

*Evaluation Study*

# EFFICACY OF HYALURONIC ACID ON PREVENTION OF ALVEOLAR OSTEITIS: A PRELIMINARY RESULT

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## ABSTRACT

Alveolar osteitis (AO) (dry socket) is a permanent tooth extraction complication characterized by intense pain and halitosis. This present study aimed to evaluate the efficacy of hyaluronic acid in preventing alveolar osteitis after tooth extraction in patients with a clinical history of AO. Adults of 18 years or older (patients with a clinical history of AO and/or traumatic extraction) were included. After tooth extraction, the socket was filled with hyaluronic acid in the test group while left empty in the control group. During healing, the patient's pain perception was assessed using a visual analog scale (VAS), and patients were screened for alveolar osteitis. All sites were evaluated clinically at baseline, after 3, 7, and 15 days. No alveolar osteitis (AO) was recorded in the test group, while only one case of AO was recorded in the control group. Within the limitation of our study, the application of hyaluronic acid after tooth extraction seems to be effective in reducing pain among patients with a clinical history of AO.

**KEYWORDS:** *alveolar osteitis, dry socket, hyaluronic acid, wound healing, socket healing, bone biomaterials*

## INTRODUCTION

Alveolar osteitis (AO) (dry socket) was first described in 1986 by Crawford. It is a complication of permanent tooth extraction, which is characterized by intense pain with or without halitosis. It most commonly develops 2-4 days after tooth extraction. Its prevalence ranges from 0.5% to 5% in the case of a regular extraction (1) and from 1% to 45% in the extraction of mandibular wisdom teeth (2). Many names of AO were used in literature such as localized osteitis, necrotic socket, postoperative alveolitis, fibrinolytic alveolitis, localized osteomyelitis, avascular socket, alveolitis sicca, delayed extraction wound healing, dolorosa, and fibrinolytic alveolitis. However, only alveolar osteitis and dry socket continue to be commonly used.

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The incidence of alveolar osteitis is increased in cases with inadequate blood supply, poor oral hygiene, excessive trauma to the bone, mechanical factors such as rinsing or sucking that may cause loss of the clot, foreign bodies or tissue in the socket, and infection (3). Several studies suggest a direct correlation between estrogen use and dry sockets for its effect on the coagulation system (4). *Treponema denticola* is found abundantly in association with gingival disease and is also involved in the pathogenesis of dry sockets (5). Furthermore, *Actinomyces viscosus* and *Streptococcus mutans* showed delayed healing of sockets after inoculation of the organisms in animal models.

Many techniques proposed to reduce the incidence of AO, such as the use of piezosurgery (6, 7) or filling the alveolus with drugs, for example, eugenol (analgesic), alveogyl, iodophorm (antimicrobial), zinc oxide eugenol and polymyxin B sulfate, tyrothricin, neomycin sulfate, or tetracaine hydrochloride (8). The management of AO is symptomatic in nature as AO is self-limiting condition. It is important to control pain control using local measures with or without systemic analgesics (9). Many authors suggest that chlorhexidine 0.12% mouthwash can be used after extraction for the prevention of AO (10, 11). However, evidence is non-conclusive. Recently, it has been proposed the use hyaluronic acid for bone healing and bone regeneration (12). Hyaluronic acid (HA) is a high-molecular glycosaminoglycan (GAG) which can be found as a constituent of the connective tissue, skin, eye, synovial fluid. HA plays an important role in cell migration, differentiation, proliferation, inflammation, wound healing, angiogenesis, cancer, diabetes and many physiological processes (13).

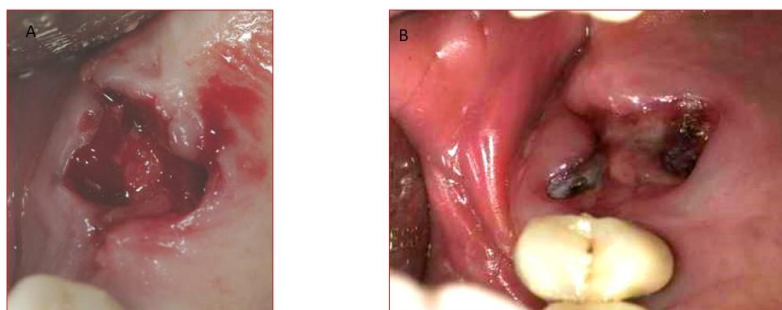
However, there is a lack of reports regarding the effect of HA in the prevention of AO. Therefore, this study was aimed to evaluate the efficacy of hyaluronic acid on the prevention of alveolar osteitis after tooth extraction in patients with a clinical history of AO.

## MATERIAL AND METHODS

A pilot study was conducted to assess the efficacy of hyaluronic acid on prevention of alveolar osteitis. Fifty patients were enrolled in the present study; 25 were randomly assigned to the test group and 25 were assigned in the control group. All patients agreed to participate by signing an informed consent form, according to the recommendations of the Declaration of Helsinki. All the patients were treated in the Department of Innovative Technologies in Medicine & Dentistry of the University of Chieti-Pescara, Chieti, Italy.

Inclusion criteria were adult patients of 18 years or older with clinical indications for permanent tooth extraction (due to caries, trauma, or fracture) without the need for flap elevation with a history for alveolar osteitis. Exclusion criteria were patients requiring extraction with flap and rotary instrument, patients with periodontal disease, patients under antimicrobial therapy, or anti-inflammatory drugs.

Dental extractions were performed in accordance with standard procedures(14). All tooth extraction was performed by a single surgeon. After tooth extraction, the socket was filled with hyaluronic acid (Skin-F 26, Ital-Farmacia, Rome, Italy) on the test group, while left empty in the control group. During healing process, the patient's behaviour was evaluated for pain perception using visual analogy scale (VAS) and presence or absence of alveolar osteitis. All sites were evaluated clinically, and photos were taken at baseline, after 3, 7, and 15 days (Fig. 1, 2).



**Fig. 1. A):** Immediately after the tooth, the socket filled with HA as a baseline. **B):** Socket filled with HA after 3 days.



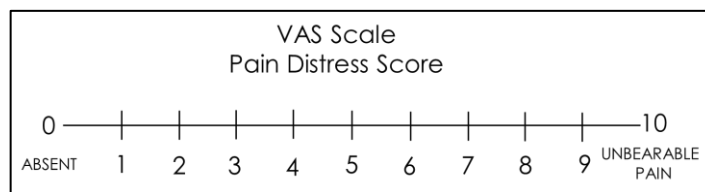
**Fig. 2.** Control group. A single case of alveolar osteitis.

*Statistical analysis*

A statistical package GraphPad 8.0 (Prism, San Diego CA USA) was used for the statistical analysis. Pain scores were described as VAS means, standard deviations and 95% Confidence Intervals. The Kruskal Wallis followed by the Dunn’s test has been applied to compare the VAS scores at the 3 different time points for each group. The Mann-Whitney test has been applied to compare the VAS score levels between the test and control group for each time point. The level of significance was considered for  $p < 0.05$ .

**RESULTS**

Pain VAS score is a numerical rating scale in which 0 stands for no pain and 10 represents the possible worst pain (Fig. 3).



**Fig. 3.** Pain VAS: Are you having pain during the post-operative time?

The VAS values showed that most patients treated with hyaluronic acid had no or mild pain (VAS score: 0–1) at 1<sup>st</sup> day (96%), 3<sup>rd</sup> day (100%) and 7<sup>th</sup> day (100%) after surgery. Pain and mild discomfort were reported in only one case (4%; VAS score 2–4) at day 1 (Table I).

**Table I.** Pain VAS distribution at days 1, 3 and 7.

	VAS Score	1 day	3 days	7 days
<b>Test group</b>	0-1	24 (96%)	25 (100%)	25 (100%)
	2-4	1 (4%)	0	0
	5-7	0	0	0
	8-9	0	0	0
	10	0	0	0
<b>Control group</b>	0-1	14 (56%)	21 (84%)	24 (96%)
	2-4	11(44%)	4 (16%)	1 (4%)
	5-7	0	0	0
	8-9	0	0	0
	10	0	0	0

On the other hand, the control group reported 14 cases with no or mild pain (VAS score: 0–1) on day 1 (56%), 21 subjects on day 3 (84%) and a total of 24 subjects on day 7 (96%) after surgery (Table II). No alveolar osteitis (AO) was recorded in the test group, while only one case of AO was recorded in the control group.

**Table II.** Descriptive statistics of the test and control groups VAS at day 1, 3 and 7.

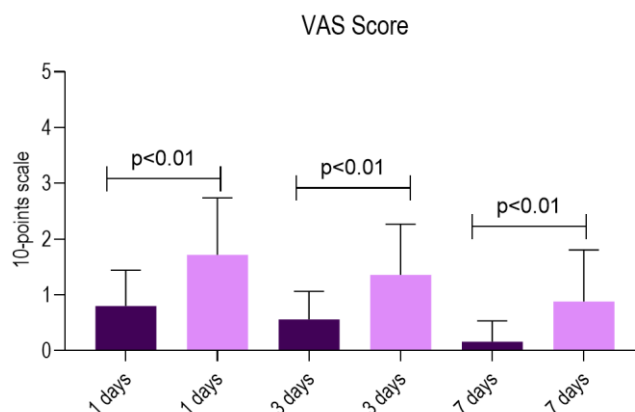
	Test Group			Control Group		
	1 day	3 days	7 days	1 day	3 days	7 days
Mean	0.8	0.56	0.16	1.7	1.4	0.88
Std. Deviation	0.65	0.51	0.37	1	0.91	0.93
Std. Error of Mean	0.13	0.1	0.075	0.2	0.18	0.19
Lower 95% CI of mean	0.53	0.35	0.0056	1.3	0.99	0.5
Upper 95% CI of mean	1.1	0.77	0.31	2.1	1.7	1.3

The means of VAS score of the test group on days 1, 3 and 7 were respectively  $0.8 \pm 0.65$ ,  $0.56 \pm 0.51$  and  $0.16 \pm 0.37$  (Tab. III). No significant differences were detected when comparing the VAS score of the test group on days 1 and 3 ( $p=0.6479$ ).

**Table III.** Kruskal Wallis followed by Dunn’s test comparison of the VAS score at the 3 different time points for each group.

