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Success in treatment with dental implants is determined not only by osseointegration, but also by the stability of the soft tissue around the restoration, giving it a natural appearance. The stability of this tissue is important for preventing periimplant bone resorption. The presence of a healthy periimplant mucosal interface has been associated with long-term implant success and protection against marginal bone loss. The soft tissue around implants plays a role in the protection and maintenance of the periimplant bone; in the crestal zone, it prevents bacterial invasion through different mechanisms in each of their components, provides resistance to frictional forces and limits the entry of foreign bodies.

The biological seal around the oral implant consists of two main layers: the epithelial junction and the underlying adhesion of the connective tissue. The main function of the epithelial junction is to form a physical barrier. The connective tissue function is much more complex, serving for defense, support and nutrition. The connective tissue is organized around the pillar in circular fibers, achieving stabilization of the pink tissue and helping to reduce bone resorption. The connective tissue is of crucial importance in stabilizing epithelial apical migration and in preventing bone resorption. The discrepancy between the diameter of the implant and the abutment can establish a point at which circular connective fibers can be retained. The connective tissue surrounding the dental implant is in direct contact with the surface of the titanium dioxide and contains a dense network of collagen fibers that originate in the peristeum of the alveolar bone crest and extend to the mucosal margin.

The quality of this mucosa is determined in part by the prosthetic accessory materials in contact with it and the topography of the implant. The development of new dental implants, prosthetic abutments and crowns offers novel surfaces and designs capable of improving soft-tissue insertion, with a view to avoiding microbial contamination of vital bone.

The biologically oriented preparation technique (BOPT) concept has been described as affording an adaptive profile of the soft tissue, invading the sulcus in a controlled manner. With this technique, the collagen fiber distribution appears to increase mucosal fixation around the teeth (and implants) and increase soft-tissue stability over the long term, with the aim of maintaining periimplant bone protection. The convergent conical portion of the implant–abutment assembly, together with the BOPT design crowns, offers positive outcomes, such as the prevention of bone remodeling and preservation of the alveolar ridge, adequate peri-implant tissue stability, and improved periimplant function and esthetics, without the need for more invasive and costly bone or soft-tissue regeneration techniques.

New histological studies and larger samples are recommended to evaluate histologically and histomorphometrically the disposition of connective tissue fibers around implants and, thereby, demonstrate that adequate tissue stability and coronal migration of periimplant soft tissue are necessary for a successful outcome in implant treatment.

Prof. Miguel Peñarrocha Diago
Editor-in-Chief
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New perspectives in periapical surgery: Ostectomy and osteotomy

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Abstract

Objective
The aim of this investigation was to review the surgical factors related to ostectomy in periapical surgery and their relationship to prognosis.

Method
An update was made of different techniques to achieve adequate access to the periapical lesion. Visual control of the affected roots is important for a successful result in periapical surgery; for this reason, the bone tissue from the vestibular cortical bone must be removed through an ostectomy or osteotomy.

Results
The technique used and the amount of bone removed must be analyzed preoperatively, since it will have a direct relationship to the surrounding anatomical structures, the healing time and the need to perform bone regeneration techniques.

Conclusion
With the use of microsurgical techniques, the size of the ostectomy should not exceed 5 mm in order to reduce the healing time and thus improve the prognosis of periapical surgery. Osteotomy is an alternative technique that allows preservation of the external cortical bone, but has been little studied.
Introduction

Periapical surgery entails 3 procedures: root end resection, root end cavity preparation and bacteria-tight sealing of the root canal system at the cut root end with a retrograde filling. For this, it is necessary to remove the periapical inflammatory pathological tissue to reach the dental apex. Many years ago, in 1845, Hullinhen proposed surgical trephination through the soft tissue and bone and into the pulp to alleviate a pathological pulp process. At present, to access the periapical lesion and obtain visual control of the affected roots, the soft tissue has to be raised and bone tissue from the vestibular cortical bone must be removed through an ostectomy or osteotomy. In some cases, the pathological periapical lesion has already perforated the cortical bone, providing direct access to the apex and allowing the removal of the pathological tissue with only a remodeling of the peripheral bone.

Before surgery, it is important to calculate on a parallel radiograph the length and number of roots, the curvature of these, and the position of the apices and the important anatomical structures, such as the foramen, inferior dental nerve and maxillary sinus. At present, the incorporation of cone beam computed tomography (CBCT) as a complementary radiographic technique has greatly simplified the diagnosis and detection of all these characteristics. Ahn et al. proposed introducing a CAD/CAM-guided surgical template in periapical surgery to minimize the extent of ostectomy for locating the root apex in cases with a thick and intact buccal bone plate and to facilitate surgery on teeth close to problematic anatomical structures.

The aim of this investigation was to review the surgical factors related to ostectomy in periapical surgery and their relationship to prognosis.

Surgical technique

Ostectomy entails the removal of bone tissue from the cortical bone to reach the dental apex. How large an ostectomy should be is predicated on the native size of the lesion, adequate armamentarium access, and proximity to vital structures, such as the mental nerve, mandibular canal and maxillary sinus. In conclusion,
the size of the ostectomy should be as small as possible, but sufficiently large to enable curettage of the entire periapical lesion and access to the instruments needed to perform apical surgery.

The ostectomy is done with a round tungsten carbide bur (size 6–10) mounted on a handpiece and abundant irrigation with physiological saline (Fig. 1). Recently, a contra-angle handpiece with a 45° angular head was
launched on the market to facilitate injection of only water, not air, to avoid possible emphysema. A point between 2 and 4 mm of the apex is selected and a hole is made perpendicular to the longitudinal axis of the tooth until dental tissue is reached. The ostectomy is then continued with small movements of the bur in order to distinguish with touch the difference between bone and root cementum.

In mandibular molars, the external cortical bone has a higher density and a complicated entry angle, so the ostectomy should be broader to have good access to the roots and be able to identify them clearly, leaving also larger bone defects after periapical surgery, which can be filled with a bone grafting material, optionally combined with the use of membranes.

In 1961, Boyne et al. measured labial bone plate destruction after ostectomy and periapical curettage. They found that the smaller defects (5–8 mm) exhibited complete bone regeneration, while the 9–12 mm defects showed herniation with fibrous tissue. Ten years later, Hjorting-Hansen and Andreasen made cavities of 5, 6 and 8 mm through buccal and lingual plates or through only the buccal plate of mandibles in 6 adult dogs. The authors concluded that bone healing was related to the size of the cavity, as well as whether both cortical plates were removed.

