental implants, removable prosthesis, dental autotransplants and orthodontic treatment for gaps closure[1,2]. However, due to the development of dental implants[3], autotransplants, although an effective alternative, are not a very popular treatment[1,2], although they are the only alternative that allows a natural, functional and aesthetic rehabilitation[4].

An autotransplant is defined as the transplantation of a retained or erupted tooth from its original position in the mouth to an alveolus where an extraction is performed or to surgically prepared localization in the same person[4-6].

The indications for autotransplants are patients treated during puberty periods, patients with non-restorative teeth requiring extraction, and that have a donor tooth, when the intentional re-implant is prescribed[7] due to premature or traumatic loss of a tooth, loss of teeth due to tumours or congenital absence of teeth[8].

It is an alternative particularly applicable to teething paediatric patients, where other surgical options are not indicated. In this sense, teeth autotransplants with immature apex are more favourable than those performed with closed apex[2], due to pulpal revascularization and a continuous root development, with a success rate of 95%[9]. The autotransplant of immature teeth also presents advantages such as proprioception, pulpal revascularization and root development[10].

On the other hand, autotransplant of teeth with closed apex can be successful if a duct treatment is performed after the procedure[10], since revascularization is less likely to occur and, in addition, it prevents both the appearance of periapical lesions or infections as root resorptions[11]. Only a 15% revascularization of teeth with closed apex are achieved after the transplant, compared to 96% of teeth with open apex[6].

In this regard, satisfactory results have also been obtained in adult patients[8], with survival rates of 74-100%, varying according to the transplanted tooth and the follow-up period[7]; Boschini et al.[12] reported survival rates of 95% and success rates of 80% after a 10 years follow-up. The systematic review and meta-analysis of Machado et al.[1] obtained a survival rate of 81% in transplanted teeth, with a minimum of a 6 years follow-up.

Therefore, due to the high success rates described in the literature, the objective of this clinical case is to evaluate clinically and radiographically the performance of an autotransplant with a closed apex, to replace a left upper first molar, as a therapeutic alternative to an implant placement in an adult patient.

CLINICAL CASE

We present a clinical case of a 28-year-old male who presented severe pain in the second quadrant, associated with the presence of root remains located in the first left upper molar (2.6).

There were no medical-surgical antecedents of interest in his medical history, without known drug allergies or unhealthy habits. No relevant data was found on the extra oral examination. In the intraoral examination, non-restorable teeth were seen in the 2.6 and 4.6 position and the presence of retained lower third molars. (Figures 1 and 2).

In the radiograph examination, through a panoramic radiograph, both lower third molars were seen retained in horizontal position (Figure 3), and apical radiolucent images in positions of 2.6 and 4.6. The cone beam scan evaluated the root morphology of the left upper third molar and the size of the apical radiolucent lesion of the left upper first molar (Figure 4), necessary data to assess the degree of adaptation of the donor tooth in the recipient bed.

The extraction of 4.6 and 2.6 and the curettage of the apical processes were planned, and the autotransplant of the left upper third molar (2.8) to sustain the 2.6 (Figure 5) was suggested to the patient.

Figure 1. Intraoral clinical examination in occlusion.

Figure 2. Intraoral clinical examination of arches.

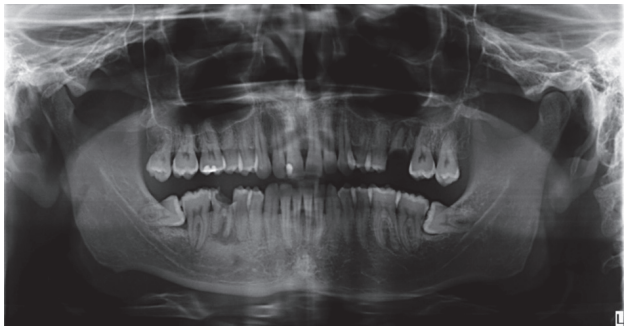

Figure 3. Panoramic radiograph showing the presence of root debris associated to apical radiolucent images in 2.6 and 4.6, in addition to the presence of the lower third molars retained in a horizontal position.

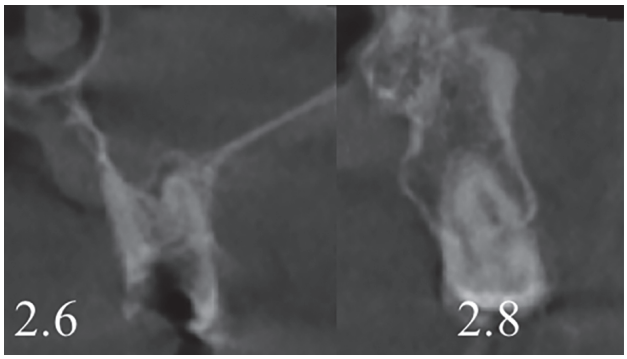

Figure 4. Cone beam scan, where the apical radiolucent image associated with the root remains of 2.6 and the conical root of 2.8 are seen.

Figure 5. Initial clinical situation, with the presence of the root remains of 2.6 and 2.8 erupted.

After obtaining the informed consent, an anaesthetic block was performed using Articaine 4% with Epinephrine 1:100,000 (Ultracaine™, Normon SL, Madrid, Spain) of the posterior and middle superior alveolar nerve, and anterior palatine. An atraumatic extraction of the root remains of the 2.6 and the curettage of the apical process (Figure 6) was performed, leaving the alveolus of the 2.6 prepared to receive the autotransplant of the 2.8 (Figure 7).

The 2.8 was then extracted with forceps (Figure 8), with minimal manipulation of the periodontal ligament of the third molar, placing the upper third molar in the position of the upper first molar (Figures 9 and 10).

The 2.5, 2.6 and 2.7 teeth were then prepared by etching with orthophosphoric acid at 37% (3M Scotchbond Universal™, Minnesota, USA) for 20 seconds (Figure 11). After heavy washing of the etched surface with water, self-etch adhesive (3M Scotchbond Universal™, Minnesota, USA) was applied to fix the rigid wire with fluid composite resin (Charisma™, Kulzer, Hanau, Germany) and conventional composite resin (G-aenial™, GC, Leuven, Belgium) (Figure 12).

After reducing the occlusion, a cross stitch with monofilament suture (Arago™, Barcelona, Spain) was applied around the transplanted tooth to increase its fixation (Figure 13), performing an intraoperative periapical radiograph with parallelism technique (Figure 14).

After ten days the suture was removed, where good soft tissue healing was observed (Figure 15). Three weeks after the postoperative period, treatment of the ducts was performed with a correct evolution (Figure 16).

After 2 months, a new clinical review (Figure 17) and a radiograph was performed by a periapical radiograph (Figure 18), proceeding to remove the ferulization. After 3 months, another clinical review (Figure 19)

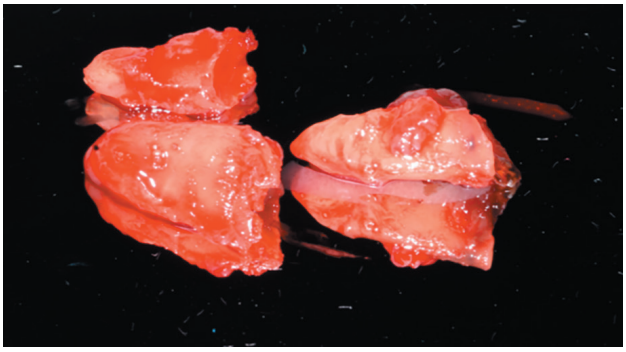

Figure 6. Root debris from 2.6.

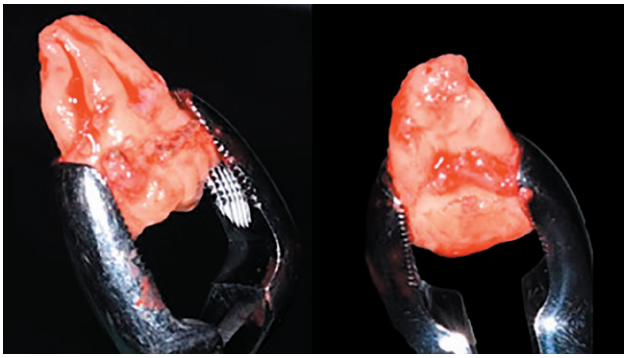

Figure 8. Removal of the left upper third molar (2.8) with forceps.

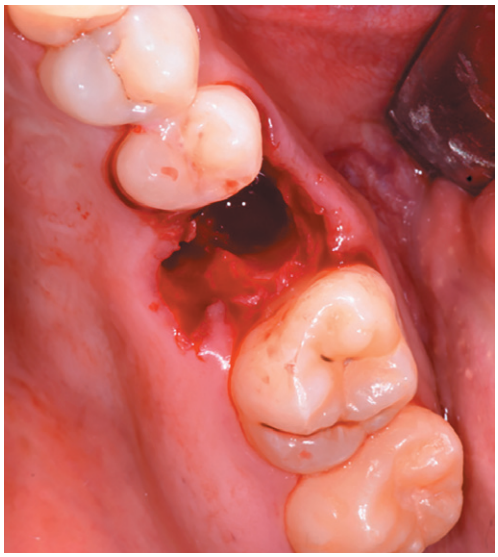

Figure 7. Appearance of the alveolus once the root remains have been extracted and the apical curettage process.