Test Group- Dunn's comparisons test	Mean rank diff.	Summary	Adjusted P Value
1 days vs 3 days	6.64	ns	0.6479
1 days vs 7 days	21.44	***	0.0002
3 days vs 7 days	14.80	*	0.0175
<b>Control Group- Dunn's comparisons test</b>			
1 days vs 3 days	8.30	ns	0.3485
1 days vs 7 days	20.08	***	0.0004
3 days vs 7 days	11.78	ns	0.0773

A significant decrease was present comparing days 3 and 7 ( $p=0.0002$ ) (Table III). The means of VAS score of the control group on days 1, 3 and 7 were  $1.7 \pm 1$ ,  $1.4 \pm 0.91$  and  $0.88 \pm 0.93$ , respectively (Table III). No significant differences were detected comparing the VAS score of the control group on days 1 and 3 ( $p=0.3485$ ). A significant decrease was present comparing the days 3 and 7 ( $p=0.0004$ ). A significantly lower VAS pain score was detected comparing the test vs, control group at days 1, 3 and 7 ( $p<0.01$ ) (Fig. 4).



**Fig. 4.** Chart of the VAS comparison on days 1, 3 and 7 [Mann-Whitney test].

## DISCUSSION

The results of the present study showed that hyaluronic acid treatment reduce post-extraction pain compared to control group, while no difference was detected for AO incidence. AO incidence in this study was only one case in the control group among patients with history of AO. Thus, the preventive effect was studied in a group known to have a high risk of developing AO.

Healing of extraction sockets is a complex process involving the reconstruction of damaged soft and hard tissues, which are regulated by various cytokines (15). Different factors can alter the healing of extraction sockets such as, gender hormones, diseases, glucocorticoid steroids, non-steroidal anti-inflammatory drugs, chemotherapy, alcoholism, and smoking. For these reasons, we have selected patients who are free from systemic disease and factors that affect tissue healing.

It has been proposed that intra-alveolar application of HA promote the wound healing (16). HA is abundant present in extracellular matrices, and have an important player in vascular disease, wound healing and cancer where fibrin deposition also occurs (17,18). Jointly with fibrin, HA is a major factor of the primary matrix formed following tissue injury. HA fragments increase angiogenesis and inflammatory reactions, which are important events in wound healing and tissue remodelling. HA together human fibrinogen promote formation and modulating the fibrin matrix( 19).

HA could be a reliable tool for wound closure and the role of HA in the bone healing has been investigated (20). Recent research including 30 patients with poorly controlled diabetes required tooth extraction, 0.8% HA placed in post-extraction socket enhanced the tissue healing, in particular on the first days after application (21). The decrease in the dry socket rate with use of a hyaluronic acid further supports the significant role of HA in socket healing.

## CONCLUSIONS

In conclusion, within the limitation of our study, we concluded that the use of hyaluronic acid after tooth extraction seems to be effective in reducing pain in patients with clinical history for AO. However, additional research with a larger sample size is needed to confirm our findings.

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Case series

# IMPLANT TIP INSERTION IN THE MEDIAL WALL OF THE MAXILLARY SINUS TO OBTAIN FIXTURE PRIMARY STABILITY DURING SINUS LIFT PROCEDURE BY LATERAL WINDOW TECHNIQUE

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## ABSTRACT

Maxillary sinus lift (MSL), a cornerstone in implant dentistry, requires a deep understanding of various surgical techniques to address bone deficiencies in the posterior maxilla. MSL by lateral approach is the elective procedure in case of extreme bone atrophies of the sinus floor. When the residual bone thickness is less than 3 mm, MSL by lateral approach is possible but not immediate implant insertion due to lack of fixture primary stability. In these cases, primary fixture stability can be obtained by bi-cortical stabilization. After Scheniderian membrane elevation, the implant is inserted through the alveolar crest and fixed to the maxillary sinus mesial (nasal) wall, leading to an implant's primary stability. Here, a case series is reported.

**KEYWORDS:** *maxilla, jaw, sinus, lift, implant, fixture*

## INTRODUCTION

Insufficient bone volume is a common problem encountered in rehabilitating the edentulous posterior maxillae with implant-supported prostheses. Bone volume is limited by the presence of the maxillary sinus, together with loss of alveolar bone height. The maxillary sinus lift (MSL), a transformative surgical procedure in implant dentistry, has evolved significantly over the years, reshaping the landscape of treatment options for patients with insufficient bone in the posterior maxilla (1-17). The early days of implantology saw limited solutions for posterior maxillary edentulism due to anatomical challenges posed by the maxillary sinus. Pursuing innovative techniques to overcome these challenges has led to the development of the MSL as a cornerstone in addressing bone deficiencies. In this light, advancements in technology and materials have significantly influenced the landscape of maxillary sinus lift procedures. Two are the main techniques to approach the maxillary sinus: the lateral window technique involves creating a window in the lateral wall of the maxillary sinus, providing direct access for graft placement, while the crestal approach accesses the sinus through the alveolar crest, eliminating the need for a lateral window.

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Several systematic reviews have focused on MSL techniques. Esposito et al. (1) reviewed the literature to test whether and when augmentation of the maxillary sinus is necessary and which are the most effective augmentation techniques for rehabilitating patients with implant-supported prostheses. They found that short implants (5 mm long) can be successfully loaded in maxillary bone with a residual height of 4 to 6 mm. Elevating the sinus lining in the presence of 1 to 5 mm of residual bone height without adding a bone graft is sufficient to regenerate new bone to allow rehabilitation with implant-supported prostheses. Bone substitutes are successfully used as replacements for autogenous bone. If the residual alveolar bone height is 3 to 6 mm, a crestal approach to lifting the sinus lining and placing 8 mm implants leads to fewer complications than a lateral window approach and placing implants at least 10 mm long. Romero-Millán et al. (2) compared implant survival, marginal bone loss, and complications in dental implants placed in the posterior maxilla in native bone or after grafting using the open sinus lift technique. The authors concluded that implant placement after sinus lift affords results in terms of implant survival, marginal bone loss, and peri-implant clinical parameters like those obtained with conventional implant placement in native bone. Parra et al. (3) studied the survival rate of dental implants installed in the posterior region of the maxilla after a graft-less maxillary sinus lift via the lateral window approach to identify the factors involved in the results. Juzikis et al. (4) reviewed all the possible uses for maxillary sinus lateral wall bony windows in an open maxillary sinus lift procedure to evaluate the influence of each method on the rate of sinus membrane perforations. Authors found 4 distinct uses for bony windows: bony window is elevated into the sinus cavity under the membrane, removed and discarded, repositioned to its original position after the surgery, and used as a graft material for a sinus lift. They discovered a statistically significant difference in sinus membrane perforations between different uses of the lateral bony window of an open sinus lift procedure. Schiavon et al. (5) performed a meta-analysis that provided moderate evidence that the repositioned bone lid favored the formation of new bone to a greater extent as compared to resorbable membranes.

In the case of extreme atrophies of the maxilla, residual bone can be thinner than 3 mm. MSL by lateral approach is possible but not an immediate implant insertion due to lack of fixture primary stability. In these cases, primary fixture stability can be obtained by bi-cortical stabilization. After Schneiderian membrane elevation, the implant is inserted through the alveolar crest and fixed to the maxillary sinus mesial (nasal) wall, leading to implant primary stability. Here, a case series is reported.

## CASE REPORT

### *Case 1*

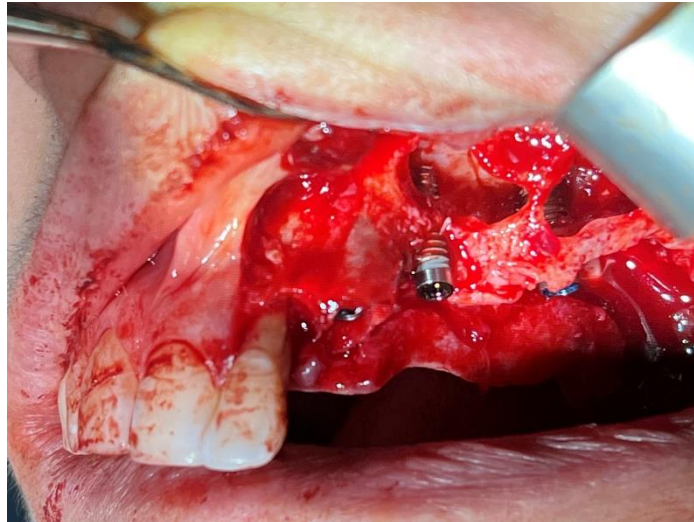
The patient presented to our clinic with complaints about her smile in 2020. She was 38 years old and was a nonsmoker. At clinical and radiological evaluation, she has a far-advanced periodontal disease (Fig. 1). A rehabilitation of the upper left and lower right implant rehabilitation was planned.



**Fig. 1.** Pre-operative X-ray.

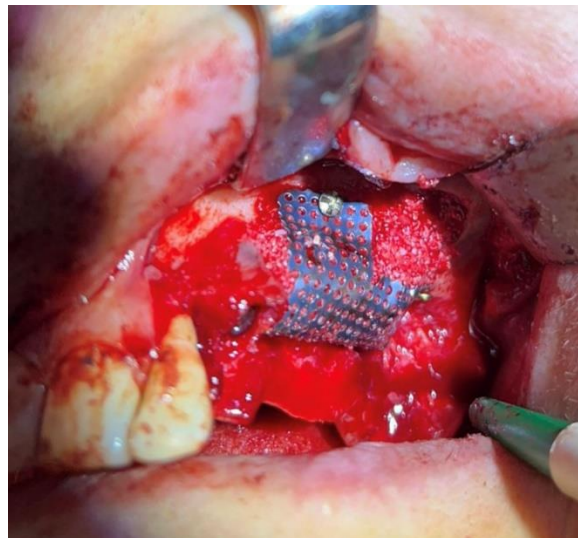
Surgically, after locoregional anesthesia and infraorbital nerve block a full-thickness flap is elevated. The lateral wall of the maxilla was exposed and an anrostomy was performed to find the Schneiderian membrane. Sinus lift was then performed with a full exposition of the medial wall of the sinus which was the target of the drill during implant osteotomy and insertion.





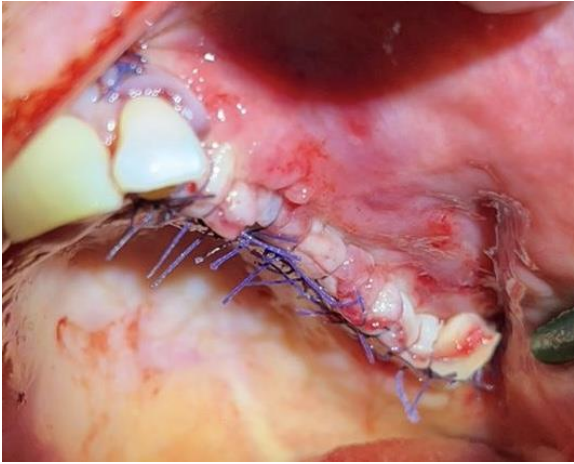
**Fig. 2.** Bone defect and inserted implant.