According to Rubinstein and Kim, there is a direct relationship between wound healing and the size of the ostectomy: a small lesion (0–5 mm) took 6.40 months to heal, a medium lesion (between 6 and 10 mm) 7.25 months and a large lesion (than 10 mm) 11.00 months. For this reason, in mandibular molars, when the radiographic diagnosis confirms the presence of apical lesions in both roots separated by an intact osseous septum and without inflammatory tissue infiltrate 2 independent ostectomies can be performed to access each root, creating smaller bone defects and decreasing the bone healing time (Fig. 2). With microsurgical techniques, the size of the ostectomy is significantly
Ostectomy in periapical surgery

Fig. 3d

Fig. 3e

Fig. 3f

Fig. 3g
Ostectomy in periapical surgery

Fig. 3h

Fig. 3i

Fig. 4a

Fig. 4b

Fig. 4c
smaller than with a conventional osteotomy,\textsuperscript{12, 13} just 4 mm in diameter. This is just larger than an ultrasonic tip of 3 mm in length, yet allows the tip to vibrate freely within the bone cavity (Fig. 3).\textsuperscript{12}

Osteotomy is an alternative surgical technique that allows the preservation of the external cortical bone. Peñarrocha and Sanchis used the so-called window osteotomy, made with hollow cylindrical trephines of different diameters.\textsuperscript{14} The osteotomy of the cortical bone begins with a trephine of adequate diameter and abundant irrigation with physiological saline, until the cancellous bone is reached, which is perceived as a decrease in resistance during drilling. Once the access window has been created, a small and fine chisel is introduced to lift the bone block. During periapical surgery, the bone lid remains in physiological saline, and it is replaced over the cavity at the end of the surgery (Fig. 4). Currently, the osteotomy can also be performed with piezoelectric instruments. For Abella et al., the advantages of piezoelectric surgery include protection of soft tissue, optimal visualization of the surgical field, decreased blood loss, reduced vibration and noise, increased comfort for the patient, and protection of tooth structures (Fig. 5).\textsuperscript{15}
García-Mira et al. showed that there are no statistically significant differences between ostectomy and osteotomy with respect to postoperative pain and prognosis. Instead, patients in the ostectomy group had increased inflammation. Peñarrocha and Sanchis showed some advantages of the osteotomy window with respect to the ostectomy: (a) simpler and faster in a complicated area such as the posterior mandibular area; and (b) conservation of the patient's own bone to promote the healing of the lesion. The surgical bone defect can be filled with different materials (such as collagen sponge and lyophilized bovine bone) before replacing the bone lid. Osteotomy has been little studied in the literature. The main complication of this technique, especially if using trephine drills, is the possibility of damaging roots if the position or direction of the cut is inadequate.

**Conclusion**

Ostectomy in periapical surgery is a key step in periapical surgery and necessary to access the apex of a tooth with periapical pathology. Currently, with microsurgical techniques, the size of the ostectomy should not exceed 5 mm if the apical lesion allows it, in order to reduce the healing time. Osteotomy is an alternative technique that allows the preservation of the external cortical bone, but has been little studied.
Ostectomy in periapical surgery

References


Legends

Fig. 1a – Panoramic image of patient referred for dental implant assessment. An apical lesion affecting a mandibular left premolar was found.

Fig. 1b – Intraoperative image after flap elevation. Adequate retraction of flap to avoid damage of the mental nerve is very important.

Fig. 1c – Ostectomy is done with a round tungsten carbide bur mounted on a handpiece and abundant irrigation with physiological saline.

Fig. 1d – The ostectomy should measure about 4 mm. This diameter allows the free movement of the ultra-sonic tips.

Fig. 1e – Five-year follow-up panoramic radiograph showing complete healing of bone around the apex.

Fig. 2a – A trapezoidal flap design with a sulcular incision was made to access the mandibular molar with an apical lesion.

Fig. 2b – Two independent ostectomies were performed to access the mesial and distal roots, creating a small bone defect.

Fig. 2c – Clinical image of sealing with mineral trioxide aggregate of 2 retrograde cavities.

Fig. 2d – One-year follow-up periapical radiograph showing complete healing.

Fig. 2e – Seal of the retrograde cavity and complete healing of bone can be appreciated in this tomographic view.

Fig. 3a – Clinical image of the maxillary right anterior teeth, with healthy soft tissue, in a male patient referred for spontaneous pain in this area.

Fig. 3b – The radiograph showed an apical lesion affecting an endodontically treated lateral incisor.

Fig. 3c – CBCT study clearly showed an apical lesion affecting the cortical bone plate of the lateral incisor.

Fig. 3d – A periodontal probe was used to check the size of the ostectomy.

Fig. 3e – Retrograde cavity preparation using an ultra-sonic tip.

Fig. 3f – Mineral trioxide aggregate sealing of retrograde cavity.

Fig. 3g – A platelet-rich plasma preparation was used to fill the bone defect.

Fig. 3h – Soft-tissue aspect after suturing.

Fig. 3i – A postoperative radiograph showing the retrograde cavity and mineral trioxide aggregate filling.

Fig. 4a – A cylindrical trephine was used to perforate the bone and expose the periapical area.

Fig. 4b – Aspect of the root after sealing with mineral trioxide aggregate.

Fig. 4c – The bone lid was replaced over the cavity at the end of the surgery.

Fig. 4d – A periodontal probe was used to check the size of the ostectomy.

Fig. 4e – Osteotomy was performed with an ultrasonic device.

Fig. 4f – Intraoperative view after lesion removal and retrograde cavity filled with mineral trioxide aggregate.

Fig. 4g – The bone block was fixed with an osteosynthesis screw.

Fig. 4h – Clinical view of the soft tissue 1 year after the surgery.

Fig. 4i – The 1-year follow-up radiograph showed bone regeneration.
Prevalence of oral lesions among patients in the dental faculty of the University of Santiago de Compostela, Spain

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Abstract

Background
The main objective of this study was to evaluate the prevalence of white, red and pigmented lesions of the oral cavity among patients attending the dental faculty of the University of Santiago de Compostela, Spain.

Materials and methods
We designed an epidemiological, cross-sectional, descriptive and observational study. White, red and pigmented lesions were evaluated randomly in a total of 100 patients. Data such as patient’s demographics, smoking habit, presence or absence of oral lesions (and their features) and whether the patient was aware of the presence of the lesion were collected. Descriptive statistics were calculated, and contingency tables were constructed using the chi-squared test. Analytical statistics were performed by comparing means in nonparametric analyses using the Mann–Whitney U test.

Results
The total prevalence of oral lesions was 22% (n = 100). The average age of the patients was 54.68 years (SD = 14.64). Most patients with oral lesions were women (60%) and the average size of the lesions was 1.83 cm. Most of the lesions were red (almost 60%) and asymptomatic (> 90%). There was a known causal link for almost all lesions, with a percentage of higher than 80%. Most patients (69.2%) were aware of the presence of the lesion when it was red ($P = 0.016$).

Conclusion
The most frequent type of lesion in this study population was a red lesion, located on the lip, with a hypertrophic surface, asymptomatic and with a known causal nexus. Periodical check-ups are fundamental to be able to make an early diagnosis of any lesions, as no patient with a white lesion was aware of the risk of it being a premalignant or malignant lesion.

Keywords
Oral mucosa; lesion prevalence; Spanish population.
Introduction

An oral mucosal lesion is defined as any abnormal alteration in color or surface appearance, swelling or loss of integrity of the oral mucosal surface, which may interfere with the quality of daily life of the persons affected. Etiological factors of oral mucosal lesions include infection, local trauma and metabolic, immunological and neoplastic diseases.1, 2 Socio-demographic factors and behavior too have been associated with oral mucosal lesions.3

Studies on distribution of oral lesions allow us to estimate disease prevalence in a population and thus identify a subpopulation of high risk. For these subpopulations, we can then prepare health strategies in the different areas.4 In several regions of the world, studies have confirmed the wide variation in both prevalence and the most common types of lesions in the oral cavity (Table 1).