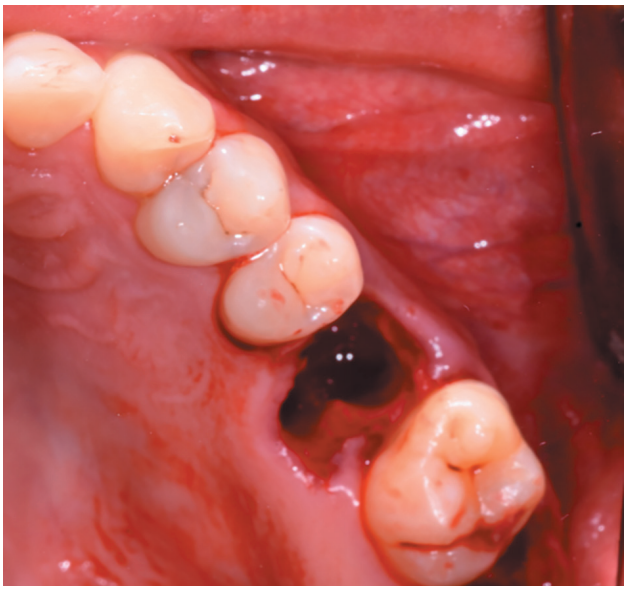

Figure 9. Appearance of both alveoli after extractions.

and a radiograph was performed by parallel periapical radiograph (Figure 20), where an adequate bone formation can be observed around the transplanted tooth.

After 5 months the autotransplant tooth was carved on its occlusal, vestibular, palatal and interproximal faces, then a heavy and fluid silicone double impression was taken in one step (Elite HD™, Zhermack, Rovigo, Italy), and then ordered the laboratory a lithium disilicate inlay (Figure 21).

In the laboratory, the impression was casted and the upper and lower models scanned using the identical

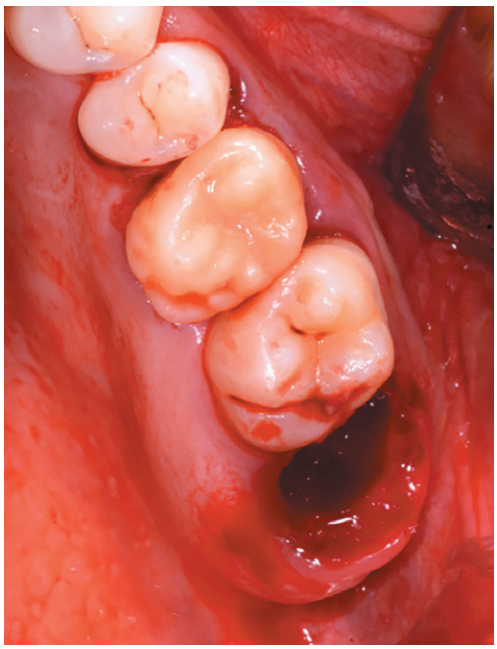

Figure 10. Placement of 2.8 in the alveolus of 2.6.

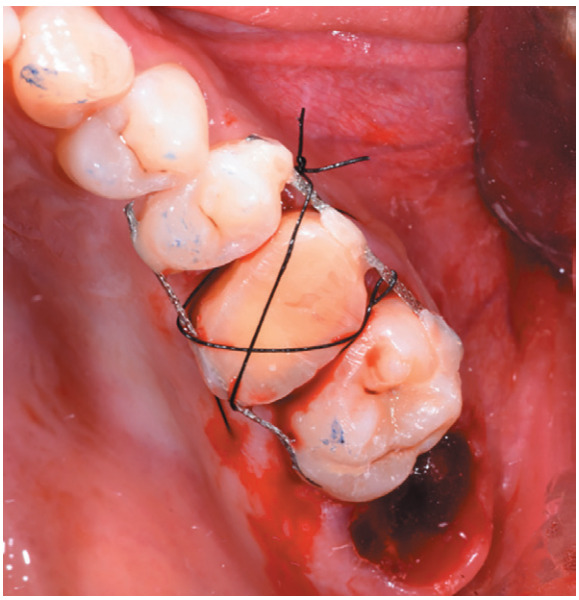

Figure 13. Cross stitch in autotransplant.

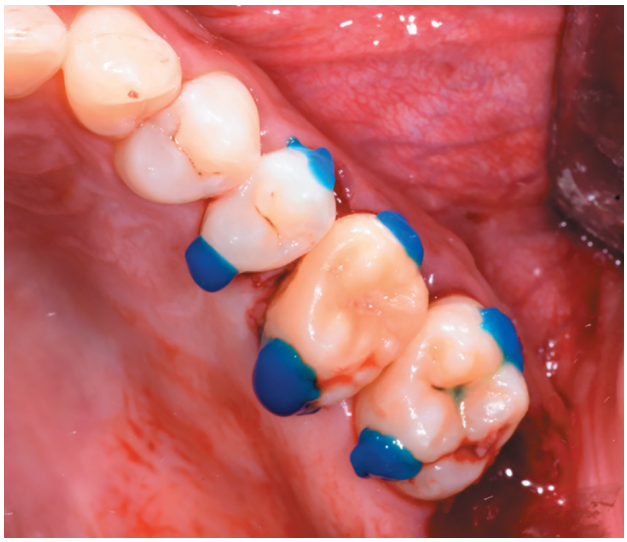

Figure 11. Etched with orthophosphoric acid from the enamel to place the ferulization afterwards.

Figure 12. Rigid ferulization of the transplanted tooth.

T710 Medit™ scanner for the computer inlay design and construction, using the Exocad Plovdiv™ software (Figure 22).

The lithium disilicate inlay was milled, which was prepared at the clinic by etching with hydrofluoric acid and silane (Ultradent™, Madrid, Spain) (Figure 23). After that, the teeth 2.5, 2.6 and 2.7 were completely insulated by rubber dam, and tooth 2.6 was prepared with orthophosphoric acid and self-etching adhesive, and then cemented the inlay with dual polymerization resin cement (3M Relyx Unicem™, Minnesota, USA). (Figure 24). After polymerizing for three seconds, the excess cement was removed, finished polymerizing and the rubber dam was removed to adjust the occlusion (Figure 25) and make a verification with a periapical radiograph (Figure 26).

DISCUSSION

Although it is an effective therapeutic alternative, dental autotransplants are not currently a very popular treatment[1,2], due to the development of dental implants[3], although they represent the only treatment that allows a natural, functional and aesthetic rehabilitation[4].

Figure 14. Intraoperative parallelized periapical radiograph of the 2.8 transplanted in the alveolus of the 2.6.

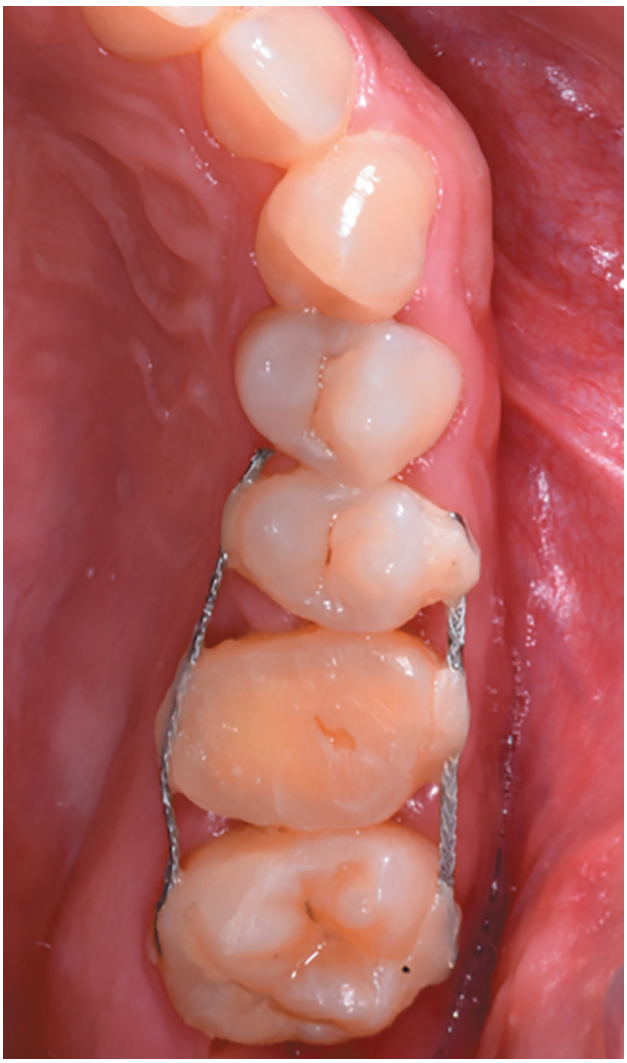

Figure 15. Revision after 10 days, coinciding with the suture withdrawal.

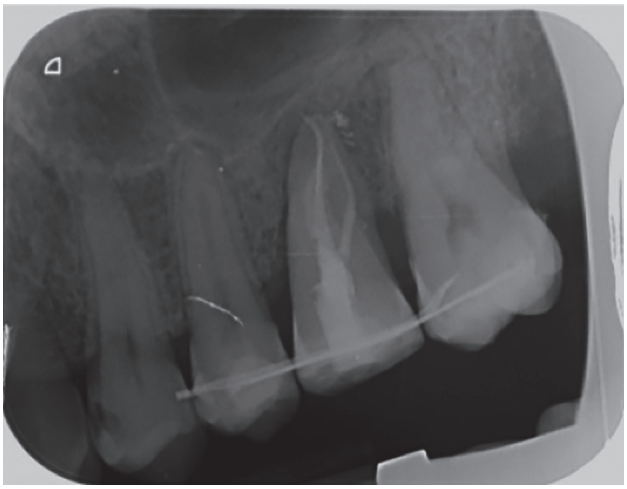

Figure 16. Parallel periapical radiograph at 3 weeks after the autotransplant, coinciding with the duct treatment.

In this sense, autotransplants are economical procedures and one of the best dental replacement options when they are successful[8,10,13]. They are 87% cheaper compared to dental implants[14], allowing,

Figure 17. Review at 2 months.