Implants were positioned and secured to the medial wall of the sinus, which allowed to reach a considerable torque of primary stability even in such a poor residual bone crest (Fig. 2). Autogenous bone chips were harvested from the tuberosity and the zygomatic process. Sub-sinus space was filled with heterologous bone, as well as peri-implant space. A mix of 50/50 autogenous/heterologous bone was then used in the superficial part of the grafting site. The titanium mesh was secured firstly palatal with 4 screws 4 mm long and then buccally with 3 screws. Mesh compacted bone chips (Fig. 3). Flap release was performed cutting periosteum, and a suture was performed with horizontal mattress and single stitches (Fig. 4).



**Fig. 3.** Ti-mesh fixed.

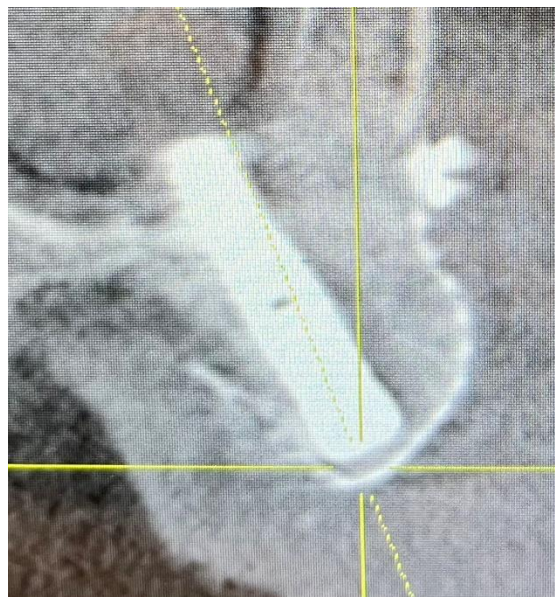
Radiographic control performed 2 weeks after surgery demonstrated the sinus lifting and the bi-cortical placement of the implant (Fig. 5, 6) with anchorage in the medial wall without perforation of the nasal membrane. After 6 months, the titanium mesh was removed, and the healing abutment was placed. Standard procedures of prosthetic rehabilitation were then done, as well as a final panorex. After 24 months, the patient had no complications.



**Fig. 4.** Suture



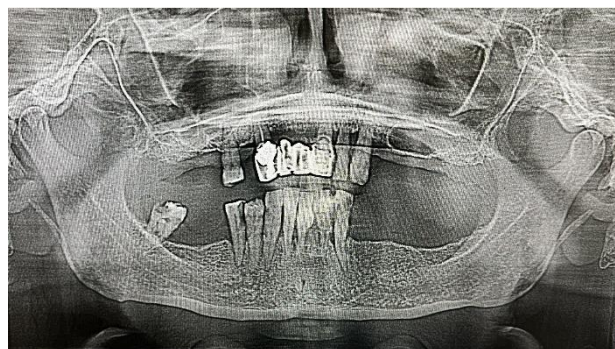
**Fig. 5.** Post-operative X-ray.



**Fig. 6.** CBCT check bicortical at 6 months

#### Case 2

The patient presented to our clinic complaining for her chewing in 2019. She was 42 years old and was a light smoker. At the clinical and radiological evaluation, she had a far-advanced periodontal disease (Fig. 7). A bi-maxillary Toronto rehabilitation was planned.



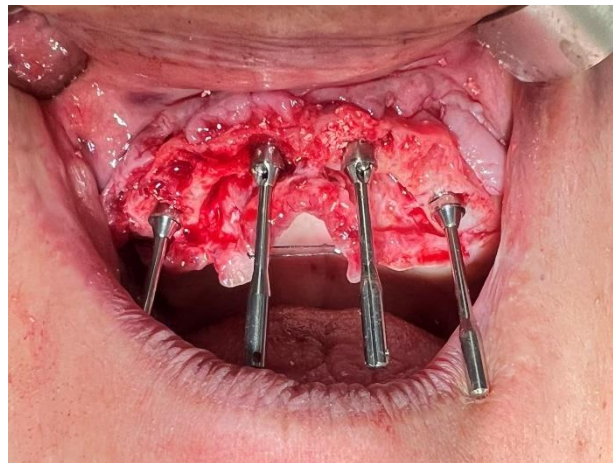
**Fig. 7.** Pre-operative X-ray.

Surgically, after loco-regional anesthesia a full thickness full arch flap was performed. Maxilla was skeletonized and bilateral antrostomy was carried out with mobilization of the Schneiderian membrane. The medial wall of the maxillary sinus was exposed and targeted with implant osteotomy (Fig. 8).



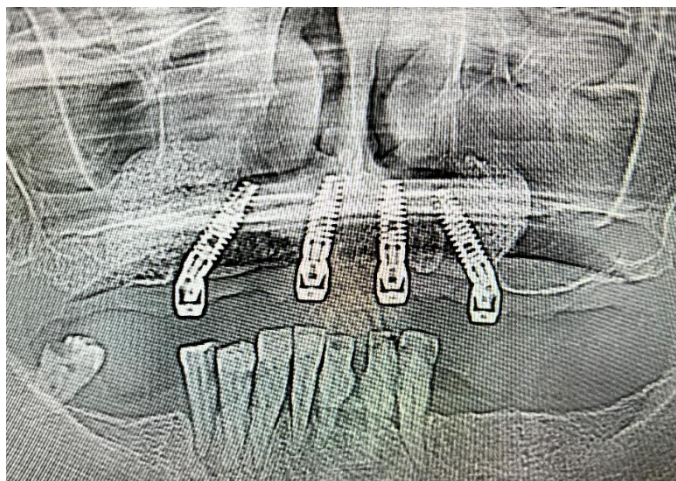
**Fig. 8.** *Right medial wall anchorage.*

Trans sinusal implants were tilted to reach a major anteroposterior spread in a transversal contracted maxilla. Poor residual bone crest would not allow sufficient primary stability to perform immediate loading but with the medial wall anchorage 60 N of torque was reached. Two additional implants were screwed in the pre-maxilla and multi-unit abutment screwed (Fig. 9).



**Fig. 9.** *Endo-oral photo showing implant orientation.*

Sub-sinus space was fulfilled with heterologous graft and antrostomy covered with a resorbable membrane. An accurate suture was done, managing the soft keratinized tissue around the healing abutment. Immediate temporary prosthesis was secured to the patient. The subsequent month the patient was operated on the mandible for placing an all-on-4 restoration. After 4 months both restorations were removed, and a final prosthetic rehabilitation was delivered as well as final X-ray control was performed. After 36 months, the patient had no complications (Fig. 10-13).



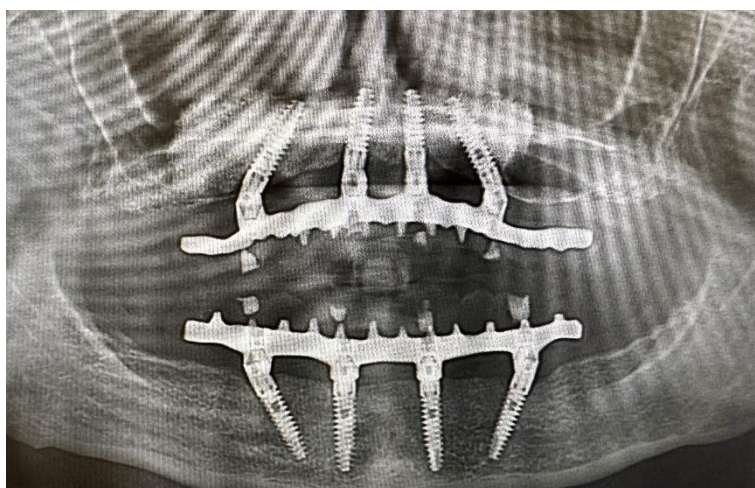
**Fig. 10.** *Post-operative X-ray.*



**Fig. 11.** *Immediate temporary rehabilitation*



**Fig. 12.** *Smile.*



**Fig. 13.** *Final X-ray.*

## DISCUSSION

The maxillary sinus lateral window technique, a pivotal procedure in implant dentistry, addresses bone deficiencies in the posterior maxilla, enabling successful implant placement (1-5). Additional solutions are also available in case of reduced bone high in maxillary floor (6-10). Potdukhe et al. (6) detected no difference in primary implant stability and increase in bone height in indirect sinus lift using osseodensification and the osteotome technique, both performed through alveolar crest. Asawa et al. (7) focused on the use of an alternative procedure in which two posterior implants are placed at an angle and two anterior implants are placed axially thereby eliminating the need for sinus lift or bone augmentation procedures.

Also, short implants are a reliable alternative to MSL (8-11). Cruz et al. (8) compared the survival rate of dental implants and rates of complications (biological and prosthetic) between short implants and long implants placed after maxillary sinus augmentation. No significant difference was observed in the survival rate or in the amount of marginal bone loss. However, higher rates of biological complications for long implants associated with maxillary sinus augmentation were observed, whereas a higher prosthetic complication rate for short implants was noted. Short implant placement is an effective alternative because of fewer biological complications and similar survival and marginal bone loss than long implant placement with maxillary sinus augmentation. The risk of mechanical complications associated with the prostheses fitted on short implants should be considered. Mokchegh et al. (9) performed a meta-analysis to investigate what would be the best choice in terms of survival rate and complications: the use of short implants or performing sinus lift and the establishment of standard implants. The results did not show a statistically significant difference in the survival rate of the two procedures over the short, medium and long term. However, the study of complications shows that in the short and medium term, the results are in favor of short implants. Consequently, compared to standard implants associated with sinus lift, short implants have the advantage of being a solution with a high survival rate, it is less expensive, requiring less surgical time, presenting fewer complications compared to advanced surgery of sinus lift and thus obtaining more patient satisfaction. Carosi et al. (10) evaluated the survival rate of short dental implants placed in the posterior area of the maxilla. Based on the evidence of the included studies, short implants ( $\leq 6$ mm) reported high survival rates over short to medium follow-up in the posterior maxilla with respect to standard-length implants plus augmentation procedures.