The oral mucosa can be affected by a great variety of injuries and conditions. Oral cavity lesions are considered a general health indicator. Early identification is essential for integral medical care. Therefore, soft-tissue examination must be done systematically to include the whole cavity.14 Although most oral lesions are benign and do not need active treatment, some of them can involve a significant pathology. Those lesions associated with a high risk of malignant transformation are especially important. Oral cancer is a malignant tumor with an increasing prevalence. Despite technological and biological advances, its prognosis has not improved in the last decades. Early diagnosis is the most important factor for an improved survival rate. Information about risk factors of oral lesions is the first step toward investigating oral cancer prevention.16

Prevalence of oral mucosal lesions and their associated factors have not been previously registered in the Santiago de Compostela population. This prevalence varies significantly between geographic locations and the extrapolation of other studies’ results would not be meaningful. Accordingly, the main aim of this study was to evaluate the prevalence of white, red and pigmented lesions in the oral cavities of patients attending the dental faculty of the University of Santiago de Compostela. A secondary aim was to analyze patients’ variable features and awareness of their lesions.

Materials and methods

An epidemiological, cross-sectional, descriptive and observational study was designed to determine prevalence of white, red and pigmented lesions among patients attending the dental faculty of the University of Santiago de Compostela.

<table>
<thead>
<tr>
<th>Country</th>
<th>Year of publication</th>
<th>Sample size</th>
<th>Identified oral lesions (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malaysia</td>
<td>19975</td>
<td>11-707</td>
<td>9.7</td>
</tr>
<tr>
<td>Slovenia (Ljubljana)</td>
<td>20006</td>
<td>1-692</td>
<td>61.6</td>
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<tr>
<td>Spain (Oviedo)</td>
<td>20027</td>
<td>308</td>
<td>51.1</td>
</tr>
<tr>
<td>U.S.</td>
<td>20048</td>
<td>17-235</td>
<td>27.9</td>
</tr>
<tr>
<td>Italy (Turin)</td>
<td>20089</td>
<td>4-098</td>
<td>25.09</td>
</tr>
<tr>
<td>India (Karnataka state)</td>
<td>200810</td>
<td>1-190</td>
<td>41.2</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>200911</td>
<td>2-552</td>
<td>15</td>
</tr>
<tr>
<td>Turkey</td>
<td>200912</td>
<td>5-000</td>
<td>15.5</td>
</tr>
<tr>
<td>North India</td>
<td>201013</td>
<td>8-866</td>
<td>16.8</td>
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<tr>
<td>Sweden</td>
<td>201014</td>
<td>6-448</td>
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<tr>
<td>Kuwait</td>
<td>201314</td>
<td>530</td>
<td>58.1</td>
</tr>
<tr>
<td>Iran</td>
<td>20131</td>
<td>1-581</td>
<td>19.4</td>
</tr>
<tr>
<td>Australia</td>
<td>20141</td>
<td>3-551</td>
<td>20.5</td>
</tr>
<tr>
<td>China (Shanghai)</td>
<td>20141</td>
<td>11-054</td>
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<tr>
<td>Brazil</td>
<td>201515</td>
<td>801</td>
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</table>

Table 1: Prevalence of oral mucosal lesions in general populations.
<table>
<thead>
<tr>
<th>Descriptive data</th>
<th>Frequency in % (n)</th>
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</thead>
<tbody>
<tr>
<td><strong>Sex</strong></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>40.9 (9)</td>
</tr>
<tr>
<td>Female</td>
<td>59.1 (13)</td>
</tr>
<tr>
<td><strong>Educational level</strong></td>
<td></td>
</tr>
<tr>
<td>No education</td>
<td>4.5 (1)</td>
</tr>
<tr>
<td>Primary education</td>
<td>13.6 (3)</td>
</tr>
<tr>
<td>Secondary education</td>
<td>22.7 (5)</td>
</tr>
<tr>
<td>Sixth form</td>
<td>27.3 (6)</td>
</tr>
<tr>
<td>Further education</td>
<td>9.1 (2)</td>
</tr>
<tr>
<td>Higher education</td>
<td>4.5 (1)</td>
</tr>
<tr>
<td>University</td>
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<tr>
<td><strong>Smoking habit</strong></td>
<td></td>
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<td>No</td>
<td>54.5 (12)</td>
</tr>
<tr>
<td>Yes</td>
<td>45.5 (10)</td>
</tr>
<tr>
<td><strong>Cigarettes per day</strong></td>
<td></td>
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<tr>
<td>3</td>
<td>30 (3)</td>
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<td>4</td>
<td>20 (2)</td>
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<td>20</td>
<td>20 (2)</td>
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<tr>
<td>40</td>
<td>10 (1)</td>
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<tr>
<td><strong>Lesion localization</strong></td>
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<tr>
<td>Gingiva</td>
<td>27.3 (6)</td>
</tr>
<tr>
<td>Lip</td>
<td>31.8 (7)</td>
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<tr>
<td>Oral mucosa</td>
<td>4.5 (1)</td>
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<td>Alveolar crest</td>
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<td>Palate</td>
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<td>Tongue</td>
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<tr>
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<tr>
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</tr>
<tr>
<td>Pigmented</td>
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<td><strong>Lesion surface type</strong></td>
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<td>22.7 (5)</td>
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<tr>
<td>Hypertrophic</td>
<td>77.3 (17)</td>
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<tr>
<td><strong>Symptoms</strong></td>
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<tr>
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<td>9.1 (2)</td>
</tr>
<tr>
<td><strong>Causal nexus</strong></td>
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<td>18.2 (4)</td>
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<tr>
<td>Yes</td>
<td>81.8 (18)</td>
</tr>
<tr>
<td><strong>Evolution time</strong></td>
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<td>59.1 (13)</td>
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<tr>
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<td>27.3 (6)</td>
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<tr>
<td>Determinate</td>
<td>13.6 (3)</td>
</tr>
<tr>
<td><strong>Number of lesions</strong></td>
<td></td>
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<tr>
<td>Single</td>
<td>72.7 (16)</td>
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<tr>
<td>Multiple</td>
<td>27.3 (6)</td>
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<tr>
<td><strong>Lesion awareness</strong></td>
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<tr>
<td>No</td>
<td>50 (11)</td>
</tr>
<tr>
<td>Yes</td>
<td>50 (11)</td>
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</table>

Table 2: Descriptive statistics.
of Santiago de Compostela. The study was conducted over a period of 8 months between September 2016 and April 2017. All of the procedures were carried out with the proper understanding and written consent of the patients in accordance with the Declaration of Helsinki.

**Eligibility criteria**
Inclusion criterion: all adult patients attending the dental faculty of the University of Santiago de Compostela.
Exclusion criterion: patients younger than 18 years old.

**Data extraction**
Two specific operators performed data collection and extraction, after previous calibration for correct evaluation of the variables. In cases of discrepancy, a third operator corroborated the results. The agreement in this process was calculated using Cohen’s kappa coefficient, and a k score of 0.8 was obtained.17 Patient exploration was carried out using an exploration kit consisting of a mirror, an exploration probe and a CP12 periodontal probe.

**Clinical parameters**
Clinical parameters noted from patients were as follows:
- demographic data (age, sex and educational level);
- smoking habit (yes/no and cigarettes per day);
- presence of oral lesions (yes/no);
- lesion features (type, localization, size, presence of symptoms, single/multiple, atrophic/hypertrophic surface, causal nexus [if the patient or the operator found any causal factor], evolution time and presumptive diagnosis);
- whether the patient was aware of the presence of the lesion (if the patient thought that he or she may have a lesion this was considered to demonstrate awareness).

We classified the type of lesion (white/red/pigmented) and surface (atrophic/hypertrophic) according to the most prevalent aspect or the more serious aspect in terms of clinical prognosis in cases of mixed lesions.

**Sample size**
To estimate the sample size, the greater proportion of patients affected by oral lesions was taken into account according to the literature, that is, 35%. To obtain a statistic potential of 80%, we needed a total of 86 patients. Finally, we analyzed a randomized sample of 100 patients.