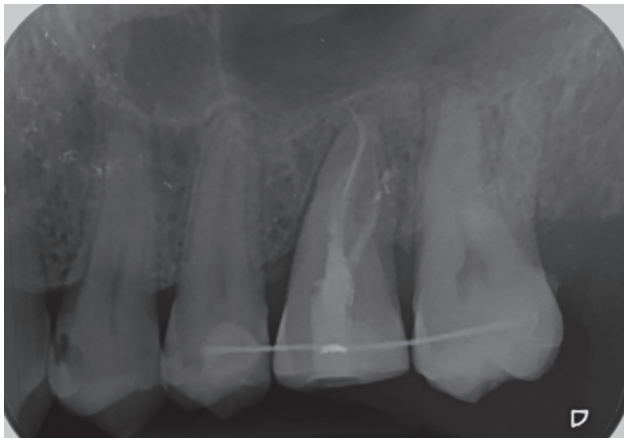

Figure 18. Periapical radiograph after 2 months of the autotransplant.

Figure 19. Clinical appearance after 3 months of the autotransplant.

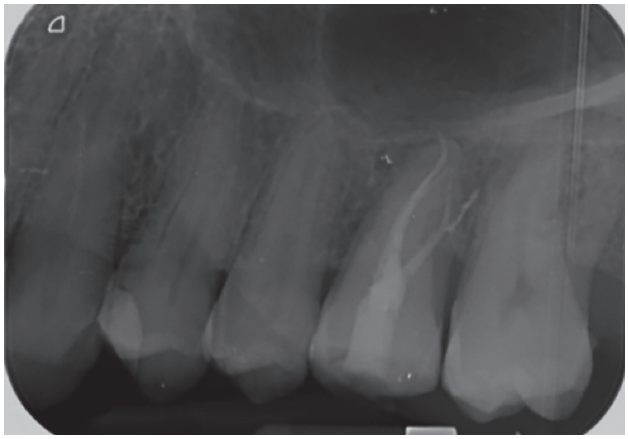

Figure 20. Periapical radiograph at 3 months after the autotransplant.

Figure 21. Carved for inlay and double silicone impression.

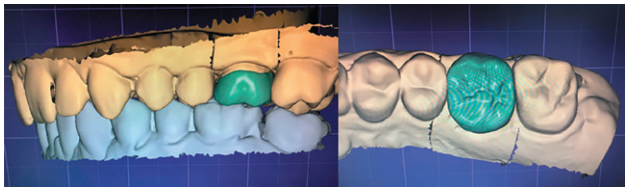

Figure 22. Computer design of the future inlay.

Figure 23. Lithium disilicate inlay.

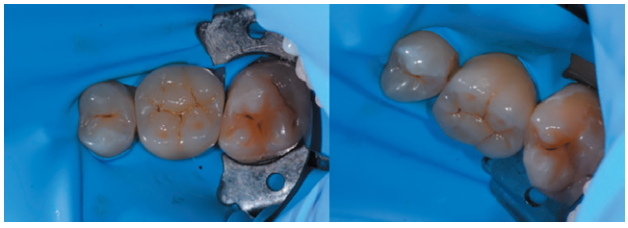

Figure 24. Cemented inlay.

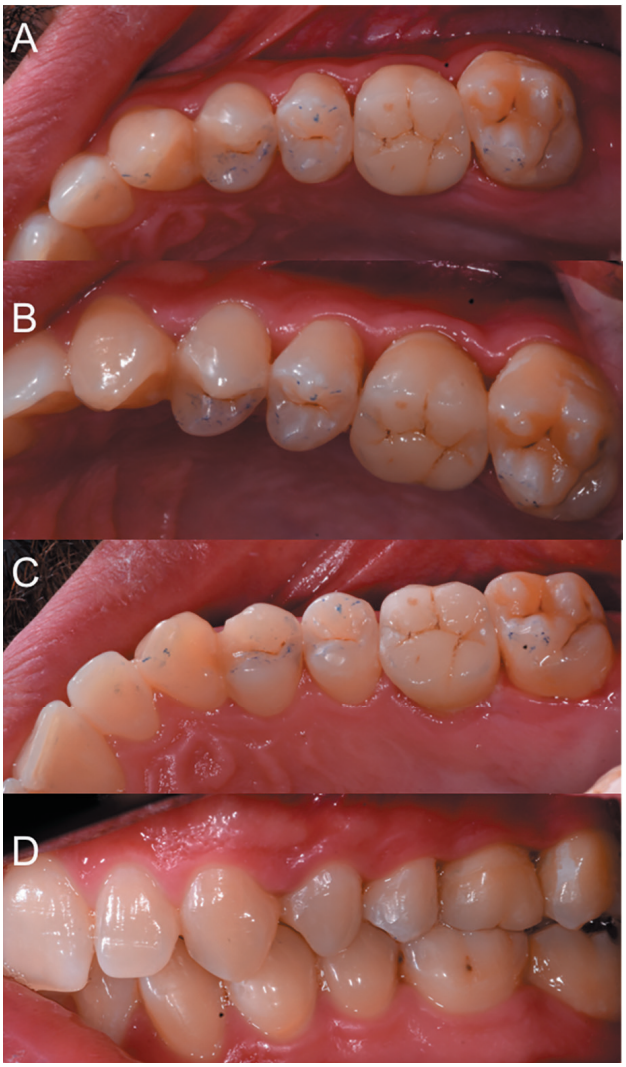

Figure 25. Clinical appearance: occlusal (A), vestibular (B), palatine (C), occlusion (D).

in addition, the placement of an implant if the autotransplant fails[10], ensuring the maintenance of the alveolar bone due to physiological stimulation of the periodontal ligament[5,15]. However, the technique is very sensitive and the presence of a donor tooth is needed[10].

The risk factors in performing autotransplants on teeth with closed apex are elderly patients, probing depths greater than 4 mm, previous duct treatment history, multirooted teeth, donor teeth with caries and absence of vestibular cortex[16]. In addition, other factors are described that may influence the prognosis of these

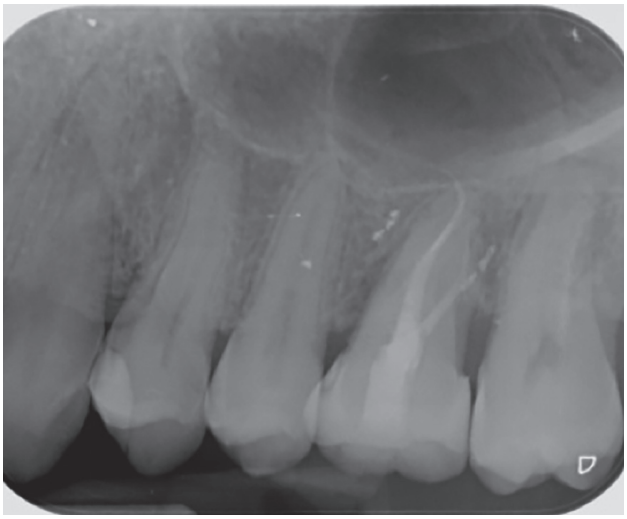

Figure 26. Periapical radiograph after 5 months of the autotransplant.

autotransplants, such as root anatomy, the degree of adaptation of the donor tooth in the recipient bed (a greater degree of adaptation is related to a greater percentage of healing and success)[13,17], the duration of the procedure (extra-alveolar time of the transplanted tooth), the experience of the surgeon (important to perform the extraction of the donor tooth as atraumatically as possible), the general health of the patient and the degree of oral hygiene, the existence or not of occlusal contacts during the healing period, and the timing and quality of treatment of transplanted tooth ducts[8,18,19].

In this case, the treatment of ducts was performed after 3 weeks of the autotransplant, in accordance with other published studies[6,20], where there are meta-analysis that conclude that conducting the ducts treatment two weeks after autotransplant reduces by half the probability of root resorptions[11].

In the literature, most of the autotransplanted teeth are upper and lower third molars (73.9%), since they are usually non-functional teeth[16]. In this patient, advantage was taken of the presence of an erupted third molar, thus assuming a conservative therapeutic alternative for a young patient. After the placement of the donor tooth in the recipient bed, the occlusion was reduced to avoid occlusal contacts and to allow

periodontal healing after the autotransplant, also in accordance with the literature[6].

Another of the fundamental aspects for the success of autotransplants is based on the type and duration of the ferulization, which are variable in the literature, coinciding in that ferulization should be used for a short period to achieve maximum physiologic benefits[21]. Authors such as Kokai et al.,[20] believe that when the ferulization is maintained for more than 4-8 weeks, the risk of ankylosis is significantly increased, with other authors performing ferulization for only two weeks[12]. Therefore, in accordance with the literature, ferulization was maintained for 8 weeks in the case presented, in order to avoid the risk of ankylosis.

The published clinical studies evaluate patients clinically and radiographically, by periapical radiographs[9,10,12,15,17,18] or by periapical and panoramic radiographs[4,13,14]. The periapical radiography shows the presence of radiolucent areas, external and internal root resorptions, ankylosis and the state of root development[18], being fundamental in the evolution of this therapeutic modality. In the present clinical case, a radiolucent area around the tooth was radiographically visible, which was modified over time, to achieve a similar bone density of the bone in contact with the transplanted tooth, compared to the surrounding bone. Additionally, no apical lesions or root resorption were observed during the follow-up period.

In addition, a good clinical and radiographic result was obtained, after 5 months of follow-up, describing the patient a good masticatory function and the absence of adverse effects, which are described in the literature with a rate of 4%, highlighting among them the ankylosis and root resorption.

Clinical and radiographic follow-up is vital to determine the apical state of the autotransplant, so one of the limitations

of this technique would be to have uncooperative patients, who are not aware of the need of an adequate maintenance programme and revisions[2]. Authors such as Tsukiboshi et al.,[7] suggest that, in the case of autotransplants that have healed correctly, periodic revisions should be made with the frequency of the rest of the teeth.

CONCLUSIONS

Dental autotransplants are a therapeutic alternative with high success rates, which can replace dental implants in well selected cases, favouring the acceptance rate by the patient, being an autologous material, which favours the development of the alveolar bone, and which does not prevent, in addition, the placement of implants if the autotransplant fails.