Another critical variable in MSL is graft material (11-16). Rickert et al. (11) performed a systematic review comparing trials where sinus floor elevations with autogenous bone (controls) were compared with autogenous bone combined with growth factors or bone substitutes, or solely with bone substitutes (test groups) were identified. They reported that bone substitutes combined with autogenous bone provide a reliable alternative for autogenous bone as sole grafting material to reconstruct maxillary sinus bony deficiencies, for supporting dental implants. Adding growth factors (platelet-rich plasma) to grafting material and the sole use of  $\beta$ -tricalcium-phosphate did not promote bone formation. Pérez-Martínez et al. (12) focused on indirect sinus lift without the use of bone graft material. They found that placement of implants with sinus lift without bone graft material is a valid surgical technique to gain residual crestal height and placed implants in an atrophic posterior maxillary with a crestal height from 5 to 9 mm. Silva et al. (13) investigated a comparative analysis of the use or not of graft material in maxillary sinus lift surgery. The implant survival rate was 96% for surgeries performed without graft material and 99% for those in which biomaterial was used, within a follow-up period of 48 to 60 months. Correia et al. (14) showed that only a few studies have demonstrated the potential of regenerative medicine in sinus lift. Lie et al. (15) evaluated the existing clinical evidence on the efficacy of graft-less maxillary sinus membrane elevation for implantation in the atrophic posterior maxilla. Results showed a high overall implant survival rate in both the graft-less and bone-grafted sinus lift groups. The graft-less sinus lift group showed a significantly lower vertical bone height gain, and a significantly lower bone density. Otero et al. (16) analyzed sinus lifting procedures to compare the efficiency of this treatment associated with platelet-rich fibrin (PRF). They found that a higher risk for implant failure after a sinus elevation might be seen in patients with residual bone  $\leq 4$  mm and PRF application was effective, suggesting reducing the time needed for new bone formation.

In case of extreme atrophies of the maxilla, residual bone can be thinner than 3 mm. In these cases, MSL by lateral approach is the only option instead of crestal approach (6) or angulated (7) and short (8-16) implants. When the maxillary sinus floor is thinner than 3 mm MSL by lateral approach is possible but not immediate implant insertion due to lack of fixture primary stability. In these cases, primary fixture stability can be obtained by bi-cortical stabilization. After Schneiderian membrane elevation, an implant is inserted through the alveolar crest and fixed to the maxillary sinus mesial (nasal) wall leading to the implant's primary stability. The reported case series shows the feasibility of this surgical technique.

Finally, particular attention should be paid to avoiding sinus membrane perforation, although suturing and doubling the Schneiderian membrane with an allograft membrane can preserve it from additional complications. In a

recent meta-analysis, Al-Moraissi et al. (17) investigated whether intraoperative Schneiderian membrane perforation in the maxillary sinus lift causes an increase in the risk of implant failure especially in terms of implant loss following the maxillary sinus lift. They found that an intraoperative Schneiderian membrane perforation could increase the risk of implant failure after sinus lift surgery.

## CONCLUSIONS

The clinical significance of maxillary sinus lifts extends beyond the technical aspects of the procedure. Implant dentistry has witnessed a paradigm shift, enabling clinicians to offer viable solutions for patients with posterior maxillary atrophy. The maxillary sinus lift, as a preparatory step for dental implant placement, holds the promise of restoring not only the patient's oral function but also their aesthetic and psychological well-being. MSL by lateral approach is the elective procedure in case of extreme bone atrophies of the sinus floor. When the residual bone is less than 3 mm thin, MSL by lateral approach is possible but not immediate implant insertion due to lack of fixture primary stability. In these cases, primary fixture stability can be obtained by bi-cortical stabilization. After Schneiderian membrane elevation, an implant is inserted through the alveolar crest and fixed to the maxillary sinus mesial (nasal) wall leading to an implant primary stability. Here a case series is reported showing the feasibility of the procedure. Additional reports with longer follow-ups have to be reported to firmly establish the advantages and disadvantages of this surgical procedure.

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Case report

# ENUCLEATION OF A GIANT RESIDUAL CYST WITH INFERIOR ALVEOLAR INVOLVEMENT: CASE REPORT WITH A 2-YEAR FOLLOW-UP

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## ABSTRACT

Residual cysts are inflammatory cysts related to dental extractions in the maxillae. Most of these lesions involve edentulous areas affected by previous surgical extractions where inflammatory cysts already existed. Residual cyst presents as well-defined radiolucency with clear margins without erosion of neighboring structures. Rhizolysis, defined as the process of resorption of hard tissues of the dental element, appears to be physiologic during permutation, pathologic in permanent elements, and a possible consequence of many dental treatments. This clinical report aims to describe a surgical treatment of a large cyst resulting from a previous extraction using a simple clot as a cavity filler. Based on clinical, radiographic, and histopathological findings, the present case was diagnosed as an infected residual cyst. The lesion was surgically enucleated; preservation of all other teeth and vital structures was achieved, with no postoperative complications and satisfactory healing.

**KEYWORDS:** *cyst, maxilla, jaw bones*

## INTRODUCTION

The maxillary bones are among the most affected by cysts because numerous epithelial remnants remain in close contact with the development of the dentition (1). Cysts can often have clinicopathologic and radiographic similarity, but they often differ in etiology and invasiveness, converging more toward what are termed neoformations (1).

Based on their origin, we classify them into odontogenic and nonodontogenic cysts. Odontogenic ones are the most common and develop from the epithelium of the early dentition. The epithelium of these cysts can be derived from the dental organ, Malassez remnants, reduced dental epithelium, and fragments of dental lamina. It is often the case that epithelial remnants can lead to the development of a residual cyst after removal of the affected tooth (2).

Underlying the etiology of residual cyst is almost always a root cyst formed apically or adjacent to an extracted tooth (2). Therefore, they present the same clinic as inflammatory but differ histologically because usually the

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inflammatory infiltrate decreases and noninflammatory fibrous collagenous tissue is present in their walls (3). They also have a thin epithelial lining that makes their identification by histopathological methods more difficult. In the literature, many studies have reported that residual cysts show active growth patterns in areas that have been edentulous for several years, often silently without giving alarm. The variable behavior of these cysts highlights the importance of further detailed studies of these often-overlooked lesions (4).

It has also been reported that cysts rarely transform into squamous cell carcinoma, and even less is known about the success of different surgical methods in their management (5). The present clinical case presents the surgical enucleation of a residual cyst in an adult subject, with a 2-year follow-up.

## CASE REPORT

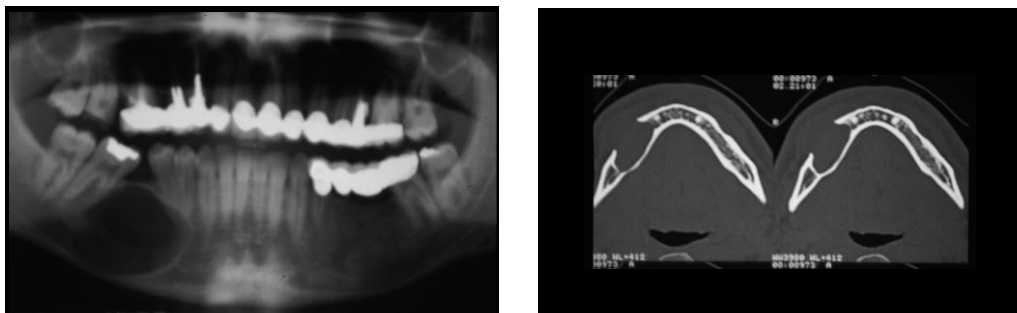
A 47-year-old male presented to the author's center with a localized swelling of the right lower jaw (Fig. 1). The swelling, according to the patient, was insidious onset, gradually progressive, non-fistulizing, involving the buccal cortical, painful on palpation. The area was already missing element 4.6, previously endodontically treated 20 years ago, with external root resorption and obvious discoloration; external examination revealed diffuse swelling on the left side of the maxilla. The overlying skin was normal and painless, and there was no associated lymphadenopathy (4). Intraoral examination revealed an intact permanent dentition, swelling in the right lower alveolus. On palpation, the surface was smooth without obvious fluctuations and showed mild bony crepitus both buccally and palatally (6).



**Fig. 1.** Intraoral photo of the buccal side with detail of the buccal swelling.

### Radiological examinations

An orthopantomography (OPG) and computed tomography (CT) scan were acquired (Fig. 2). Coronal and axial sections and three-dimensional reconstructions were performed. On OPG, the lesion appeared to have a rounded radiolucency with well-defined margins with mesiodistal extension and adjacency to the mesial roots of element 4.7 and the root of element 4.5, but without signs of rhizolysis.



**Fig. 2.** OPG and CBCT demonstrate the presence and extent of the cyst.

CT scan revealed an expansile, primarily cystic lesion measuring 13.5 mm x 12.8 mm x 11.6 mm in maximum size that had led to thinning and erosion of bone along the cyst walls in several areas. Laterally the lesion was well

circumscribed. The patient's biochemical parameters and investigations were all within normal limits (6). Ancillary tests revealed normal levels of serum calcium, phosphorus and alkaline phosphatase (7-9). Based on the clinical and radiological picture, a provisional diagnosis of residual cyst was made. In view of its clinical characteristics, which are similar to some lesions commonly found in the oral cavity, the differential diagnosis of radical cysts should include dentigerous cyst, Pindborg's tumor, periapical cementoma, traumatic bone cyst, ameloblastoma, odontogenic keratocyst and odontogenic fibroma. The confirmatory diagnosis of a residual cyst is established only after surgical biopsy and histopathological examination of the lesion (8,10-12).

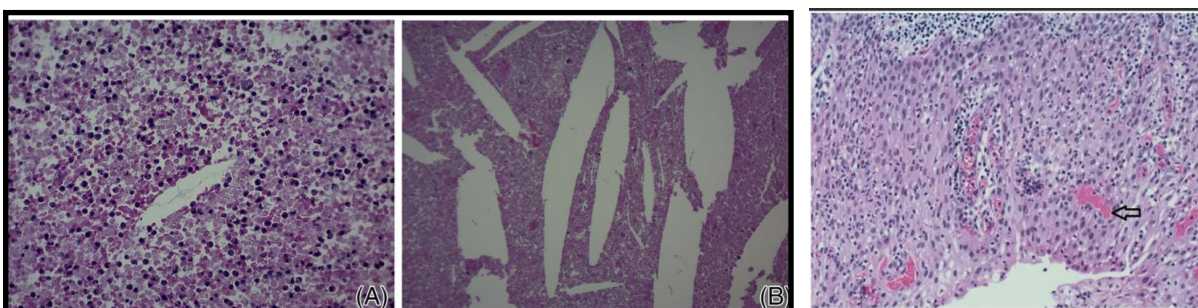
#### *Management and treatment*

Since the involved bone had multiple cortical erosion involving the buccal wall, the enucleation of the lesion was planned with tooth extraction #4.5 (Fig. 3). After lifting a thick mucoperiosteal flap, the margins of the cystic lesion were revealed.