**Statistical analysis**
All data were coded and analyzed using IBM SPSS Statistics software (Version 20). Descriptive statistics were calculated using frequencies and percentages for the categorical variables and means and standard deviations for the quantitative variables. Contingency tables were constructed using the chi-squared test. Analytical statistics were performed by comparing means in nonparametric analyses, using the Mann–Whitney U test and 1-way analysis of variance. All of the differences in which the P value was ≤ 0.05 were considered statistically significant.

**Results**
A total of 100 patients were examined. Table 2 summarizes descriptive data of the patients with oral lesions. The patients’ mean age was 54.68 years (SD = 14.64). Most patients with oral lesions were women (almost 60%). The mean lesion size was 1.83 cm (SD = 41.79). In the bivariate analysis, in which the main variable was the type of lesion, white, red or pigmented (Table 3), we observed that the patient was aware of the lesion when
the lesion was red (69.2%) or pigmented (66.7%), but not when it was white (0%). Regarding the influence of sex on the type of lesion, we observed that more than 60% of pigmented lesions occurred in males, while red and white lesions were predominant in women.

According to smoking habit, 66.7% of the total pigmented lesions were in smokers. Of those smokers with pigmented lesions, all smoked more than 10 cigarettes per day.

The location affected the type of lesion in the following way: In the case of red lesions, most were located on the lip. In white lesions, most were located on the palatal mucosa. The pigmented ones appeared in the gingivae.

All of the white lesions diagnosed had a hypertrophic surface. Of the red lesions, almost 80% had a hypertrophic surface. However, most of the pigmented lesions had an atrophic surface (66.7%). More than 80% of the white lesions and more than 70% of the red lesions had a known causal nexus. All of the pigmented lesions in this study had a known causal nexus.

More than 80% of the red lesions presented singularly. In the case of white lesions, the majority were also single lesions (66.7%). The pigmented ones, however, presented in multiples. No patient with a white lesion was aware of the lesion. However, almost 70% of patients with red lesions were aware that they had them. These differences are statistically significant, according to the chi-squared test ($P = 0.016$). Red lesions tended to appear in older patients, and white and pigmented lesions affected younger patients. Pigmented lesions were less frequent than white lesions and white lesions were less frequent than red lesions.

**Discussion**

Our results revealed a prevalence of 22% of oral lesions in patients attending the dental faculty. Previous studies show that prevalence varies significantly in general populations (range: 9.7–61.6%; Table 1). The majority of the lesions were red (59.1%), followed by white (27.3%) and pigmented ones (13.6%).

According to our study, red lesions are more frequent in older people than white or pigmented ones. A study carried out in an elderly Chilean population agrees with our finding of a higher frequency of red lesions at older ages. In the total number of patients diagnosed with any type of lesion, white, red or pigmented, there was a greater number of women (59.1%). In other studies, a higher prevalence of lesions in women had already been reported. Other studies have reported a higher prevalence of lesions in males. However, there are studies that support no significant difference in prevalence between women and men.

In our study, 63.6% of patients with lesions had only sixth form and secondary education. We would think that patients with a higher educational level would have a greater concern for oral health and therefore come to the consultation with a suspicion of a lesion. In other studies, a higher prevalence of oral diseases was reported in patients of lower socioeconomic status, which may be the result of a lower educational level.

A slightly higher percentage of patients who participated in this study were nonsmokers. We could attribute this to the growing antismoking campaign of recent decades, increasing gradual awareness of the dangers of this habit. In a study conducted in 2001 in Italy, 88% of the sample were already aware of the damage caused by smoking. In another study conducted in Kuwait in 2013, smoking participants reported that they would consider quitting if an improvement of oral health could be demonstrated as a result.

The relative risk of oral cancer increases proportionally with the level and duration of tobacco use. It has been reported that the benefit of stopping smoking is large and can be realized in a relatively short period. Two pathogenic factors are fundamentally involved in the development of pigmented lesions: race and smoking. Regarding tobacco, it stands out in this study that 66.7% of the total pigmented lesions were in smokers who smoked more than 10 cigarettes per day. Regarding the influence of race, in the Asian population, the prevalence of pigmented lesions was 79%, while in this study it was 3%, similar to that in other studies in European populations.

The location of the most frequent lesions in the present study was the lip (31.8%). We suggest that this is related to the lips being the first barrier to the oral cavity. Because of this, they are constantly exposed to various irritants, which play an important role in the etiology of lesions in this location. Most of the lesions had a hypertrophic surface, almost 80%, which could be related to the higher prevalence of traumatic injuries. Only 9.1% of patients reported symptoms. This result was similar to that of other studies.
More than 70% of the lesions diagnosed were single lesions, a fact that coincides with the study of the population of Oviedo, where single lesions also predominated.7

None of the patients with white lesions in this study were aware of them, probably because this type of lesion is usually asymptomatic. However, those with red lesions were aware of these (69.2%), as were those with pigmented lesions (66.7%). This is a very important result because it indicates that patients may miss some types of premalignant lesion, resulting in a delay in seeking diagnosis and treatment. The knowledge of risk factors and the recognition of symptoms by patients are crucial factors. A study conducted in Scotland in 2010, which assessed the initial recognition of symptoms in oral cancer patients, described a great variety of symptoms, among which were “bulbo” and “white spot.”25 Many of the patients stated that they used self-medication obtained from a pharmacy after noticing the initial symptoms, which generally resulted in delayed diagnosis and treatment.25

Conclusion

The prevalence of lesions in the oral cavity found in this study was 22%. Most lesions appeared in women. The most frequent type of lesion in this study population was red; in terms of location, the lip was the most prevalent site. Hypertrophic and asymptomatic lesions were more frequent. In more than 80% of the patients, we could identify a known causal nexus. No patient with a white lesion was aware of it. Periodical check-ups are fundamental to be able to make an early diagnosis of any lesions, as no patient with a white lesion was aware of the risk of it being a premalignant or malignant lesion.

Competing interests

The authors declare that there are no conflicts of interest in connection with this article, including there being no funding sources.

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Introduction

Yttria-stabilized tetragonal zirconia polycrystal (Y-TZP) is a ceramic material that has been widely used in clinical practice owing to its attractive proven mechanical properties and biocompatibility. Since zirconia is a chemically inert material, different surface treatments can be performed to increase its bonding to resin-based cements. Air abrasion with alumina or silica-coated alumina particles is one of the most common and simple procedures used to improve micromechanical interlocking between zirconia and resin-based cements.1, 2 These particles are deposited on the surface, which differ chemically from one another, and participate in the chemical bond that occurs at the zirconia–resin cement interface.1

The efficacy of the different air abrasion parameters (particle type, pressure, angle) on the adhesive bonding between the zirconia and resin cements have largely been evaluated,3–5 and it is known that air abrasion is an effective method for removing salivary contamination.2 However, there is neither concern nor standardization regarding the cleaning procedure applied after air abrasion of the zirconia surface, and the cleaning methods often vary among studies. Simply dry air streaming,1, 6, 7 ultrasonic cleaning in distilled water8 or in some alcohols, such as isopropanol1, 5 or ethanol,9 all followed by dry air streaming, are the most used cleaning methods.