Autotransplants and dental implants are two surgical techniques with identical objectives. While the former has more limited indications, requiring a more sensitive technique, with a lower economic cost for the patient and a simpler restoration for the professional, dental implants lack eruptive and movement capacity, not being recommended in growing patients.

The autotransplants undergo micromovements and achieve occlusal harmony in relation to the adjacent teeth, offering better aesthetic results and a better emergence profile.

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Update

Assessment of the different therapy options in the clinical management of Burning Mouth Syndrome (BMS)

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SUMMARY

Introduction: The Burning Mouth Syndrome (BMS), whose definition and pathophysiology continue to be a topic of current debate, which also it does not have a universally accepted guidelines for its therapy. Therefore, the objective of this work is to present an assessment of the different treatments for the clinical management of patients with BMS based on the available scientific evidence, so that its application is evaluated in each specific case.

Material and methods: PubMed (MEDLINE) and The Cochrane Library (Wiley) databases were searched for different treatments of BMS. With the data obtained regarding the effectiveness of each therapeutic modality and the adverse effects it produces, three different therapy lines have been developed.

Results: In the first line of therapy we find chewing gum, LLLT (Low-level laser therapy), lingual protector, psychotherapy, topical clonazepam, ALA (Alpha Lipoic Acid) and Catauma.

Conclusion: More research is needed to provide sufficient guidance to clinicians on effective therapeutic modalities and that allow to establish a correct strategy in the BMS management.

KEY WORDS

Burning Mouth Syndrome; Therapeutics; Management; Treatment.

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INTRODUCTION

The Burning Mouth Syndrome (BMS) has received several definitions since it was first described. The last of these was published in 2020 in the first edition of the International Classification of Orofacial Pain (*ICOP*)[1] proposed by the International Headache Society (*IHS*). BMS is defined as a burning sensation or oral dysaesthesia that recurs daily for more than two hours a day in a period greater than three months, with no causal lesions evident on clinical examination or research (Table 1). This condition is classified within the category of "idiopathic orofacial pain", that is to say, no known cause can be attributed to it. However, in the third edition of the International Classification of Headache Disorders (*ICHD*- III)[2], proposed by the same society just two years earlier, the BMS is included in "painful cranial nerve injuries and other facial pains", thus attributing it a neuropathic origin. Miller et al.[3] question whether BMS can really be considered as a syndrome, since patients do not always suffer from the consistent set of clinical features (dysgeusia and/or xerostomia) that would constitute it. They propose as the most appropriate term the Burning Mouth Disorder.

There is currently consensus that the secondary burning to a local or systemic disorder should not be considered BMS. It is not accepted that there is a primary and a secondary BMS. Diagnosis of BMS will not be made until all possible alterations are treated and/or controlled and any other possible etiology of oral burning has been ruled out (Table 2)[1,2,4].

The prevalence of BMS is particularly high among middle-aged women, coinciding with the peri- and postmenopause[5] period. The symptoms are usually bilateral, although the diagnosis is not ruled out if it is unilateral. The most frequent location of the burning sensation is the anterior two thirds of the tongue, followed by the dorsum and lateral edges, the anterior part of the hard palate, the labial mucosa and the gum[1,2].

The pathophysiology of BMS is still unknown, although there is growing evidence suggesting that it could have a neuropathic origin existing alterations in different levels of the central or peripheral nervous system that could be involved in its pathogenesis[1,2,6]. Three different hypotheses have been proposed about its neuropathic origin: small-fibre peripheral sensory neuropathy; a subclinical neuropathy of the trigeminal system (lingual nerve, mandibular nerve, or complete trigeminal nerve); or a hypofunction of dopaminergic neurons[6].

On the other hand, Yunus[7] included BMS within the Central Sensitivity Syndromes (CSSs) along with other

Table 1. Diagnostic criteria for the BMS according to the ICOP.

A.	Oral pain that meets B and C criteria.
B.	Daily recurrence for >2horas a day for >3 months.
C.	The pain has the following two characteristics: 1. Burning quality. 2. It is felt superficially in the mucosa.
D.	The appearance of the mucosa is normal. Other possible burning causes have been excluded both local and systemic.
E.	It is not better explained by another ICOP diagnosis or ICHD-III.

Table 2. Initial steps in a suspected case of BMS.

1.	**Ask for background:** - Systemic. With special attention to - Central Sensitivity Syndromes, - neurodegenerative diseases, nutritional deficiencies or endocrine disorders. - Psychiatric: anxiety, depression or personality disorders. - Allergic: food, medicine or oral hygiene products.
2.	**Evaluate the characteristics of pain and co-existing manifestations:** - Timeline, location, aggravating factors and improvement. - Presence of dry mouth and/or dysgeusia.
3.	**Perform a thorough oral examination to exclude injuries that may cause discomfort.**
4.	**Request complementary tests if justified.**

medical disorders with no apparent organic cause (such as fibromyalgia, migraine and temporomandibular disorders) that would be linked by a common central sensitization mechanism, in which there is hypersensitivity to noxious and non-noxious stimuli (hyperalgesia and allodynia). All of these syndromes share multiple symptoms, including pain, fatigue, restless sleep, and psychosocial difficulties[8].

The lack of scientific evidence regarding the BMS etiology means that, at present, the therapeutic strategy focuses on burning reduction and an improvement in quality of life, without universally accepted guidelines[9]. The different therapeutic options that have been proposed for the management of the symptoms related to BMS can be divided according to their origin, in non-pharmacological or pharmacological, and these according to their application topically or systemically.

The aim of this work is to present to the clinical practice an assessment of the different treatments for the clinical management of patients with BMS based on the scientific evidence available to assess their application in each specific case.

The detailed explanation of the theories about the mechanisms involved in the BMS pathogenesis, as well as the action mechanism of the different treatments which are beyond the objective of this article.

MATERIAL AND METHODS

Search strategy and inclusion criteria

PubMed (MEDLINE) and The Cochrane Library (Wiley) databases were searched using the combination of MeSH terms and free terms: *"Burning Mouth Syndrome" [Mesh] AND ("Therapeutics" [Mesh] OR management OR therapy)*. The search was completed by manual selection of references cited in related systematic reviews.

We included clinical trials (randomized or not), cohort studies, and case-control studies, with at least 10 participants published in English or Spanish, that evaluated the effectiveness of any therapeutic modality used to treat BMS. There was no restriction on the date of publication. In-vitro or animal studies, case reports and cross-sectional studies were excluded. Of the 609 studies found in the initial search, after applying the inclusion and exclusion criteria and discarding irrelevant articles based on the title and the summary, 56 articles were finally selected.

Data synthesis

The different therapeutic modalities used for BMS management have been summarized in a table in which the following has been considered:

1. Articles analysed: it is the number of analysed articles for each modality. In the following variables the result reported by the majority has been considered and, in case there were only two articles, the result of the one with a larger sample has been considered.

2. Ability to relieve the symptoms: in case that the therapeutic modality studied has shown an improvement the box is green. The contrary, is shown in red.

3. Significant improvement compared to the control group: favourable data is displayed in green and unfavourable in red. White are those therapeutic modalities that have not been compared with a control group (without data).

4. Appearance of side effects: in green appear those modalities that, if they were compared with a control group, the differences between the two groups were not significant and that, if they were not compared they did not show adverse effects. In red appear those modalities that, if compared with a control group, showed significantly more adverse effects and, if not compared, showed some adverse effect.

With the results of said table (Table 3), different therapy lines have been proposed.

Table 4 shows the side effects of those modalities that had presented them.

Table 3. Data on the different therapeutic modalities regarding their effectiveness and side effects.

			Analysed articles	Ability to relieve symptoms	Significant improvement compared to the control	Occurrence of side effects
Non-pharmacological therapy		Acupuncture[29]	1			
		Chewing gum[10]	1			
		rTMS[35]	1			
		LLLT[11]	10			
		Tongue protector[12]	2			
		Psychotherapy[13–15]	3			
Pharmacological therapy	Topical agents	EVOO with lycopene[30]	1			
		Bupicavaine[36]	1			
		Chamomile[31]	1			
		Capsaicin[21,37]	2			
		Clonazepam[16–18]	3			
		Benzydamine hydrochloride[39]	1			
		Lactoperoxidase[21]	2			
		Melatonin[40]	1			
		Urea[32]	1			
	Systemic therapy	ALA[14,19–27]	9			
		ALA + gabapentin[19]	1			
		Antidepressants[41]	1			
		Bethanechol[20]	1			
		Cannabis[42]	1			
		Capsaicin[38]	1			
		Catauma[28]	1			
		Clonazepam[27,43,44]	3			
		Clonazepam + NAC[44]	1			
		Gabapentin[19]	1			
		Hypericum perforatum[33]	1			
		NAC[44]	1			
		PEA–um[34]	1			
		Pregabalin[27]	1			
		Trazodone[45]	1			
		Vortioxetine[41,46]	2			
	Other	Lidocaine[47]	1			

Favourable results are green, unfavourable results are red, and white when data is missing.

rTMS Repetitive transcranial magnetic stimulation; LLLT: low-level laser therapy; EVOO: Extra Virgin Olive Oil; ALA: Alpha-lipoic acid; NAC: N-acetylcysteine; PEA-um: Ultramicronized palmitoylethanolamide

Table 4. Main side effects of the mentioned therapeutic modalities.