**Fig. 3.** Full-thickness (osteomucosal) detachment of the flap with evidence of the buccal cortical bone structure and the wall of the cystic lesion.

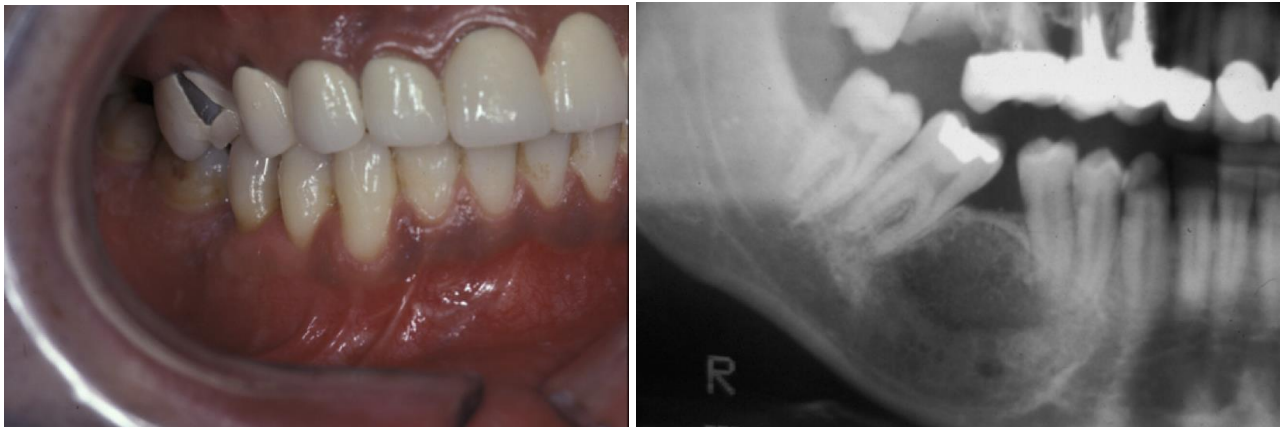
The lesion was completely removed. The defect was filled with the simple native clot without the use of biomaterials. The area was completely sutured with non-reabsorbable sutures. Appropriate antibiotics (Amoxicillin 875 mg+clavuronic acid 125 mg), pain medications (Naproxen 550 mg tablet), and dietary instructions were provided.



**Fig. 4.** Cyto-histological analysis: arcading pattern of epithelium and chronic inflammatory cells with the presence of cholesterol cleft and erythrocytes.

The surgical wound healed well after 20 days (13-15). After surgical enucleation and biopsy, histopathological examination revealed a non-keratinized layered squamous epithelium with long irregular-net-like ridges showing a

characteristic arc pattern (Fig. 4). The underlying connective tissue was vaguely fibrocellular with a chronic inflammatory infiltrate containing predominantly lymphocytes and plasma cells. Many newly formed blood vessels with areas of bleeding have been observed. Histological results confirmed the clinical diagnosis of the root cyst. The success of surgery and the total recovery of bone volumes are highlighted in Fig. 5 at the 2-year follow-up.



**Fig. 5.** *Intraoral photo and OPG demonstrating the perfect healing of the soft tissues and the continuous ossification process of the former cystic cavity at 2 years follow-up.*

## DISCUSSION

Residual cysts often have no symptomatic relevance and for this reason only a few detailed case series are available in the literature (16). The frequency of residual cysts has been reported to range from 1.4% to 18% of odontogenic cysts in the jaws. With the present clinical case, the damage resulting from the presence of cysts was evaluated. It is necessary to measure the size of the preoperative defect and the amount of defect after enucleation because the area, size and contour of the residual bony cavity influence the type of flap and any releasing incisions (17). The pathogenesis of radicular and residual cysts is similar, because the process begins with the spread of bacteria from a non-vital tooth into the periapical region of the jaw bones. If left untreated, this infection leads to the formation of a periapical granuloma that contains activated T cells that produce cytokines. These cytokines act on epithelial remnants leading to proliferation of these remnants and differentiation into cyst formation. The proliferating epithelium becomes edematous through the accumulation of fluid and coalesces to form microcysts lined by epithelial cells with inflammatory infiltrate (18). The wall of the cyst has a semipermeable membrane and therefore the cyst increases in size by osmosis. Furthermore, lytic products of epithelial and inflammatory cells increase the osmotic pressure within the cyst leading to further expansion and the formation of large intraosseous cysts (19).

Residual cysts occur mainly in middle-aged patients in the third decade of life. Most authors report that the lesion has a slightly greater predilection for males, as shown in this case report. A review by Kambalimath et al. showed in their sample that males are 3.5 times more affected than females (9).

Clinically they are often asymptomatic and can be detected incidentally on routine radiographs, such as an OPG or intraoral x-ray. However, if the cyst becomes secondarily infected, patients may report pain and swelling and become aware of the lesion. As the cyst gradually increases in size, it can cause shifting and mobility of the teeth (20-22). The patient treated in this case report comes in for pain and swelling, but the symptoms are not specific as other odontogenic lesions may have a similar presentation (23).

The culprits are therefore bacteria, their toxins, and the products of bacterial metabolism, which can reach the periapical tissues (periodontal ligament and alveolar bone) through the internal canals of the tooth, previously affected by chronic infectious pathology (pulpitis), or by necrosis, in turn almost always caused by deep caries, more rarely following trauma or deep non-carious lesions (24-25).

One of the most common complications is empyema or cystic cavity infection. In this case the typical manifestations linked to an acute infection will appear, difficult to distinguish from those of a simple alveolar abscess, with pain, swelling and increase in body temperature. Fistulization can occur in the oral cavity or, more rarely, in the skin of the face. In cases of large cysts, massive growth can lead to compression of local nervous structures, resulting in the appearance of paresthesias and subsequent disappearance of sensitivity, and to the deformation of bone and facial structures, due to its progressive externalization. Sometimes the cystic lesion can reach such a size that it poses the risk

of fracture of the affected bone. Development of ameloblastoma and squamous cell carcinoma from a radicular cyst has been reported (26-29).

In the case of very large lesions, it is necessary to proceed with surgical enucleation of the entire lesion (cystectomy or Partsch II), or, in cases in which this is not advisable due to the risk of damage to vascular-nervous bundles. The opening in the oral cavity and marsupialization (cystotomy or Partsch I) are performed (30).

The first type of operation (cystectomy) involves exposure to bone breach (31-33) and the total removal of the cystic tissue. Therefore, the closure of the cavity may involve the use of a filler (autologous or heterologous bone) to facilitate healing (31, 34, 35). The advantage of this procedure is the timing and the possibility of histological diagnosis of the entire lesion, factors that make it the first surgical choice therapy in all cases in which there is no risk of injury to the vascular and nervous bundles. In all cases, the primary cause (i.e., the infection of dental origin) must be eliminated with adequate endodontic treatment or extractions (36, 37). The recurrence rate is 3-5% within a short postoperative period.

Guided bone generation methods are in use to assist the repair process after surgical enucleation. However, there is considerable controversy regarding the use of guided bone regeneration techniques in periapical defects (38). Few studies are of the opinion that regenerative techniques are not superior, both in speed and quality of healing (39). On the contrary, other studies (40) have stated that the results of conventional treatment were lower than expected compared to cases in which regeneration methods were used (28). Among all odontogenic cysts, radicular/residual cysts have the highest potential for malignant transformation of their epithelium. It was reported that residual cysts were the cysts most frequently transformed (60%) into squamous cell carcinoma, followed by dentigerous cysts (16%) and odontogenic keratocysts (14%) (6). This further highlights the importance of performing a biopsy.

The pathogenesis of malignant transformation of odontogenic cystic epithelium remains unknown (6). Some authors have proposed that prolonged chronic inflammation may be a precursor factor for malignant transformations in the cyst epithelium. This finding is supported by the presence of chronic infiltrate of lymphocytes and plasma cells in the cystic lining of malignant cystic epithelium (41).

## CONCLUSIONS

Residual cysts present with clinical-pathological characteristics similar to more aggressive cystic lesions. Their timely management is of extraordinary importance. Biopsy and histopathological examination are the main methods of accurate diagnosis, along with radiological correlation.

Enucleation is an appropriate surgical method for the management of residual cysts with a very low recurrence rate without the need for bone regeneration techniques. In this clinical case, it was possible to obtain excellent healing of the bone structure and tissues at 24 months without the use of more invasive regeneration techniques.

### Consent

Written informed consent was obtained from the patient for publication of his clinical details and clinical images.

### Conflicts of Interest

The authors declare no conflicts of interest.

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Case Report

# SURGICAL TREATMENT OF A COMPOUND ODONTOMA ASSOCIATED WITH LOWER SECOND MOLAR GERM: A CASE REPORT

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## ABSTRACT

Among the mixed odontogenic tumors, i.e. with both epithelial and mesenchymal components, are the odontomas. These neoformations are basically classified into two types, complex and compound. The aim of this report is to present a case of a small size compound odontoma associated with the germ of a lower second molar in an 8-year-old child. The initial diagnosis was based on the radiological aspect of the lesion and the treatment choice was the conservative surgical removal of the neoformation, performed in the Clinic of Odontostomatology of San Sebastiano Hospital, Frascati (Rome). The histopathological examination gave the confirm of initial diagnosis of compound odontoma. The excision of the lesion was chosen to ensure the right eruption path of the lower second molar.

**KEYWORDS:** *compound odontoma, odontogenic tumor, child, surgery*

## INTRODUCTION

In 1869, a French physician and professor of pathology and clinical surgery, Pierre Paul Broca, wrote a monograph where he introduced various classifications of tumors, including odontogenic tumors. He coined the term “odontome” for tumors arising from the dental formative tissues and suggested classifying the lesions according to the stage of development of the tooth when abnormal growth commenced (1). After Broca's initial attempt, many classifications have been published and focused on the structural tissues which tumors grew from (2, 3)

According to Robinson, in 1952, he limited the term odontoma to those tumors that arose from both epithelial and mesenchymal dental forming tissues (4). Nowadays, this term is mainly used to define only tumors that involve tooth-hard tissues (2).

In 1971, the World Health Organization proposed to differentiate odontomas only into two main types: complex and compound (5).

Odontomas could be considered the most common type of odontogenic tumor, composed of mixed epithelial and ectomesenchymal tissues, encompassing both dental hard and soft components. Odontomas were generally considered as malformations or hamartomas rather than true neoplasms. Complex odontomas consist of a conglomeration of dentin, enamel, and cementum. Meanwhile compound odontomas is formed by small tooth-like structures (5, 6).