Two questions should be posed: whether cleaning the air-abraded surface is necessary and, if the answer is positive, if there is a method that is more effective than others. Of the few studies1, 10–12 that have evaluated the efficacy of the cleaning method on the resin bonding to zirconia, none of them tested an only air-abraded surface, that is, without having been air streamed even. Therefore, there is no answer to the first question. In relation to the second question, there is no consensus in the literature. Two studies10, 11 reported that ultrasonic cleaning, when compared with air streaming for 5 s, decreased the bond strength,
regardless of whether the ceramic was air abraded with silica-modified alumina particles\textsuperscript{10} or simply with alumina particles.\textsuperscript{11} It was argued that ultrasonic cleaning removes not only the loose particles, but also the silica layer deposited on the zirconia surface,\textsuperscript{10} and air abrasion with alumina particles provides a highly active surface, which could easily be contaminated during the cleaning procedure,\textsuperscript{11} suggesting that this procedure should be avoided. However, Attia et al. and Attia and Kern believe in the effectiveness of ultrasonic cleaning at removing the loose particles from the air-abraded surface, which could negatively affect the bond strength.\textsuperscript{1,12} although Attia et al. did not find a significant difference in bond strength between air streaming and ultrasonic cleaning for both particles.\textsuperscript{1}

Considering the lack of studies on the subject, as well as the divergence between their results, as well as the possible influence of this procedure on the adhesive bonding to zirconia, the present study aimed to investigate whether cleaning is necessary and to compare the efficacy of different cleaning methods applied after air abrasion with different particles on the Y-TZP, on the shear bond strength between the zirconia and an adhesive resin cement. The null hypotheses were that it would not be necessary to clean the air-abraded zirconia surface and that there would be no difference among the cleaning methods.

Materials and methods

Specimen preparation

One hundred and twenty Y-TZP nonsintered disks (6.25 mm in diameter and 2.50 mm thick; Lava, 3M ESPE) were prepared. The bond surface was manually and standardly polished with 600- and 1,200-grit wet silicon carbide sandpaper.

After the sintering process in a specific oven (inFire HTC speed, Sirona Dental Systems), following the manufacturer’s instructions, half of the zirconia disks (5 mm in diameter and 2 mm in thickness) were air abraded with 110 µm aluminum oxide (Al\textsubscript{2}O\textsubscript{3}) particles, while the remaining half were air abraded with 110 µm silica-modified Al\textsubscript{2}O\textsubscript{3} particles (Rocatec Plus, 3M ESPE). For standardized air abrasion, the disks were mounted in a custom-made device. This step was performed for 15 s in an air abrasion unit (Basic classic, Renfert) at 0.28 MPa air pressure, at a 90° angle and 10 mm from the specimen surface.

Afterward, the specimens were treated with 1 of the following methods:

1. no cleaning (control);
2. dry air streaming for 15 s;
3. air and distilled water spraying for 15 s, followed by dry air streaming for 15 s;
4. ultrasonic cleaning in distilled water for 10 min, followed by dry air streaming for 15 s;
5. ultrasonic cleaning in 99% isopropanol for 10 min, followed by dry air streaming for 15 s.

The composite resin disks (Filtek Z350 XT, 3M ESPE) were produced in equal amounts and with the dimensions of the zirconia disks similar to the methods used in a previous study.\textsuperscript{5} To bond the composite resin disk to the zirconia disk, the latter was accurately placed into a custom-made alignment apparatus with the air-abraded surface facing upward. Prior to this, the zirconia disks were treated with CLEARFIL SE BOND PRIMER/CLEARFIL PORCELAIN BOND ACTIVATOR (both Kuraray Noritake Dental), and the proportion of 0.010 g of paste of the PANAVIA F 2.0 dual-cured resin cement (Kuraray Noritake Dental) was mixed and placed onto the resin disk, which was positioned over the zirconia surface. After the excess cement had been removed, the cementation line was light-cured in 3 different positions (120°, 240° and 360°) for a total of 120 s (40 s per side), and load of 1,000 g was applied to the resin–zirconia disks for 5 min. The specimens were stored in distilled water at 37°C for 24 h prior to the shear bond strength (SBS) test.

Shear bond strength test

A custom-made special holder device, developed based on the study by Fawzy and El-Askary,\textsuperscript{13} for SBS testing was attached to a universal mechanical testing machine (EMIC Equipment and Systems Testing) equipped with a 1 kN load cell. The bonded disks were positioned in the holder device and tested for SBS, subjected to a uniaxial tensile force at the adhesive interface at a constant crosshead speed of 0.5 mm/min until failure. SBS values were recorded in MPa. Statistical analysis was performed by 2-way analysis of variance (ANOVA) and Tukey’s HSD post hoc test (α = 0.05).
Analysis of failure mode
The fractured zirconia–resin cement interfaces were examined using a stereomicroscope (M80, Leica Microsystems) at ×20 magnification. Failure mode was recorded by a single calibrated observer and classified as:

1. cohesive within the composite substrate;
2. cohesive within the cement layer;
3. mixed failure;
4. adhesive at the composite resin–cement interface; and
5. adhesive at the zirconia–resin cement interface.

The bonded surface was divided into 4 quadrants, and depending on the predominant mode of failure, the bonded surface was classified when 1 of these modes predominated in 3 or more of the 4 quadrants.

Scanning electron microscopy
For the scanning electron microscopy (SEM) analysis, 1 additional specimen from each group was obtained. The specimens were mounted on metallic stubs and analyzed under a high-resolution field emission scanning electron microscope (model JSM-7500F, JEOL), which operated at ×200 magnification with an accelerating voltage of 5 kV.

Results
Shear bond strength results
The results of the 2-way ANOVA test indicate that the difference between the groups regarding the 2 particles used for the air abrasion was statistically significant ($P < 0.01$; Table 1).

Table 2 shows the mean SBS values, standard deviations and statistical analysis results for each group. All the groups air abraded with 110 µm Al$_2$O$_3$ particles exhibited a significantly higher SBS than the groups treated with Rocatec Plus. The highest SBS was found in the control group (110 µm Al$_2$O$_3$ particles), while the lowest SBS was presented by the group cleaned with air and water spraying, followed by dry air streaming after air abrasion with Rocatec Plus. Regardless of the different cleaning methods used, the SBS within the groups air-abraded with Rocatec Plus showed no significant difference ($P > 0.05$). A similar result was obtained in the groups air abraded with 110 µm Al$_2$O$_3$ particles.

The failure mode observed was 20% mixed failure and 80% adhesive at the zirconia–resin cement interface failure in the group air abraded with 110 µm Al$_2$O$_3$ particles, and 44.4% mixed failure and 55.6% adhesive at the zirconia–resin cement interface failure in the group for which Rocatec Plus was used (Fig. 1).

Scanning electron microscopy analysis
SEM images of the zirconia bonding surfaces treated with different particles and cleaning methods are shown in Figure 2. Although it is not possible to identify particles from air abrasion, and thus which cleaning method was most effective, all the groups air abraded with Rocatec Plus seem slightly rougher than the ones treated with 110 µm Al$_2$O$_3$ particles.

Discussion
In the present study, 2 questions were posed regarding whether cleaning the air-abraded surface is necessary, using an only air-abraded zirconia surface as a control group, and whether there is difference in efficacy among the cleaning methods. The null hypotheses of the present study were confirmed since, regardless of the particle used, it was not necessary to clean the air-abraded surface and there was no significant difference among the different cleaning methods.

In the literature, few studies were found that evaluated the efficacy of the methods of cleaning of the air-abraded zirconia surface on its bond strength to resin-based materials. Furthermore, since none of these studies used an only air-abraded zirconia surface as a control group, even without air streaming, up to now, the necessity of cleaning had not been definitively determined. In the current study, the SBS results indicated that cleaning was not necessary, regardless of the particle used for air abrasion. However, for both alumina and silica-coated alumina particles, some differences in the failure pattern among the groups were detected, which could guide us regarding how to better proceed after air abrasion.