			Taste disturbances	Increased serum prolactin	Weight gain	Increased appetite	Dry mouth	Diarrhoea	Sexual dysfunction	Decreased blood pressure	Abdominal pain	Headache	Muscle pain	Constipation	Intense burning sensation	Dizziness	Gastrointestinal discomfort	Nausea	Palpitations	QTc prolongation (electrocardiogram)	Drowsiness	Cold Sweat	Vivid dreams / nightmares	Tremors
Non-pharmaco-lo-gical therapy		rTMS										■												
Pharmacological therapy	**Topical agents**	Bupivacaine	■																					
		Capsaicin													■									
	Systemic therapy	Paroxetine			■				■															
		Sertraline			■	■			■		■					■								
		Escitalopram							■		■							■		■	■			
		Duloxetine		■	■	■	■		■							■					■		■	
		Bethanechol								■	■					■		■				■		
		Cannabis										■		■		■								
		Capsaicin																■						
		Clonazepam						■					■			■					■			
		Clonazepam + NAC												■		■								
		Gabapentin																			■			
		NAC						■									■							
		Pregabalin				■		■								■		■						
		Trazodone					■					■				■			■			■		■
		Vortioxetine																■						
	Other	Lidocaine													■									

rTMS Repetitive transcranial magnetic stimulation; NAC: N-acetylcysteine.

RESULTS

Summary tables of therapeutic modalities

With the results obtained in the data evaluation of the available cases, a table has been prepared showing, of each of the therapeutic options, the number of analysed studies and the results of each of them regarding the ability to relieve the symptoms, if this capacity is significant with respect to the control group and the side effects they produce (Table 3).

Table 4 summarizes the main secondary effects of those therapeutic modalities that, if compared with a control group, showed significantly more adverse effects and, in case of not being compared showed some adverse effects (i.e., those that have obtained an unfavourable result in the variable "occurrence of side effects" of Table 3).

Lines of therapy

With the data cited above in the tables, several therapy lines have been developed, so that the clinician can assess, in each particular case, the benefit – risk.

1st line of therapy

It includes those therapeutic modalities that have shown an improvement in the BMS symptoms, with significant differences regarding the control group and without adverse effects.

- Non-pharmacological therapy:
  - Chewing gum: chewing unflavoured gum for 20 minutes at a comfortable pace[10].
  - LLLT (Low-level laser therapy): laser wavelengths, output power, irradiation duration, number of sessions and the radiation frequency varied between 630- 980 nm, 20-300 mW, 10 seconds and 15 minutes, 1 and 20 sessions and 1 to 5 sessions per week, respectively[11].
  - Tongue protector: single-use transparent plastic, used for 15 minutes 3 times a day for 2 months[12].
  - Psychotherapy: cognitive therapy (1 or 2 1hr weekly sessions for 2-3 months)[13,14] or group psychotherapy (groups of 4 patients, once a week for 3 months)[15].
- Pharmacological therapy:
  - Topical Agents:
    - Clonazepam: suck/dissolve tablet of 0.5 or 1mg for 3 minutes in the mouth without swallowing, or rinse with 5ml of solution with 0.1mg/ mL of clonazepam, 3 or 4 times a day[16-18].
  - Systemic therapy:
    - ALA (alpha-lipoic acid; dietary supplement): 200 to 800mg per day for 1 to 2 months[14,19-27].
    - Catauma (dietary supplement): 2 capsules daily for 2 months. The Catauma contains: *Paullinia cupana* (125 mg), *Trichilia catigua* (87.5 mg), *Zingiber officinale* (10 mg) and *Ptychopetalum olacoides* (87.5 mg)28.

2nd line of therapy

Therapeutic modalities that have shown BMS relief of the symptoms are included, although the differences were not significant with respect to the control group, but without adverse effects. Also, options that despite not having been able to compare them with a control group improved the symptoms and did not show side effects.

- Non-pharmacological therapy:
  - Acupuncture: Half-hour sessions 3 times a week for 4 weeks at points ST8 (*Tou Wei*), GB2, TE21, SI19 (*Ting Gong*), SI18 (*Quan Liao*), LI4 (*Yuan*) bilaterally as well as GV20 (*Bai Hui*)[29].
- Pharmacological therapy:
  - Topical Agents:
    - EVOO (Extra Virgin Olive Oil) enriched with lycopene: EVOO spray with 300ppm lycopene (Surat™) 3 times a day[30].

- Chamomile: Gel at 2% 2 times a day for 1 month[31].
- Lactoperoxidase: mouthwash (Biotene™) 5 times a day[21].
- Urea: at 10% applied topically 3 or 4 times a day for 3 months[32].

• Systemic therapy:

- *Hypericum perforatum* (dietary supplement): 300mg 3 times a day for 3 months[33].
- PEA–um (Ultramicronized palmitoylethanolamide; dietary supplement): sublingual dose 600mg 2 times daily for 2 months[34].

3rd line of therapy

Included are those therapeutic modalities that have been shown to produce BMS symptoms relief, with significant differences from the control group, but which have caused side effects.

▪ Non-pharmacological therapy:

• rTMS (repetitive transcranial magnetic stimulation): 10 sessions of 10Hz pulse series of 5 seconds, at a power intensity of 110% RMT, with an interval between series of 10s during 15 minutes (for a total of 30,000 pulses)[35].

▪ Pharmacological therapy:

• Topical Agents:

- Bupivacaine: suck/dissolve tablet 5mg 3 times daily for 2 weeks[36].
- Capsaicin: mouthwash at 0.02% 3 times a day for 2 months[21,37].

• Systemic therapy:

- ALA + gabapentin (anticonvulsant): 600mg ALA + 300mg gabapentin per day for 2 months[19].
- Capsaicin: Capsules at 0.25% 3 times a day[38].
- Gabapentin: 300mg per day for 2 months[19].

Figure 1. Reticular lichen planus in dorsum of the tongue and saburral tongue.

Figure 2. Geographic tongue.

Figure 3. Erythematous candidiasis.

In each particular case, the benefits provided by each therapeutic modality must be weighed with the risks presented and the most appropriate decision made.

Therapy not recommended

These are those therapeutic modalities despite having shown BMS relief of the symptoms, the differences were not significant with respect to the control group, or were not compared with it and also present side effects. Also included are those options that have not shown symptoms relief or have shown conflicting results (such as improvement in one group of patients and worsening in another).

- Pharmacological therapy:
  - Topical Agents:
    - Benzydamine hydrochloride: rinse at 0.15% for 1 minute, 3 times a day for 1 month[39].
    - Melatonin: compresses applied to oral mucosa with 3mg of melatonin 4 times a day for 2 months[40].
- Systemic therapy:
  - Antidepressants: Paroxetine (20 mg daily), Sertraline (50 mg daily), Escitalopram (10 mg daily), or duloxetine (60 mg daily) for 12 months[41].
  - Bethanechol (anticholinergic): 15mg per day[20].
  - Cannabis: 10 to 40 drops of Bediol™ (6.3% THC and 8% CBD) 2 times a day[42].
  - Clonazepam: 0.5 – 2 mg daily for 2 months[27,43,44].
  - Clonazepam + NAC (N- acetylcysteine, dietary supplement): 0.25mg of clonazepam + 200mg of NAC twice daily for two months[44].
  - NAC: 200mg twice a day for two months[44].
  - Pregabalin (anticonvulsant): 150mg a day during 4 months[27].
  - Trazodone (antidepressant): 200mg 1 time a day for 2 months[45].
  - Vortioxetine (antidepressant): 10 – 20 mg daily for 12 months[41- 46].
- Other:
  - Lidocaine: lingual nerve block[47].

DISCUSSION

Currently the BMS therapy is mainly symptomatic with the sole aim of relieving the symptoms and improving the quality of life of people who have it. Therefore, the purpose of this review has been to review the scientific evidence available to develop therapy lines aimed at guiding clinical practice. The different existing therapeutic modalities were evaluated and summarized in Tables 3 and 4.

In the first line of therapy, we have placed all the non-pharmacological therapeutic modalities (except

acupuncture, whose study lacked a control group, and rTMS, which showed side effects) and, among the pharmacological modalities, topical clonazepam, ALA and Catauma. All of them have been shown to be effective regarding the ability to relieve symptoms in a meaningful way compared to the control group and without any side effects. Even so, among these treatments, the most studied and, therefore, the most recommended would be LLLT, psychotherapy, ALA and topical clonazepam. Since many professionals do not have laser equipment in their clinics, and that many patients may be reluctant to a psychological therapy for social reasons and the first Cultural[15], ALA and topical clonazepam may be the best options to start with.

However, it is important to note that before starting to treat a patient, it is essential to make a correct diagnosis and differentiate primary or "real" BMS and secondary burning to another underlying condition. The diagnostic criteria proposed at the *ICOP1* should be applied both when selecting cases for new research and before a suspected case in daily clinical practice. One of the criteria of said classification is to exclude other possible local and systemic causes. Therefore, a meticulous differential diagnosis is required. The main pathologies to rule out would be oral lichen planus (Figure 1), geographic tongue (Figure 2) and erythematous candidiasis (Figure 3). All of them have clinical lesions that characterize them and, therefore, can be identified on the examination.

It is advisable to inform patients of the chronic nature of the process and that it lacks the potential for malignancy to reduce anxiety and prevent cancerophobia, which could complicate the condition.

The burning sensation in patients with BMS is exacerbated by the presence of xerostomia[31] and many patients report relief when they eat, drink, chew gum or suck some candy. Therefore, even if it is not found as such in the management proposal presented above due to the fact that it is not specific for BMS, intervention will be aimed at improving oral lubrication and hydration, as well as avoiding and/or controlling the possible xerostomia medication. In our opinion, it is possible that some therapeutic modalities that improved the symptoms, but not significantly (second line of therapy), owe their results precisely to a lubricating and moisturizing effect.

The three proposed therapy lines have been developed following the maxim of the medical professions of *primum non nocere* (above all do no harm). In this sense, therapeutic modalities that may have some side effects have been reserved for those patients who do not respond to the treatments described in the two first therapies. However, considering the possible BMS multifactorial origin (with both central and peripheral causes), certain strategies may be effective in some groups of patients, while they will not be appropriate for others. Therefore, the choice of therapy has to be evaluated individually and should be adapted according to the needs of the patient. In cases where it is considered that the benefits could reduce the risks, as in patients with severe impairment of quality of life, any therapy, both first and third line, should be evaluated.