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The aim of this case report was to describe the surgical removal of a compound odontoma in the mandible of an 8-year-old child.

## CASE REPORT

An 8-year-old male with no relevant medical history presented in the Clinic of Odontostomatology of San Sebastiano Hospital, Frascati (Rome) in occasion of a first visit. The young patient had no previous dental consultations. The parents wanted to know how the processes of growth and teeth changes was progressing. The clinical examination did not highlight any pathological aspects related to hard and soft tissues. (Fig.1).



**Fig. 1.** *Intraoral frontal photograph of the patient.*

On the radiographic examination the attention has fallen on the gem of the left second molar. There were two small size radiopaque formations over the crown of the unerupted tooth (Fig. 2).



**Fig. 2.** *Orthopantomography of the patient. The neoformation is visible over the crown of the left lower second molar germ.*

These radiopaque formations had anatomical similarities to small normal teeth surrounded by a radiotransparent zone. The diagnosis was immediately oriented towards the compound odontoma. Hence, the treatment chosen was the surgical enucleation, to prevent eruption disturbances. After an inferior alveolar nerve block and a local anesthesia injection, a mucogingival incision was made with reflection of mucoperiosteal flap (Fig. 3).





**Fig. 3.** *Triangular flap design to access the neoformation.*

The lesion was removed, divided into two small denticules, keeping intact the germ of the second molar (Fig. 4). The primary wound closure was realized using 3-0 silk suture material. The following histopathological examination gave the confirm of initial diagnosis hypothesis of compound odontoma.



**Fig. 4.** *The odontoma removal.*

## DISCUSSION

Odontomas are benign mixed odontogenic tumors that occur during development, due to the growth of completely differentiated epithelial and mesenchymal cells, forming ameloblasts and odontoblasts. These neoformation consist mainly of enamel and dentin, but can also contain varying amounts of cement and pulp tissue (7). These lesions are characterized by slow growth and non-aggressive behaviour (8-10). These tumors may be found at any age and with no gender predilection; however, as the case presented in this paper, most are detected in the first two decades of life (11).

When enamel and dentin are arranged in a way that resembles normal teeth, the condition is called a compound odontoma. In contrast, if the dental tissues form an irregular mass without a specific pattern, it is termed a complex odontoma (12). Compound odontomas are more common than complex odontomas (13-15).

The compound odontoma presented in this case had a peculiar radiological aspect: two small denticules with a radiolucent rim, leaving not many doubts on the diagnosis. Usually these lesions are asymptomatic, so in most cases the diagnosis is occasional, unless they are large enough to cause a swelling of the jaw (10). In the case presented in this paper the diagnosis was done during a visit to control teeth changes.

However, an affected patient may present when a permanent tooth or multiple teeth that fail to erupt (11, 16). To avoid future problems in dental eruption, in this clinical case it was decided to surgically remove the tumor. Compound odontomas are lesions primarily found within the bone, although there have been rare cases reported in the soft tissues. Instances of odontomas occurring in primary teeth are scarce in the literature. Typically, these growths are more common in permanent teeth. They are usually found between the roots of erupted teeth or between deciduous and permanent teeth. The most common locations for compound odontomas are the anterior maxilla, followed by the anterior mandible, and the postero-inferior areas (10, 11). Hence, the localization of the compound odontoma in this article is therefore unusual. In the patient's anamnesis of this case, there were not relevant elements that suggest a possible aetiology of this lesion.

Usually, the aetiology of odontomas is unknown, but it could be due to trauma during primary dentition, as well as to inflammatory and infectious processes, hereditary anomalies (Gardner's syndrome, Hermann's syndrome), odontoblastic hyperactivity, or alteration of the genetic components responsible for controlling dental development (10, 17-19).

Just as the present case was approached, the treatment of choice for compound odontomas is surgical removal, followed by histopathological analysis to confirm the diagnosis (20-25).

## CONCLUSIONS

Compound odontomas are common amartomatose benign tumors with non-aggressive growth pattern and a peculiar radiological aspect. In the present case the conservative surgical removal of the lesion, even if it was of modest dimensions, it was crucial for ensuring the right eruption path of the lower second molar.

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Case report

# HOW AND WHY TO EXTRACT IMPACTED CANINES? MULTIDISCIPLINARY BEST PRACTICES FOR DENTISTRY

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## ABSTRACT

Surgical extraction of impacted canines represents a significant challenge for dentistry. It is a relatively frequent clinical problem whose management, more often than not, requires a multidisciplinary approach. Surgical exposure of the impacted canine or the complex orthodontic mechanics applied to realign the tooth in the arch can frequently lead to complications involving the supporting tissues, not to mention the lengthy treatment times and high costs imposed on patients. In the face of this, it is worth emphasizing the importance of early diagnosis to intervene effectively and as soon as possible. This clinical case combines concepts and tips, such as the prevalence, etiology, and classification of impacted canines, and describes the different clinical management options that can help solve the problem.

**KEYWORDS:** *impacted canine, oral surgery, jaws*

## INTRODUCTION

Impacted lower canines often present a challenge, as they play an important role in achieving good facial and smile aesthetics, given their strategic position above the canine eminences, which support the lower lip (1). They result in very nice anterior tooth proportions and correct smile lines when aligned correctly and with good shape and size. Regarding functional aspects, canines are equally important in supporting the overall dentition and contributing to posterior disocclusion during lateral excursions (2).

After third molar impactions, canines are the second most frequent cause of displacement and impaction among all teeth. Generally, they have an estimated prevalence ranging from 1 to 4 percent. Impacted upper canines affect about 2 percent of the population and are twice as common in females as in males (3). The incidence of canine impingement is twice as high in the maxilla as in the mandible. Of all patients with impacted lower canines, 3% have bilateral impacts (4).

Among local etiologic factors, the ectopic position of the dental germ could be considered the most important, in addition to arch length discrepancies caused by lack of space and the absence of an eruption guide, which is very

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common in cases of agenesis of lateral incisors (5). What results is a long eruptive pathway to allow the canine to reach the arch. Literature shows that only 75% of vestibular-impacted lower canines have sufficient space in the arch to erupt. In comparison, only 25% of lingually impacted lower canines have insufficient space for eruption (6).

As a result, timely diagnosis and early intervention during the mixed dentition phase are indispensable; only then can treatment time be shortened, costs reduced, and more complex treatments to be performed during the permanent dentition be avoided (7). Clinically, delayed eruption of the permanent canine is observed; prolonged retention of deciduous canines after 14-15 years of age; absence of labial canine eminence; delayed eruption and distal tipping or abnormal migration of lateral incisors. A CBCT is essential for a 3d evaluation of the included element and the best plan, either extraction or its traction (8). The limitations of 2D radiographic techniques are pretty well-known and include augmented images, other distortions, and overlapping structures. Approximately 37% of lateral incisors affected by root resorption appear normal on 2D radiographs (9). Therefore, CT is currently the gold standard for diagnosing impacted teeth. It is possible to accurately identify and localize the location of the impacted tooth, assess any damage to adjacent roots, and quantify the bone around each tooth.

The literature describes that the most significant risk is the possibility of root resorption in adjacent teeth. Studies using Cone Beam CT indicate that the percentage of root resorption in lateral incisors caused by impacted canines ranges from 19% to 54% (10).

The extraction of the impacted canine followed by the insertion of an implant or the orthodontic closure of the space is indicated in cases with poor prognosis, which is impossible in orthodontic traction (11). A deep impact represents the clinical and radiographic signs or, when the root of the canine is completely formed, when the space in the arch is restricted, or when the orthodontic displacement of the teeth involved can damage others. In all these cases, we proceed with the extraction of the impacted tooth, replacing it with an implant or a first premolar (12). Other causes, such as cysts, resorptions, or rhizolysis of adjacent teeth, are high indications for surgical extraction.

On the other hand, the indication for orthodontic traction of the affected canine is more appropriate for cases with a better prognosis, such as those of growing patients without severe arch space shortages. Treatment involves surgical exposure of the affected tooth, followed or not by orthodontic traction, which will guide and align the tooth in the arch (13). Bone loss, root resorption, and gum recession around the pulled tooth are the most common complications of this procedure. In surgical exposure to trigger the affected canine displacement, good communication between the orthodontist and the surgeon is essential to adopt the most appropriate technique (14).

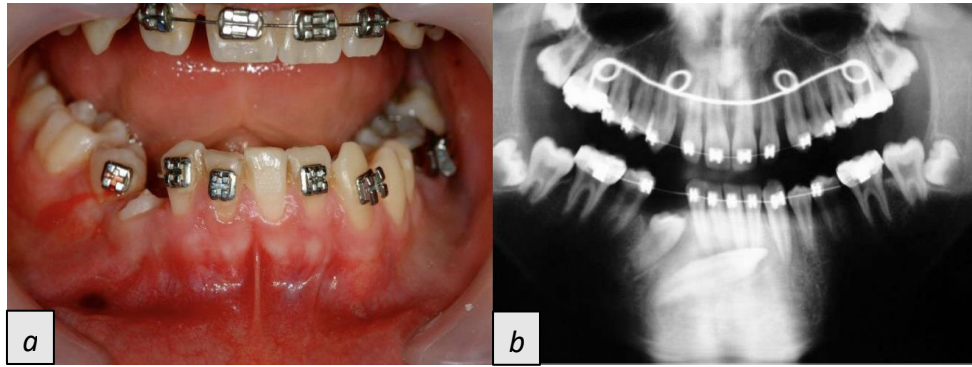
The most common traction method for palatally impacted canines involves surgical exposure followed by the bonding of the orthodontic attachment so that a light and slow force can be applied to move the tooth along the correct position (15).

## CASE REPORT

A 12-year-old male patient, in the final phase of mixed dentition and beginning permanent, came to the visit with delayed eruption 4.4 and absence 8.3. He appeared in good health without allergies, signs, and symptoms worthy of note, and he had no family history of dental impacts or severe dental ectopic events.