For the Al$_2$O$_3$ particles, the group cleaned with air and water spraying and then dry air streaming exhibited the highest percentage of adhesive failure (100%), followed by the control group and the group cleaned with air and water spraying alone.
Table 1: Two-way analysis of variance.

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>SS†</th>
<th>df</th>
<th>MS†</th>
<th>F§</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particle</td>
<td>227.9</td>
<td>1</td>
<td>227.9</td>
<td>40.6</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Surface treatment</td>
<td>54.7</td>
<td>4</td>
<td>13.7</td>
<td>2.4</td>
<td>&gt; 0.05</td>
</tr>
<tr>
<td>Particle and surface treatment</td>
<td>12.2</td>
<td>4</td>
<td>3.0</td>
<td>0.5</td>
<td>&gt; 0.05</td>
</tr>
<tr>
<td>Residual</td>
<td>448.8</td>
<td>80</td>
<td>5.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>13277.0</td>
<td>90</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

†SS = Sum of squares.
†MS = Mean square.
§F = Fisher variable.

Table 2: Mean shear bond strength values and standard deviations (MPa) and statistical results.

<table>
<thead>
<tr>
<th></th>
<th>Rocatec Plus</th>
<th>110 μm Al₂O₃</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (no cleaning)</td>
<td>10.5 ± 2.1 Ab</td>
<td>14.5 ± 2.1 Aa</td>
</tr>
<tr>
<td>Dry air streaming</td>
<td>11.6 ± 2.3 Ab</td>
<td>14.1 ± 3.9 Aa</td>
</tr>
<tr>
<td>Air and water spraying + dry air streaming</td>
<td>8.4 ± 1.2 Ab</td>
<td>13.6 ± 1.4 Aa</td>
</tr>
<tr>
<td>Ultrasonic cleaning in water + dry air streaming</td>
<td>9.4 ± 2.9 Ab</td>
<td>12.0 ± 3.2 Aa</td>
</tr>
<tr>
<td>Ultrasonic cleaning in isopropanol + dry air streaming</td>
<td>10.1 ± 1.3 Ab</td>
<td>12.7 ± 1.8 Aa</td>
</tr>
</tbody>
</table>

Different uppercase letters indicate significant differences in columns (P < 0.05).
Different lowercase letters indicate significant differences in rows (P < 0.05).
cleaned with ultrasonic cleaning in water and then dry air streaming (89%). In the literature, no studies were found that evaluated the effects of either air and water spraying followed by dry air streaming or the absence of any treatment after air abraison, that is, the control group in the present study, on the resin bonding to zirconia. However, we suppose that the high percentage of cohesive failure of the control group may be attributed to the particles that were weakly adhered to the air-abraded surface. The importance of removing loose particles not firmly attached to the ceramic surface after air abrasion by ultrasonic cleaning prior to bonding has been already reported. Additionally, Attia et al. and Attia and Kern believe in the effectiveness of ultrasonic cleaning at removing the loose particles from the air-abraded surface, which could negatively affect the bond strength, although Attia et al. did not find a significant difference in the bond strength between air streaming and ultrasonic cleaning for both particles.

However, Nishigawa et al. observed that ultrasonic cleaning in distilled water (5 min) followed by air streaming (240 min) after air abrasion with Al₂O₃ particles decreased the bond strength at the zirconia–resin cement interface when compared with only air abrasion for 5 s, from which they concluded that ultrasonic cleaning should be avoided after air abrasion. According to these authors, air abrasion with Al₂O₃ particles provides a surface layer high in purity and activity, which presents with high chemical affinity to react with chemical compounds; therefore, they raise the possibility that the highly active zirconia surface may have been contaminated during the ultrasonic cleaning procedure.

Still regarding the failure modes in the present study, the groups cleaned with dry air streaming only and with ultrasonic cleaning in isopropanol followed by dry air streaming presented 33% and 45% mixed failure, respectively, for the Al₂O₃ particles. Attia et al. also observed no significant difference between ultrasonic cleaning by air streaming and in isopropanol after the zirconia had been air abraded with 110 µm Al₂O₃ particles, both groups having shown cohesive failure within the luting resin and the composite. Based on all these findings, among the cleaning methods tested in the present study, air streaming only, which is a more practical technique than ultrasonic cleaning in isopropanol followed by dry air streaming, could be an appropriate choice.

Regarding the 110 µm silica-modified Al₂O₃ particles (Rocatec Plus), in the present study, as occurred with the Al₂O₃ particles, no statistical difference in the SBS was observed among the cleaning methods, but there were some subtle differences in the failure mode pattern. Again, only adhesive and mixed failures were observed; the control group and the group cleaned with ultrasonic cleaning in distilled water followed by dry air streaming having the highest percentages of mixed failure, 55.6% for both. In contrast, different from what was observed in the present study, Nishigawa et al. observed a lower mean SBS value and 100% adhesive failure when the silica-coated zirconia surface (Rocatec Plus) was ultrasonically cleaned in distilled water for 1 min (8.1 MPa) or 5 min (7.2 MPa), than when it was cleaned with air streaming (9.6 MPa), which exhibited a higher percentage of cohesive failure (50%). According to these authors, this behavior could be explained by the silica on the surface easily being removed by ultrasonic cleaning, and consequently, it was concluded that this cleaning procedure should be avoided after silica coating. Different from our study, in which air streaming was used to dry the wet zirconia surface after an ultrasonic bath, these authors left the surface to air-dry for 60 min. Maybe this drying method was insufficient to remove all of the moisture from the silica-coated surface, impairing adhesion and explaining the lower mean SBS values. Moreover, in our study, ultrasonic cleaning in distilled water (9.4 MPa), which was performed for a longer time (10 min) than used by Nishigawa et al. (1 or 5 min), as well as our control group (10.5 MPa), provided mean SBS values similar to those of the best group reported by those authors (9.6 MPa). Besides that, in the present study, the group cleaned with air streaming only yielded higher mean SBS values (11.6 MPa), but a lower (33%) percentage of mixed failure. Based on these findings regarding the mean SBS values and the failure mode patterns for the groups treated with 110 µm silica-modified Al₂O₃ particles (Rocatec Plus), we believe that the most efficient and most practical procedure for treating the silica-coated surface is simply not to clean it after silica coating.

Although the comparison between both 110 µm particles was not the main purpose of the present study, the significant superiority in SBS of the Al₂O₃ particles over the silica-modified ones, regardless of the cleaning method, must be discussed. The SEM images...
Bond strength at the zirconia–resin cement interface showed that all of the groups air abraded with Rocatec Plus seemed slightly rougher than the ones treated with Al₂O₃ particles, although the latter obtained higher SBS values. It indicates that particles with the same size, but with chemical differences in their surfaces may behave differently toward the material applied afterward. In this case, the materials used were the CLEARFIL SE BOND PRIMER/CLEARFIL PORCELAIN BOND ACTIVATOR and PANAVIA F 2.0. Considering that Al₂O₃ is an adsorbent for phosphoric acid and that these materials contain MDP, which is a phosphate monomer, coating the zirconia surface with
alumina particles contributes to improving the bond strength at the zirconia–resin cement interface. The high affinity of the MDP phosphate monomer present in this resin cement to Al₂O₃ particles achieves high and durable bond strength values, which has already been evidenced in some studies.