Some of the side effects mentioned in Table 4 will be more acceptable than others, both due to their medical impact and their intensity. In fact, some authors[19,27,35,36,38,42,44,46] mention that their side effects were mild, transient and that in most cases they did not lead to the abandonment of participants in the study.

In the study conducted by Lopez-D'alessandro et al.[19], it is mentioned that for the groups treated only with gabapentin and with ALA + gabapentin the secondary effects were present, and although they are described as "very mild", we consider it an unfavourable outcome for the variable "side effects", fact that placed both modalities in the third line of therapy. However, the Cochrane[48] review mention that, after contacting the authors, only the gabapentin alone group showed significantly more side effects than the control group and, interestingly, the ALA + gabapentin combination did not.

The injection with lidocaine for anaesthesia of the lingual[47] nerve is placed in "not recommended treatments" since it presented contradictory results: one group of patients felt a decrease in symptoms and

another group felt a worsening or no change in pain (although they felt anaesthetised). When comparing the changes with the VAS (Visual Analogue Scale) before and after the injection in both groups, significant differences were obtained between the two groups. These curious results, although they cannot be taken as a reference for BMS management

in daily practice, they could explore future research on the possible existence of both central and peripheral causes in the BMS pathophysiology.

It is critical to note that the magnitude of the placebo response in BMS appears to be important. Ku-ten-Shorrer et al[49] found that the average placebo response, calculated as a fraction of the active drug response, was 72%. In the daily clinical practice, treatments will not be obfuscated and, therefore, the clinician's position or opinion of a therapy could modify the patient's response to the same. It would be important to avoid terms such as "let's try with…", "X therapy seems to have…", etc., since, if the patient perceives that such therapy is not going to be effective, the placebo response could be diminished.

In the scientific literature there are several systematic reviews[11,48,50–54], of which the most recent is that of Ślebioda et al.[50], in which it was observed that the most effective therapeutic modality was clonazepam (both topical and systemic), and that, in addition, lingual protectors and capsaicin appeared to have promising effects. The Cochrane systematic review by McMillan et al.[48] in 2016 concluded that the treatments most supported by scientific evidence for BMS pain relief were, in the short term, photobiomodulation with LLLT, topical clonazepam, lingual protector, and gabapentin. In the long term, psychotherapy, topical capsaicin, and topical clonazepam would be the most effective. In the present work, only topical capsaicin, gabapentin and systemic clonazepam were placed in the 3rd line of therapy and in treatments not recommended due to the fact that they had significantly more side effects than the control group, or by having presented them without having compared them to the control group. All others are on the 1st therapy line.

Most of the articles analysed present, in general, a low number of participants, a great heterogeneity in the study design and an important difference in the metrics used to evaluate the results. On the other hand, the existence of different BMS definitions and the lack of standardization in the diagnostic criteria (inclusion/exclusion) may have led to a great variability in case selection. It is important to note that in almost none of the evaluated studies the continuity

of the therapeutic effect was analysed once the active therapy was suspended nor the subsequent recurrence of symptoms was analysed. All this has contributed to the lack of rigour of these trials and the disparity of the obtained results, so we currently do not have agreed criteria to manage these patients[48,55].

In the scientific literature there are other case reports or pilot studies with other therapeutic modalities, such as Pramipexol[56], which have been excluded from this work, but which should be considered for future research increasing the number of cases.

In conclusion, there is currently a need for more studies with a correct choice of cases and an adequate control group, with easily reproducible study designs and longer follow-up periods, and in which the time of the symptoms recurrence after stopping the therapy is evaluated in order to establish an agreed therapeutic algorithm for BMS.

The present narrative review has not analysed the quality or risk of bias of the articles included, nor has it been evaluated whether a therapeutic modality was studied in a single or in several studies, therefore, the results should be considered with caution.

CONCLUSIONS

1. A correct BMS diagnosis, after the exclusion of other possible conditions that cause similar symptoms will be key to establish an appropriate therapy regimen.

2. In the first line of therapy we find chewing gum, LLLT, lingual protector, psychotherapy, topical clonazepam, ALA and Catauma, which are therapeutic modalities that have benefits without side effects, while rTMS, bupivacaine, topical and systemic capsaicin, ALA + gabapentin and gabapentin, located in the third therapy line are also effective, but their side effects should be weighed.

3. More research is needed to provide sufficient guidance to clinicians on effective therapeutic modalities that allow to establish a correct strategy in BMS management.

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Bibliographic review

Physical properties of clinical utility of the new endodontics sealant cements based on silicates. Bibliographic review

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SUMMARY

Introduction: The obturation of the duct system plays a key role in the success of endodontic treatment. In an attempt to improve the properties of sealants cements, silicate-based sealants have recently been introduced to the market. Therefore, when carrying out the sealing of the duct system, it is useful to know the physical properties that the cement sealants present.

Objective: The objective of this work was to review the literature of the useful clinical physical properties that the new silicate-based cements present, and to compare them with the physical properties of the conventional epoxy resin-based cements.

Material and method: After establishing the adapted research question, a literature review was carried out in two databases (Medline via Pubmed and Wiley Library via Chrocane Library) combining MeSH terms (Medical Subject Headings) and free terms. In addition, a manual electronic search was carried out. The useful clinical physical properties selected were discoloration, sealing capacity, radiodensity, setting time and solubility.

Results: 224 potential studies were obtained. Finally, applying the inclusion and exclusion criteria, 22 studies were included in the review. The different studies compared the different physical properties of silicate-based cements, comparing them with resin-based cements.

Conclusions: Between silicate-based cements and resin cements, no differences in tooth discoloration were observed. Nor differences were observed in sealing in most of the studies consulted. All the cements analysed presented radiodensity values within the recommended standards. Both the setting time and the solution depended on the type of cement evaluated. Some of the silicate-based cements showed higher solubility compared to resin-based cements.

KEY WORDS

Obturation; Endodontic cements; Bioceramic cements; Resin cements.

INTRODUCTION

To achieve success in endodontic treatment, it is necessary to obtain a complete obturation, after cleaning and conformation of the duct[1] system. The materials commonly used in obturation are gutta-percha and 2 sealants. Sealing cements are substances capable of penetrating between the obturation material and root canals[3]. There are different types available on the market, however, despite gathering many of the features described by Grossman, they do not manage to gather all[4]. They can be classified according to their main components[5] in: zinc oxide–eugenol cement, calcium hydroxide cements, glass ionomer cements, silicone cements, resin cements or ceramic[6] cements.

At present, cements composed of resins are the most used, being considered the epoxy resin cement AH Plus™, the gold standard[3,7]. However, this cement presents a number of limitations such as a possible cytotoxicity, mutagenicity and inflammatory response[8]. In addition, another limitation of this cement is the absence of bioactive properties[9]. Therefore, new types of sealants called bioceramic[10] have recently been introduced to the market. These cements are based on the biological characteristics of MTA[11] and include in their composition calcium silicates, calcium phosphates, calcium hydroxide and zirconium oxide as radiopacifier[12]. Therefore, the development of bioceramic cements has been based on obtaining a good biocompatibility. However, these cements must also have adequate physical properties[4].

One of the physical properties that has gained importance in recent years is aesthetics[7]. The aesthetic result of the treatment of the opening is important, especially in the previous region[13], since, although the access cavity is adequately prepared and cleaned with alcohol, there is a possibility that some cement sealant[14] remains. On the other hand, the evaluation of the sealing capacity of new cement sealants is another property that has been considered an important parameter to consider[5]. The dimensional changes of the canal system, as well as the lack of adhesion of the gutta-percha, condition the achievement of complete sealing. Therefore, the adaptation of the sealing cement is a factor that influences the microfiltration and reinfection of the canal[15] system. Another property considered essential is radiodensity, since it allows clinicians to distinguish between the materials used and adjacent anatomical structures[16], as well as to assess the quality of the canal filler[17]. Another physical property that the clinician must take into account is the setting time. A slow or incomplete setting time may result in increased tissue irritation[18], while a very short setting time may decrease the working time complicating and interfering with the obturation process[19]. Therefore, the setting time should be long enough to allow easy handling, especially in those sealing techniques that require more time[20]. Another property that has special relevance when evaluating sealants cements is the solubility[21]. Dissolution of the sealing cement could interfere with the quality of the canal treatment and trigger an inflammatory response of periapical tissues[21,22]. In addition, a vacuum could occur between the sealing material and the canal, increasing filtration over time[21]. Therefore, sealants should have a low solubility rate[22].

Since there are different resin-based cements available on the market, it is important to know their physical properties. The objective of this literature review study was to analyse the scientific evidence of different physical properties of clinical applicability of different silicate-based sealants cements such as tooth discoloration, sealing capacity, radiodensity, setting time and solubility, and compare them with conventional resin-based cements.

MATERIAL AND METHODS

To carry out the present bibliographic review, taking into account the non-clinical nature of the studies, the following research PICO question was applied: In teeth or samples, silicate-based cements have better properties of discoloration, sealing, radiodensity and solubility compared to conventional cements based on epoxy resin? (Figure).

The bibliographic search was carried out in the databases of Medline via PubMed and the Wiley Online Library via Cochrane Library. The search was performed by combining MeSH (Medical Subject Headings) terms with free terms, in a simple or multiple way and using Boolean operators. In vitro studies published between 2015 and 2021 were included. The last search was conducted on January 31, 2021. Studies evaluating cements that were not marketed or modified in the composition of marketed cements were excluded. Also excluded were those studies that compared obturation modifications of physical or technical properties. The search equations used in English are described in Table 1. In addition, a manual electronic search was conducted in the Journal of Endodontics, International Journal of Endodontics, Australian Endodontic Journal and Iranian Endodontic Journal.

A preliminary selection of the articles was made by the title and the summary. Duplicate articles were discarded. Then, the full text of the articles was obtained, excluding the articles that did not meet the established criteria. Manually selected articles were added and those that did not meet the criteria were excluded. The selected articles were grouped according to the analysed property. Those articles that analysed more than one property were identified and included in the corresponding groups. Taking into account the nature of the review, the characteristics of the studies were summarized in a descriptive way.