### *Radiological examinations*

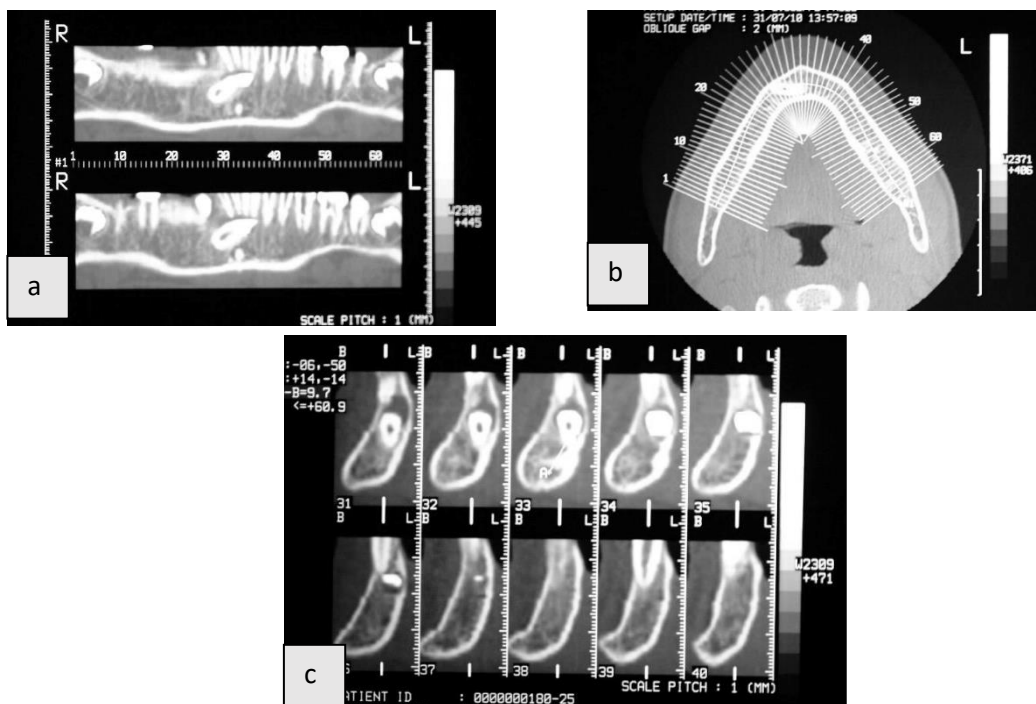
Initial panoramic radiographs revealed the presence of all permanent teeth except for the impacted lower right canine and delayed eruption of the lower right first premolar. The root contour, periodontal space, and bony ridges were normal. The CT examination confirmed the radiographic findings, where the right lower canine was angled with the crown mesially in a very apical position, displaced vestibular, and in contact with neighboring teeth (Fig. 1).



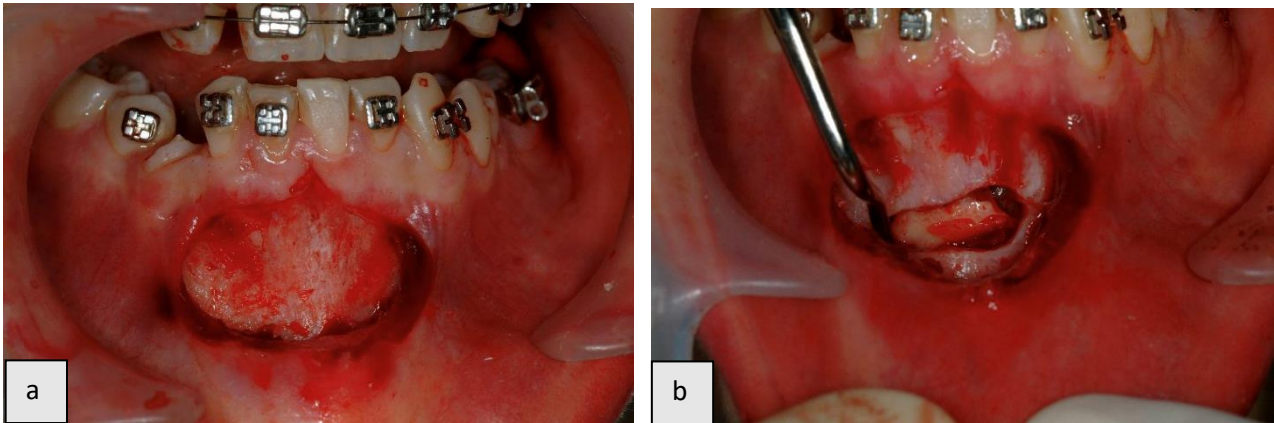
**Fig. 1a, b.** In preoperative images, one can appreciate the absence of the canine and its included apical mesioverse position.

#### Management and treatment

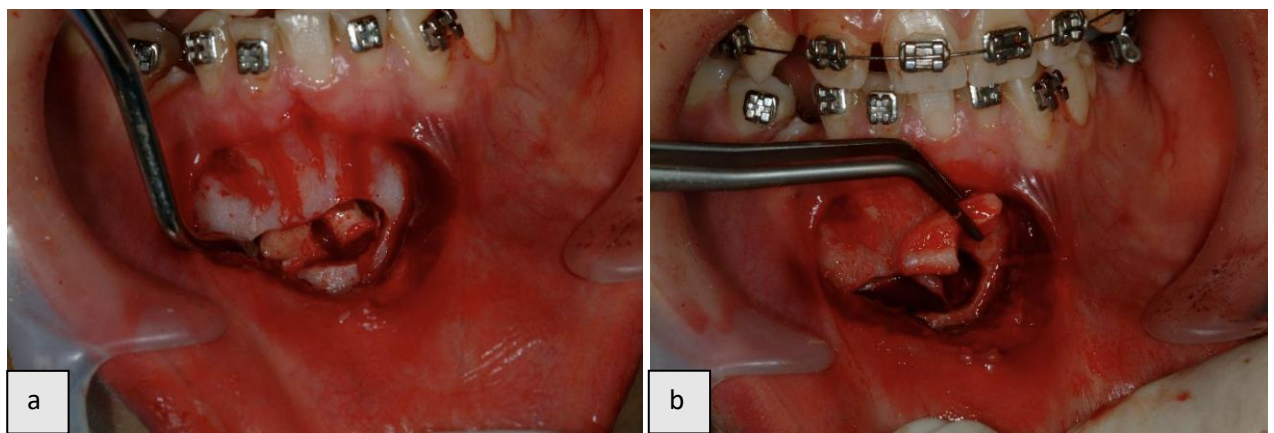
The mental vestibular cortex was exposed after raising a thick paramarginal mucoperiosteal flap. Subsequently, a bone breach was performed, and the impacted element was exposed, which was removed only after conducting a coronotomy. The area was sutured with non-absorbable sutures (Fig. 2-6).



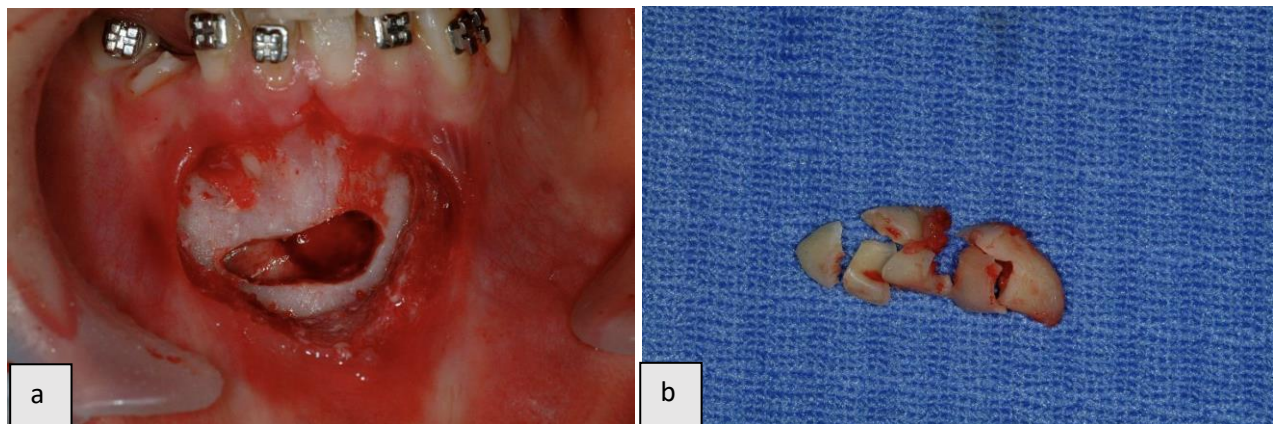
**Fig. 2a, b, c.** CBCT sections demonstrate the included hostile position of the impacted mandibular canine with signs of areas of osteolysis.



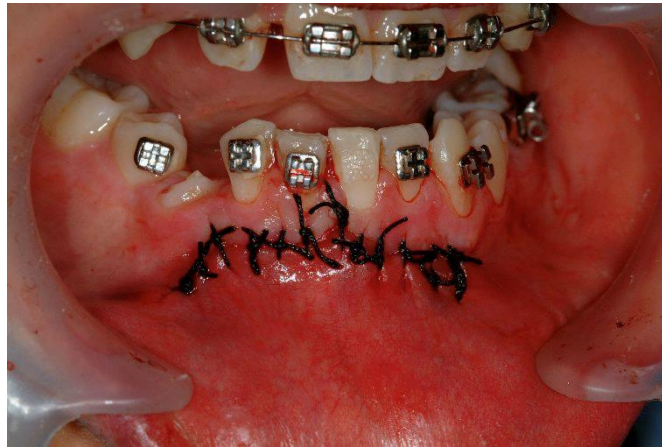
**Fig. 3 a, b.** Paramarginal full-thickness flap with relief of the mental cortical slope and impacted canine.



**Fig. 4.** Section of the impacted canine and its removal.

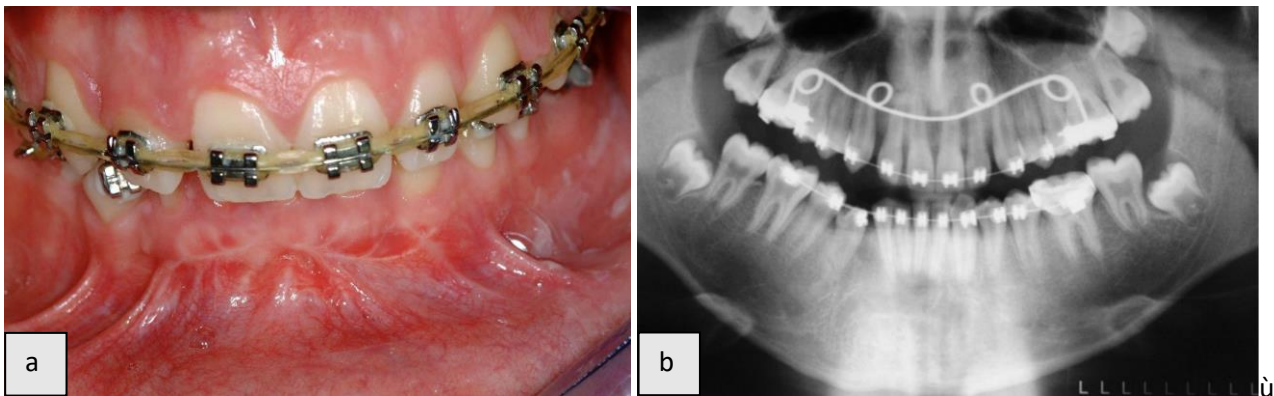


**Fig. 5 a, b.** The post-extraction cavity is free from the presence of the canine and previously dissected removed canine. Multi-part cutting of the included element facilitates its extraction and makes the procedure less invasive on the bone.