Moreover, Fonseca et al. showed that the association between Al₂O₃ particles and the MDP phosphate monomer is stronger than the association between this monomer and a silica-coated surface. Nothdurft et al. reported that, with the use of the Rocatec system, a partially significant increase in SBS could be achieved with cements that do not contain phosphate monomer in comparison with those that contain this monomer. Also, some studies showed that the association between a silica-coated surface and the MDP phosphate monomer is not as strong as the association between that surface and the silane. These findings indicate that the chemical affinity between Al₂O₃ particles and the MDP phosphate monomer is higher than that between this monomer and silica-modified Al₂O₃ particles. Based on this, the superiority of the Al₂O₃ particles over the silica-modified ones was already expected.

However, regarding the failure pattern resultant from the Al₂O₃ particles and the silica-modified ones in the present study, the silica-coated groups tended to present more mixed failures. This finding leads us to reflect on the actual significance of the bond strength values obtained for the silica-coated groups, which partially reveal the cohesive strength of the resin cement, which, in some cases, was lower than the adhesive bonding of the zirconia–resin cement interface. It is still not clear in the literature whether there is a chemical affinity between phosphoric acid groups, such as the MDP phosphate monomer with silica particles. Further research is necessary to clarify this aspect.

Conclusion

Within the limitations of the present in vitro study, the following conclusions were drawn:

1. Regardless of the particle used, the cleaning method did not influence the zirconia–resin cement bond strength; thus, it was not necessary to clean the air-abraded surface.
2. The particle type applied by the air abrasion influenced the zirconia adhesive bond strength more than the cleaning method did.

Competing interests

The authors declare that they have no competing interests.

Legends

Fig. 1 – Failure mode. G1: no cleaning (control); G2: dry air streaming for 15 s; G3: air and distilled water spraying for 15 s, followed by dry air streaming for 15 s; G4: ultrasonic cleaning in distilled water for 10 min, followed by dry air streaming for 15 s; G5: ultrasonic cleaning in 99% isopropanol for 10 min, followed by dry air streaming for 15 s.

Fig. 2 – SEM images of the zirconia bonding surfaces treated with different particles and cleaning methods.

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Periapical surgery with a new retrograde root canal filling material: Tricalcium silicate cement

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Abstract

Background
The prognosis of periapical surgery has been improved in recent years with the use of new instruments and materials. Mineral trioxide aggregate (MTA) is considered the cement of choice for periapical surgery; however, a new calcium silicate-based material seems to improve on some of the properties of MTA.

Case presentation
Two patients were referred to the oral surgery department of the University of Valencia, Valencia, Spain, for periapical surgery of 2 maxillary teeth. Clinical examination revealed pain in both cases. Periapical radiography and CBCT confirmed the diagnosis. The same surgical protocol was employed using a tricalcium silicate cement as a retrograde filling material. Up to 1-year clinical and radiographic control showed complete healing of soft and hard tissue.

Conclusion
The success of periapical surgery achieved in both cases and the adequate management of tricalcium silicate cement as a retrograde filling material are highly promising.

Keywords
Endodontic surgery; periradicular surgery; Biodentine; retrograde filling.

Introduction
Recent meta-analyses1–3 have documented that the prognosis of periapical surgery is significantly greater with high-power magnification (microscope/endoscope) and mineral trioxide aggregate (MTA). The properties of the ideal root end filling material are as follows: biocompatibility, promotion of tissue regeneration without causing inflammation, ease of handling, low solubility in tissue fluids, bonding to dental tissue, nonabsorbability, dimensional stability, radiopacity and no staining of surrounding tissue.4 However, the very long setting time, high cost and difficult manipulation of MTA prevent clinicians using it for many cases.

In 2009, a new material containing tricalcium silicate, calcium carbonate, zirconium oxide and calcium chloride, specifically designed as a dentin replacement and named Biodentine, was formulated by Septodont. Recent studies on the material’s properties concluded that tricalcium silicate cement can be used in similar applications to MTA.5 The main advantages of this cement over MTA are a quicker setting time, better con-
Tricalcium silicate cement as retrograde filling material

Fig. 1a

Fig. 1b

Fig. 1c

Fig. 1d

Fig. 1e
sistency and improved handling (product packaging in a capsule allows the practitioner to achieve a reproducible material with optimal properties every time). 4, 6

The use of tricalcium silicate cement as a retrograde filling in periapical surgery is little documented. The aim of the following case reports is to describe its use as a retrograde filling material.

Case report 1
A 36-year-old male patient was referred to the oral surgery department of the University of Valencia, Valencia, Spain, for possible periapical surgery of the maxillary right first premolar because of a persistent apical lesion after 6 months of endodontic retreatment. In the review of his medical history, the patient did not mention any kind of health problem and reported no history of allergies nor use of any medication. Clinical examination (Fig. 1a) elicited pain, and the periapical radiograph showed a radiolucent area surrounding the tooth apex (Fig. 1b), confirmed by a CBCT scan (Fig. 1c). Probing depths were normal at the vestibular and lingual aspects.

The surgery was carried out under local anesthesia with 4% articaine and 1:100,000 epinephrine (Inibsa). After elevation of a full-thickness mucoperiosteal flap, ostectomy was carried out using round 0.27 mm tungsten carbide burs (JOTA) mounted in a handpiece and abundant irrigation with sterile physiological serum, and debridement of the pathological tissue around the apex was performed. The root of the premolar was then resected approximately 3 mm from the apex (Figs. 1d & e). Hemostasis of the bony crypt was achieved with epinephrine (1 mg/mL; B. Braun). Root end cavities were prepared with sonic-driven microtips (Piezomed, W&H Dentalwerk Bürmoos) and were retrofilled with Biodentine (Fig. 1f). After cleaning of the wound area, a hemostatic sponge was introduced into the bony crypt (Gelatamp, ROEKO) to avoid soft-tissue collapse, and primary wound closure was accomplished with multiple interrupted sutures using a 4/0 thread (POLISOFT, Sweden & Martina). The postoperative periapical radiograph showed adequate retrograde filling (Fig. 1g).

The following medication was prescribed: amoxicillin (500 mg/8 h) preoperatively (2 days before surgery) and 5 days after the intervention, ibuprofen (400 mg/8 h) for 4 days, a 0.12% chlorhexidine rinse 3 times a day for 7 days, and paracetamol (500 mg) as needed. The sutures were removed after 1 week. At the follow-up visit after 1 year, the teeth were asymptomatic, no gingival recession had occurred and normal periodontal probing depths were found (Fig. 1h). The periapical radiograph showed complete bone regeneration around the apex (Fig. 1i).

Case report 2
A 64-year-old female patient was referred to the oral surgery department of the University of Valencia with pain at the maxillary left lateral incisor, which had received a fixed ceramic restoration (Fig. 2a). The periapical radiograph did not show any pathological condition around the apex; however, a small amount of endodontic cement extruding into the periapical region could be observed (Fig. 2b) and was confirmed with CBCT (Fig. 2c). Clinical examination discovered localized pain on palpation of the apical region of the lateral incisor. The patient was provided with full information about alternative treatments and their success rates. Finally, periapical surgery was performed.