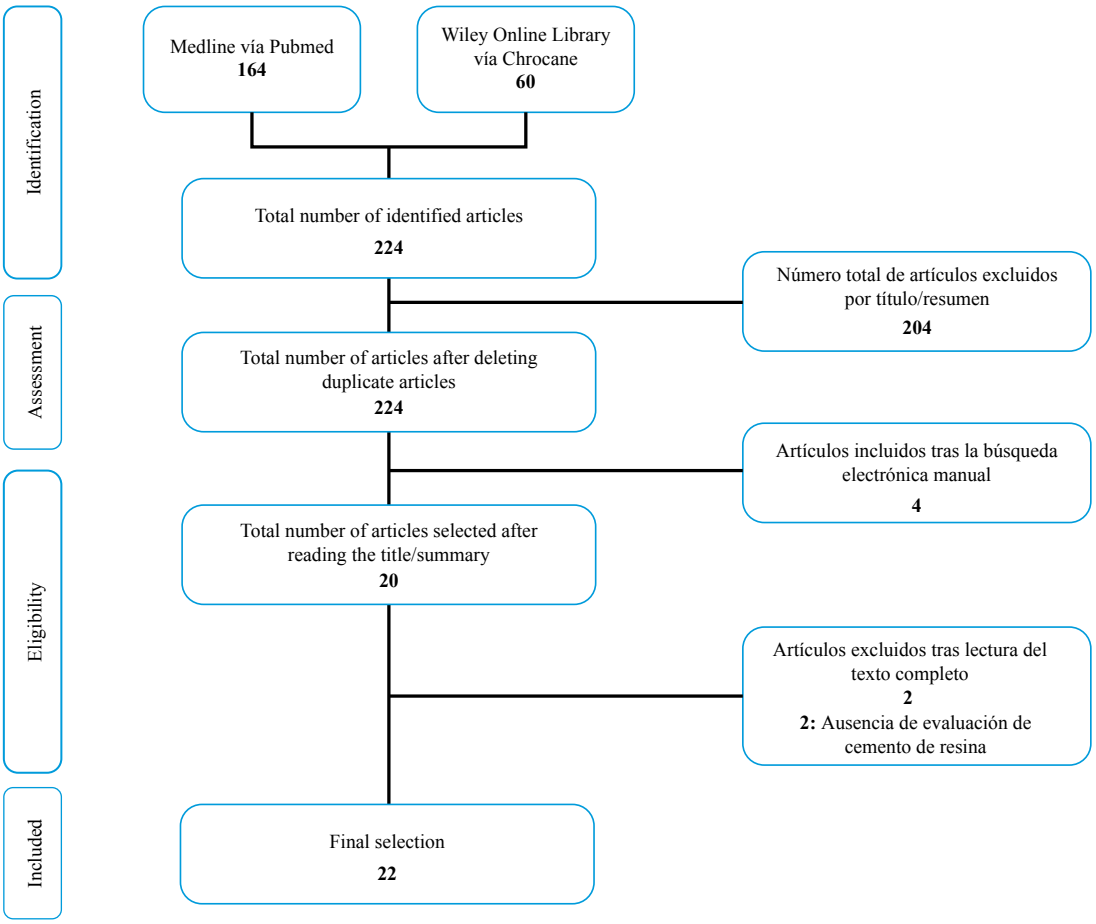

Figure. Flowchart to identify the selected studies.

RESULTS

The flow chart that was used for the selection of the articles can be seen in the Figure. A total of 224 studies were identified in the initial search. No duplicate articles were found. After evaluating the titles and summaries of the studies obtained in the initial search, 204 studies were excluded because they did not meet the inclusion and exclusion criteria. Therefore, 20 studies were selected to read the full text, to which four more studies were added that were obtained by an electronic manual search. After reviewing the full text of the 24 studies, two were excluded because they did not include a comparative group of epoxy resin[23,24]. Therefore, the final number of articles included in the bibliographic review to carry out the data extraction was of 22. The studies were grouped according to the analysed property (Table 2): 2 discoloration (A); 4 sealing capacity (B); 11 radiodensity (C); 9 setting time (D); and 12 solubility (E). 9 articles analysed several properties.

DISCUSSION

The selected articles evaluated different physical properties of the new silicate-based sealing cements. In order to evaluate the properties of the different cements, it is essential to establish standardized methodologies, so that the results can be reproduced and perform a reliable comparison of the data[19].

Discoloration of dental tissue

Studies that analysed the discoloration evaluated the same resin-based cement, the AH Plus™[7,14] sealant cement. However, different silicate-based cements were evaluated, being Endoseal™[14], MTA Fillapex™ and iRoot™ SP[7] the evaluated cements. Between both studies the discoloration of a total of 100 teeth was evaluated, including both bovine teeth[14] and human teeth[7]. The technique used in the discoloration evaluation was spectrophotometry for both studies, using the CIELAB system. However, different evaluation periods were applied, 0-2 months[14] and 0-6 months[7].

The results obtained in the two selected studies did not find significant differences regarding discoloration between the analysed cements and the resin-based AH Plus™. However, Forghani et al.,[7] observed a progressive discoloration of all cements during the first three months after the cement application, with a tendency to decrease during the second quarter and up to the sixth month of the evaluation.

Sealing capability

The studies that evaluated the sealing of the new silicate-based sealants were[4,5,15,25,26]. Regarding the selected silicate cements, one study evaluated BioRoot™ RCS[5], two studies analysed EndoSequence™ BC Sealer[15,25] cement and one study iRoot™ SP[26] cement. All studies were based on the AH Plus™ resin cement.

In three of the selected studies[5,15,26] there were no differences in sealing capacity between silicate-based

Table 1. Search equations.

Database	Evaluation
MEDLINE (via Pubmed)	((Tooth [Mesh] OR specimen) AND/OR ("Epoxy Resins"[Mesh] OR tricalcium silicate endodontic sealer OR calcium-silicate-based sealer) AND ("tooth discoloration"[Mesh] OR discolouration OR sealing OR radiopacity OR setting time OR solubility))
Cochrane	(MeSH descriptor: [Tooth] AND/OR MeSH descriptor: [Root Canal Filling Materials])

cement and epoxy resin-based cement. On the other hand, in one of the studies[26], a better seal was obtained with Endosequence™ BC Sealer silicate cement than with epoxy resin cement.

Radiodensity

Eleven studies[9,16,17,19,20,27-32] were selected that evaluated the radiodensity of silicate-based cements, comparing them with epoxy resin-based cements. The silicate-based cements analysed in the studies were: EndoSequence™ BC Sealer[16], EndoSeal™ MTA[16,28], TotalFill™ BC Sealer[9,30], BioRoot™ RCS[20,29,31], MTA Fillapex™[16,20,31,32], Sealer Plus™ BC[17,19,27] and BioC™ Sealer[9]. All studies evaluated cement based on epoxy resin AH Plus™. In addition, two studies also included epoxy resin-based cements ADSEAL™, Radic-Sealer™[16] and Sealer Plus™[32].

The American National Standards Institute and the American Dental Association (ADA) in their specification number 57 of the year 2000 establish a minimum radiodensity equivalent to 3.00 mm Al[33]. The standard established by the International Organization for Standardization (ISO) 6878 also specifies that the radiodensity must be equal to or greater than 3 mm Al[31]. All the cements evaluated presented radiodensity values within the recommended ISO standards.

In most studies AH Plus™ cement presented higher radiodensity values than BioRoot™ RCS[29,31], TotalFill™ BC[9,30], Bio-C™ Sealer[9], Endosequence™ BC Sealer[16], Sealer Plus™ BC[17,19,27], MTA Fillapex™[9,30,32] and Endoseal™[28]. How ever, in other studies, there were no significant differences between AH Plus™ and BioRoot™ RC, MTA Fillapex™[20] and EndoSeal™ MTA[16] cements. In studies that also analysed other resin-based cements, radiodensity results with respect to silica-based cements were similar. The MTA Fillapex™ cement showed lower radiodensity than the resin cements Sealer Plus™[9], Pulp Canal Sealer™[31], Radic-Sealer™ and AD Seal™[16].

Similarly, BioRoot™ RCS cement showed a lower radiodensity compared to the Pulp Canal Sealer™[31] resin cement. On the other hand, the Endosequence™ BC Sealer cement also presented a lower radiodensity compared to Radic Sealer™ cement. However, the Endosequence™ BC Sealer cement presented a higher radiodensity than the AD SEAL™[16] resin cement.

When evaluating the radiodensity differences between silicate-based cements, the results differ between the studies and depending on the analysed cements. One study observed greater radiodensity with MTA Fillapex™ compared to BioRoot™ RCS[31]. However, in another study, no differences were obtained between the two cements[20], nor between the cements Bio-C™ Sealer and TotalFill™ BC Sealer[9]. The only study that analysed three silicate-based cements[16] showed different radiodensity values between cements, with EndoSeal™ MTA cement being the largest, followed by Endosequence™ BC Sealer and MTA Fillapex™. The differences in radiodensity could be caused by the presence of different radiopacifying agents in the composition of the cements[16].

Setting time

The 9 selected studies[9,17-20,27,29,30,32] evaluated the setting time through needles that were introduced in the cement models, as established in IS0 6876[19] ANSI/ADA 57[27] standard.

The following silicate-based cements were evaluated: BioRoot™ RCS[20,29]; Sealer Plus™[17,18,27]; TotalFill™ BC Sealer, Bio-C™ Sealer[9,18,30]; and MTA Fillapex™[20,32]. In all studies, the setting time results of silicate-based cements were compared with AH Plus™ epoxy resin cement. One study also analysed Sealer Plus™[32] cement.

Two studies analysed the setting time of the BioRoot™ RCS[20,29] cement. Both observed that BioRoot™ RCS had a setting time lower than that of the resin-based cement AH Plus™[20,29]. In one of the two studies20, they also evaluated the setting time of the MTA Fillapex™ cement, which was completed in one week, the evaluation period established in the study. In another study, MTA Fillapex™ had a higher setting time than AH Plus™ and Plus™[32] Sealer cements.

Table 2. Table 2. Articles included in the review according to the proposed methodology that evaluate physical properties of sealants cements: (A) discoloration; (B) sealing; radiodensity; (C) setting time; (D) solubility.

(A). Discoloration

Author/Year	Evaluation	Silicate based sealing cement	Resin based sealing cement
Forghani et al.,[7] (2016)	Discoloration	MTA Fillapex™ iRoot™ SP	AH Plu™
Lee et al.,[14] (2016)	Discoloration	EndoSeal™ MTA	AH Plus™

(B). Sealing

Author/Year	Evaluation	Silicate based sealing cement	Resin based sealing cement
Viapiana et al.,[5] (2016)	Sealing	BioRoot RCS™	AH Plus™
Zhang et al, (2017)	Sealing	iRoot™ SP	AH Plus™
Huang et al.,[15] (2018)	Sealing	Endosequence™ BC Sealer	AH Plus™
Asawaworarit et al.,[26] (2020)	Sealing	Endosequence™ BC Sealer	AH Plus™

(C). Radiodensity

Author/Year	Evaluation	Silicate based sealing cement	Resin based sealing cement
Lim et al.,[27] (2015)	Radiodensity	EndoSeal™	AH Plus™
Khalil et al.,[29] (2016)	Radiodensity	BioRoot™ RCS	AH Plus™
Prüllage et al.,[20] (2016)	Radiodensity	BioRoot RCS™, MTA Fillapex™	AH Plus™
Tanomaru-Filho et al.,[28] (2017)	Radiodensity	TotalFill™ BC Sealer™	AH Plus™
Lee et al.,[16] (2017)	Radiodensity	EndoSeal™ MTA, MTA Fillapex™, Endosequence™ BC Sealer	AH Plus™ ADSEAL™ Radic-Sealer™
Siboni et al.,[30] (2017)	Radiodensity	BioRoot™ RCS, MTA Fillapex™	AH Plus™ Pulp Canal Sealer™
Mendes et al.,[19] (2018)	Radiodensity	Sealer Plus™ BC	AH Plus™
Vertuan et al.,[17] (2018)	Radiodensity	Sealer Plus™ BC	AH Plus™
Zordan-Bronzel et al.,[9] (2019)	Radiodensity	Bio-C™ Sealer, TotalFill™ BC Sealer	AH Plus™
Tanomaru-Filho et al.,[31] (2019)	Radiodensity	MTA Fillapex™	AH Plus™ Sealer Plus™
Silva et al.,[32] (2020)	Radiodensity	Sealer Plus™ BC	AH Plus™

(D). Setting time

Author/Year	Evaluation	Silicate based sealing cement	Resin based sealing cement
Khalil et al., [29] (2016)	Setting time	BioRoot™ RCS	AH Plus™
Prüllage et al.,[20] (2016)	Setting time	BioRoot™ RCS, MTA Fillapex™	AH Plus™
Tanomaru-Filho et al., [28] (2017)	Setting time	TotalFill™ BC Sealer	AH plus™
Vertuan et al.,[17] (2018)	Setting time	Sealer Plus™ BC	AH Plus™
Mendes et al.,[19] (2018)	Setting time	Sealer Plus™ BC	AH Plus™
Tanomaru-Filho et al.,[31] (2019)	Setting time	MTA Fillapex™	AH Plus™ Sealer Plus™
Zordan-Bronzel et al.,[9] (2019)	Setting time	Bio-C™ Sealer, TotalFill™ BC Sealer	AH Plus™
Silva et al.,[18] (2020)	Setting time	Bio-C™ Sealer, TotalFill™ BC Sealer	AH Plus™
Silva et al., [32] (2020)	Setting time	Sealer Plus™ BC	AH Plus™

(E). Solubility

Author/Year	Evaluation	Silicate based sealing cement	Resin based sealing cement
Lim et al., [27] (2015)	Solubility	Endoseal™	AH Plus™
Prüllage et al., [20] (2016)	Solubility	BioRoot™ RCS MTA Fillapex™	AH Plus™
Silva Almeida et al., [23] (2017)	Solubility	MTA Fillapex™	AH Plus™
Tanomaru-Filho et al., [28] (2017)	Solubility	TotalFill™ BC Sealer	AH Plus™
Mendes et al., [19] (2018)	Solubility	Sealer Plus™ BC	AH Plus™
Urban et al.,[36] (2018)	Solubility	BioRoot™ RCS MTA Fillapex™	AH Plus™
Vertuan et al., [17] (2018)	Solubility	Sealer Plus™ BC	AH Plus™
Torres et al.,[35] (2019)	Solubility	MTA Fillapex™	AH Plus™
Elaetsset et al., [34] (2019)	Solubility	MTA Fillapex™ BioRoot™ RCS TotalFill™ BC Sealer	AH Plus™ Obturys™
Zordan-Bronzel et al.,[9] (2019)	Solubility	Bio-C™ Sealer, TotalFill™ BC Sealer	AH Plus™
Tanomaru-Filho et al., [31] (2019)	Solubility	TotalFill™ BC Sealer	AH Plus™
Silva et al., [32] (2020)	Solubility	Sealer Plus™ BC	AH Plus™

Three studies evaluated Sealer Plus™ BC[17,19,27] silicate cement. Similar to the results observed with BioRoot™ RCS cement, Sealer Plus™ BC also presented a lower setting time than AH Plus™[17,19,27] epoxy resin cement. In two studies[18,30] TotalFill™ BC Sealer cement was analysed. In both, the setting time of silicate-based cement was lower than that of AH Plus™. However, the two studies that analyse Bio-C™ Sealer cement presented differences in the results from each other.

In one study AH Plus™ cement had a shorter working time compared to Bio-C™ Sealer[9], while in the other study[18], epoxy resin-based cement AH Plus™ had a longer setting time lower than Bio-C™ Sealer.

When analysing the setting time of silicate cements, in one study[20] there were no differences observed between BioRoot™ RCS and MTA Fillapex™ cements, while two studies observed a shorter setting time of Bio-C™ Sealer cement compared to TotalFill™ BC Sealer[9,18]. This cement in one of the 18 studies did not set after the 25 days established in the study conditions.

Solubility

Twelve articles evaluated the solubility of the sealants cements by comparing it with the solubility of the epoxy resin cements[5,9,17,19,20,27,28,30,34-37].

The selected studies analysed silicate-based cements: BioRoot™ RCS[20,34,37]; MTA Fillapex™[20,32,34-37]; TotalFill™ BC Sealer[9,30,34]; Sealer Plus™ BC[17,19,27,33]; Bio-C™ Sealer[9]; and Endoseal™[28]. All articles used as control group the AH Plus™ resin cement. Two articles, in addition to the AH Plus™ cement, analysed the properties of the Obturys™[34] and Sealer Plus™[32] cements.

Differences were observed, both between the different silicate-based cements as between the evaluation periods, in relation to resin-based cements. The BioRoot™ RCS cement presented higher solubility than the AH Plus™[20,34,37] and Obturys™[34] resin cements. The Bio-C™ Sealer cement also showed higher solubility than the AH Plus™[9] cement. Similarly, TotalFill™ BC Sealer cement obtained greater solubility than AH Plus™ resin cement in most of the analytical periods in the different studies[9,30,34]. However, in the first evaluation period of a study[34], no significant differences were observed between BioRoot™ RCS and AH Plus™ and Obturys™ resin-based cements. On the other hand, in most studies and periods analysed of the MTA Fillapex™ cement, a higher solubility was observed compared to resin cements[20,32,34,35,37]. However, one study observed greater solubility of MTA Fillapex™ compared to AH Plus™ at two hours of evaluation[20]. On the other hand, different studies did not show any differences regarding solubility between the two cements during the first minute of evaluation[20], at 24 hours[34] and after a week[34,36]. However, studies that analysed longer evaluation periods, the solubility of MTA Fillapex™ cement was superior to that of resin cement[32,35,37]. On the other hand, the silicate cement Sealer Plus™ BC obtained contradictory results. In one study[19] presented greater solubility than AH Plus™, while in two studies there were no differences between both[17,27].

Similarly, the only study that analysed the Endoseal™[28] cement did not obtain solubility differences with respect to AH Plus™ resin cement in the analysed period.

When evaluating the solubility between the different silicate-based cements different results were observed between the different evaluation periods. Bio-C™ Sealer cement presented higher solubility than the TotalFill™ BC Sealer[9] cement. On the other hand, in one study there were no significant differences in the different periods between TotalFill™ BC Sealer, MTA Fillapex™ and BioRoot™ RCS cements, except in the first evaluation period (24 hours), in which, the BioRoot™ RCS cement presented higher solubility than the MTA Fillapex™[34]. However, the solubility of both cements differs between studies, since greater solubility can be observed of MTA Fillapex™ compared to BioRoot™ RCS[20], as greater solubility of BioRoot™ RCS cement compared to MTA Fillapex™[37]. Further research would be needed to analyse the solubility of both cements in the long term.

CONCLUSIONS

Taking into account the lack of long-term clinical studies and the limitations of in vitro studies, the physical properties of new silicate-based sealants can guide the dentist in the selection of the sealing cement.

There were no differences in tooth discoloration between silicate-based and epoxy resin-based cements. Neither were differences observed between both types of cements, regarding sealing, in most of the studies selected in the present work. Both epoxy resin-based cement and silicate-based cements presented radiodensity values within the recommended ISO standards. The setting time of silicate-based cements, compared with resin cements, varied depending on the type of cement. Although solubility varied according to the cement type and the evaluation period, some of the silicate-based cements showed higher solubility than resin-based cements.

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