The surgery was carried out under local anesthesia with 4% articaine and 1:100,000 epinephrine (Inibsa). After elevation of a full-thickness mucoperiosteal flap, ostectomy was carried out using round 0.27 mm tungsten carbide burs (JOTA) mounted in a handpiece and abundant irrigation with sterile physiological serum. The minimum bone removal necessary to access the apex was performed, and the pathological soft tissue and endodontic cement extruding around the apex were thoroughly debrided (Fig. 2d). A retrograde cavity was prepared using ultrasonic retrotips (Piezomed) to a 3 mm depth (Fig. 2e). Hemostasis of the bony crypt was performed using gauze with epinephrine (1 mg/mL; B. Braun). The root end cavity was filled with Biodentine (Fig. 2f). Tensionless soft-tissue flap closure was performed with a 6/0 thread (POLINYL, Sweden & Martina). The intraoral radiograph showed adequate retrograde filling (Fig. 2g).

The patient was prescribed amoxicillin (500 mg/8 h) preoperatively (2 days before surgery) and 5 days after the intervention, ibuprofen (400 mg/8 h) for 4 days, a 0.12% chlorhexidine rinse 3 times a day for 7 days, and paracetamol (500 mg) as needed in the event of intense pain. The sutures were removed after 1 week. At the follow-up visit after 1 year (Figs. 2h & i), the tooth was asymptomatic, no gingival recession had occurred and the minimal bone defect created with the ostectomy for apical access was completely regenerated.
Tricalcium silicate cement as retrograde filling material

Fig. 1f

Fig. 1h

Fig. 1g

Fig. 1i
Tricalcium silicate cement as retrograde filling material
Discussion
In recent years, MTA has been considered the gold standard material for periapical retrograde filling, since it has proved to be better than other materials studied.7–9 Recently, a new calcium silicate-based material, initially developed for restorative dentistry, began to be used as a retrograde filling material.

In vitro studies have shown promising properties of tricalcium silicate cement. A comparative analysis between Biodentine, glass ionomer cement and MTA showed better marginal adaptation of Biodentine.10 From a biomechanical point of view, the sealing properties of Biodentine have been reported to be superior to those of MTA.11 This phenomenon is due to the absence of calcium aluminates and calcium sulfate in its formulation, which are known to decrease mechanical strength and extend setting time.4

Biočanin et al. evaluated in an in vitro study the quality of retrograde filling (wettability, porosity and volume of the gap at the material–dentin interface) with Biodentine, MTA and glass ionomer.12 The results showed that MTA and Biodentine possess certain advantages in comparison with glass ionomer with respect to wettability and porosity. Furthermore, Biodentine showed a tendency toward the lowest marginal gap at the cement–dentin interface.

Clinically, the faster setting time, easier manipulation and low cost seem at this time greater advantages of Biodentine compared with MTA.10,12 The primary clinical limitation of tricalcium silicate cement is its low radiopacity. This poor radiopacity makes visualization of the retrograde obturation difficult when small amounts of the material are used.3

Conclusion
The success of periapical surgery achieved in both cases and the adequate management of tricalcium silicate cement as a retrograde filling material are highly promising. The absence of studies with large and long-term series make the prognosis of apical surgery with this new material unknown. More clinical studies are necessary to establish whether tricalcium silicate cement is an alternative to MTA in periapical surgery.

Competing interests
The authors declare that they have no competing interests.

Legends
Fig. 1a – Clinical examination of the maxillary right first premolar.
Fig. 1b – The periapical radiograph showed a lesion around the tooth apex.
Fig. 1c – CBCT confirmed the diagnosis.
Fig. 1d – Intraoperative photograph after apicoectomy.
Fig. 1e – Apical retrograde micromirror view of apicoectomy.
Fig. 1f – Root-end filling was performed with tricalcium silicate cement.
Fig. 1g – Postoperative periapical radiograph.
Fig. 1h – Clinical photograph at 1-year follow-up.
Fig. 1i – The periapical radiograph after 1-year follow-up showed complete bone healing.
Fig. 2a – Clinical examination of the maxillary left lateral incisor.
Fig. 2b – The periapical radiograph showed endodontic cement extrusion.
Fig. 2c – CBCT confirmed the diagnosis.
Fig. 2d – Intraoperative photograph after apical resection.
Fig. 2e – Apical retrograde micromirror view of apicoectomy.
Fig. 2f – Root-end filling was performed with tricalcium silicate cement.
Fig. 2g – Postoperative periapical radiograph.
Fig. 2h – The clinical photograph after 1-year follow-up showed adequate soft-tissue healing.
Fig. 2i – The periapical radiograph after 1-year follow-up showed complete bone regeneration.
References


Additive digital dentistry:
SolFlex 3-D printers in three sizes for laboratories and practices

An ever-growing number of dental practices and laboratories are digitalizing their workflows. The SolFlex 3-D printer from VOCO paves the way for additive production technologies. The combination of scans with subsequent design and 3-D printout allows users to create, for example, models and splints for orthodontic dentistry both quickly and precisely. The SolFlex printer comes in three sizes for use in both laboratories and practices.

The SolFlex 3-D printer uses the tried-and-tested digital light processing units. Together with the innovative high-performance UV LEDs used, it is capable of printing layer after layer with an exceptional degree of precision. Furthermore, it is based on a solid-state UV LED light source with a low level of energy consumption and a long service life. The outstanding performance stability of the light source leads to a highly reproducible printing process. The use of a patented flexible vat (Flex-Vat) results in only minimal pull-off forces. As such, it is possible to generate thinner and finer components, thus requiring only minimal support material. Thanks to the revolutionary Pixel Stitch Technology, the printer boasts impressive performance in terms of resolution and construction volume.

The SolFlex 3-D printers are available either with or without sensor technology (sensor-monitored production). On the one hand, the special sensor ensures consistent illumination intensity, which, in turn, guarantees a consistently high-quality component production (SolFlex 170/350/650). On the other hand, a further laser sensor system monitors the construction process while also enabling optimization of the construction speed. Weighing between 15 and 20 kg, all the SolFlex printers are very light. In the laboratory, the printer takes up roughly the same amount of space as a conventional PC printer. The large vat volume also allows the devices to run without supervision, for example overnight.

V-Print splint, V-Print model beige and V-Print SG 3-D printing material

Those suffering from bruxism can often be helped with an occlusal splint, which should be worn as frequently as possible and therefore needs to be of a certain durability, which is best achieved by a high grade of elasticity. VOCO’s 3-D printing material V-Print splint offers exactly that.

V-Print splint is a light-cured resin designed for generative production using a 385 nm LED DLP printer. This printing material is suitable for
- splints used in treatments;
- bleaching trays; and
- auxiliary and functional parts for dental diagnostics.

V-Print splint can be used for printing in layers of 25, 50, 75 or 100 μm thick. Just like V-Print SG and V-Print model beige, V-Print splint has been carefully matched to the SolFlex printer, thus producing optimal printing results.

The V-Print model beige printing material is a light-cured methacrylate-based resin suitable for the additive production of precision components, for all dental models. The material allows optimal visibility of the preparation margins and prevents showing through when applying shades to restorations—especially in the case of cores.

V-Print model beige impresses with its smooth and scratch-resistant surface. The material is suitable for DLP printers with a UV LED spectrum of 385 nm.

The V-Print SG 3-D printing material is a Class IIa medical device developed for the additive production of drilling templates. The high precision makes it easier to plan the implantation and produces more accurate results. For optimal clinical use, V-Print SG can be steam sterilized at 134 °C for a maximum of 5 minutes without any detrimental effect on the accuracy of fit.

V-Print SG is biocompatible and flavorless, and impresses in use with its high flexural strength. The high-quality methacrylate-based resin is ideal for DLP printers with a UV LED spectrum of 385 nm.

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