**Fig. 6.** Wound closure using 3.0 nonabsorbable sutures.

Appropriate antibiotics (amoxicillin 875 mg + clavuramic acid 125 mg), pain medications (naproxen 550 mg tablet), and dietary instructions were provided (15). The surgical wound healed well after 20 days (Fig. 7).



**Fig. 7 a, b.** 1-year follow-up images demonstrate perfect tissue and bone healing.

## DISCUSSION

Canine impaction is often defined as an intrabony position of the tooth that has passed the expected time for eruption (16). The diagnosis is always on a clinical-radiographic basis. Prolonged retention of the deciduous canine (after 14-15 years of age) and delayed eruption of the permanent canine, distal inclination, or migration of the lateral incisor are indicators of canine impaction. Differently, transmigration is a rare clinical tendency of the impacted tooth to deform the midline (17).

"transmigration" is observed mainly in the mandibular canine and very few cases in the maxillary canine; the female sex is more affected than the male sex (18). Due to intraosseous movement, the canine tooth remains impacted or erupts in the median/contralateral position. In many cases, such a canine tooth remains asymptomatic, but in some cases, it can cause displacement of adjacent teeth or resorption of the root (19). Compared to superiors, orthodontic correction of these mandibular canine cases is very difficult; untreated cases may develop dentigerous cysts. In such conditions, extraction of the impacted canine and enucleation of the cystic lining is the treatment of choice. Most commonly, the permanent mandibular canine moves in a vertical and labial direction (20). Shreya Singh has drawn up a classification of the canines included (7):

- Type – 1: canine impacted mesioangularly along the midline, labial or lingual to the anterior teeth;
- Type – 2: horizontally impacted canine near the lower edge of the mandible, inferior to the tips of the incisors;
- Type – 3: canine erupted mesial or distal to the contralateral canine;



Type – 4: horizontally impacted canine near the lower edge of the mandible, under the apices of the premolars or molars on the opposite side;

Type – 5: Canine positioned vertically on the midline, with the long axis of the tooth crossing the midline.

If the impacted canine is left untreated, it can cause further migration of adjacent teeth and loss of arch length, dentigerous cyst formation, internal resorption, infection, and external root resorption of the impacted tooth and neighboring teeth (22). For this reason, even if asymptomatic, their extraction is always recommended.

## CONCLUSIONS

Diagnosis, evaluation, and treatment of canine transmigration are essential to prevent related complications, both cosmetically and functionally. Recognizing dental abnormalities early can avoid many complications, mainly by preventing tooth extraction.

The ideal treatment to follow in this specific case is extraction of the tooth and the inflamed tooth follicle, with subsequent orthodontic treatment to stabilize the arches to provide an aesthetic and definitive solution through a dental implant once the patient's growth is finished.

### Consent

Written informed consent was obtained from the patient for publication of his clinical details and clinical images.

### Conflicts of Interest

The authors declare no conflicts of interest.

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# THE WEIGHT OF THE SCIENTIFIC ACTIVITY OF RESEARCHERS IN DENTISTRY: A BIBLIOMETRIC IMPACT UPDATE OF THE ITALIAN ACADEMY

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## ABSTRACT

The aim of the present investigation was to conduct a transversal scientometric analysis of Italian academics in the field of dentistry. The Scopus database was searched with no limitations regarding the timespan and classified according to the current list of Italian researchers, associates, and full professors. The bibliometric indicators and documents count has been used for the comparative evaluation. The cumulative articles count was  $88.88 \pm 43.79$  while the citations were  $1912.66 \pm 1471.42$ . The cumulative h index was  $20.88 \pm 9.54$ . A difference was present considering separately the study groups. The present bibliometric analysis reported a considerable impact on the scientific activity of the different academic classes. Novel dynamic indicators and correction indexes are necessary to equalize the bibliometric approach in dental research.

**KEYWORDS:** *bibliometric analysis, dentistry, oral health, teeth, bone Italian academics*

## INTRODUCTION

Dentistry is a medical field characterized by a growing impact in research medicine and science (1). In fact, oral health is strictly correlated to function and aesthetics with strong relationships with the support of the human quality of life (2, 3). These needs generated a continuous activity to identify and investigate novel therapies, biomaterials and clinical protocols to maintain the health of the mouth's hard and soft components, including the teeth and the supporting bone basis (4-6).

It is evident that the knowledge in this field, due to a multidisciplinary activity in translational research needs a constant activity of updating and validation. In this way, the universities and the public/private academies play a key role for the knowledge promotion and research in medicine, defining the technological advance in clinical protocols and in pharmacological and medical device advances (7-9). The medicine is commonly considered a bibliometric field where the scientific knowledge is generally divulged in different peer-reviewed forms including original articles, clinical studies including trials, reports/series, editorials, literature reviews, editorials (10). Other non-peer reviewed publications include books/ book chapters, letters and short communications (10, 11). Bibliometrics is a scientometric field that consider indicators to evaluate the impact of the scientific activity in several field of science and medicine (12).

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The scientometry consider quantity indicators to investigate the productivity, quality indicators to measure the performance and structural indicator to identify the connections involving different publications, researchers, academies and research fields (13, 14).

The number of scientific publications and citations/h index count represent respectively the most common quantity and quality indicators used for bibliometric measurement purposes (15). In addition, also different parameters have been introduced to classify the journal impact factor and the reference field quartiles (15). In this way, the scientific production characterization is useful to define the recent trends and orientation in medicine research. The aim of the present investigation was to study the updated scientific production of the Italian researchers in dentistry and oral medicine.

## MATERIAL AND METHODS

### Population sample

The bibliometric assessment has been conducted considering the list of Italian researchers, full and associate professors at the Italian Universities taken from the freely available national database CINECA (<https://www.cineca.it>). The data have been assessed by a special designed electronic form with the Excel software package (Microsoft Corporation, Redmond, Washington, USA). The data have been classified considering the different researchers, associate professors, and full professors of the odontostomatology diseases (MED/28) institutional category.

### Data analysis

The data were updated to 29 October 2023, using the Scopus Elsevier (<https://www.scopus.com>). The data collection was performed by two expert examiners and classified considering number of documents, citations count and h-index.

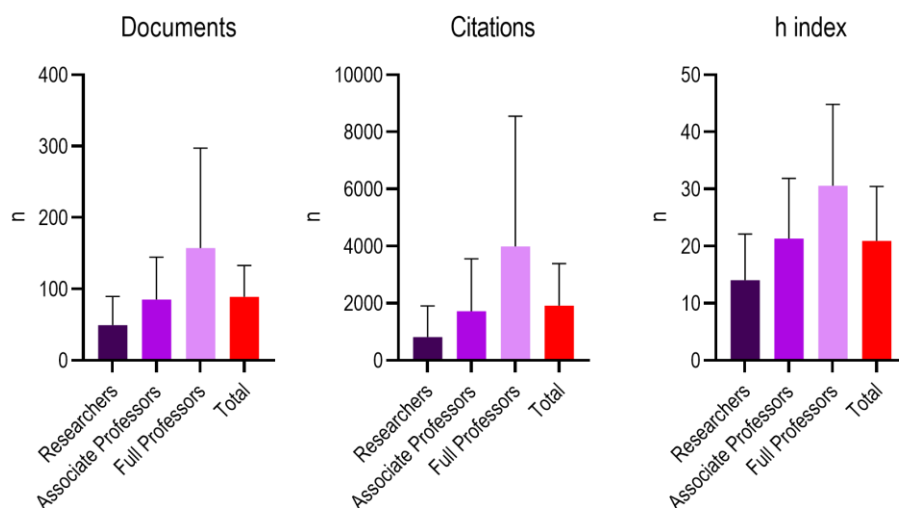
### Statistical assessment

The descriptive statistics considered the means and standard deviation of the total document citations and h-index for all researcher categories considered. The study data were elaborated through GraphPad 8.0 software package (Prism, San Diego CA. USA).

## RESULTS

### Population sample

The study data showed a total of 441 academics classified as 145 researchers, 200 associate professors, 94 full professors. A total of 39278 publications were considered for further statistical analysis (Table I). The cumulative documents and citations means were respectively  $88.88 \pm 43.79$  and  $1912.66 \pm 1471.42$ . The academics h index mean was  $20.88 \pm 9.54$ .



**Fig. 1.** Charts of the documents, citations and h index means of the three groups of Italian academics.

### Researchers

Researchers group showed a total of 7153 articles. The cumulative documents and citations mean were respectively  $49.33 \pm 40.04$  and  $814.68 \pm 1093.33$ . The researchers h index mean was  $14.02 \pm 8.09$  (Fig.1, Table I).

**Table I.** Summary of the documents, citations and h index means of the three groups of Italian academics.

### Associate professors

	Researchers		Associate Professors		Full Professors		Total	
	Mean	dv	Mean	dv	Mean	dv	Mean	dv
<b>Documents</b>	49.33	40.04	85.28	59.21	157.08	140.25	88.88	43.79
<b>Citations</b>	814.68	1093.33	1719.96	1832.81	3989.72	4552.11	1912.66	1471.42
<b>h index</b>	14.02	8.09	21.33	10.54	30.55	14.28	20.88	9.54

Associate professors group showed a total of 17359 articles. The cumulative documents and citations means were respectively  $85.28 \pm 59.21$  and  $1719.96 \pm 1832.81$ . The associate professors h index means was  $21.33 \pm 10.54$  (Fig.1, Table I).

### Full professors

Full professors group reported a total of 14766 articles. The cumulative documents and citations mean were respectively  $157.08 \pm 140.25$  and  $3989.72 \pm 4552.11$ . Full professors h index mean was  $30.55 \pm 14.28$  (Fig.1, Table I).

## DISCUSSION

The main findings of the present investigation were a wide intra-classes heterogeneity regarding the bibliometric indexes considered in the present investigation. The total documents spread was limited comparing the researchers and the associate professors.

The full professors class reported the higher quantity of documents despite the reduced population sample size compared to the researchers and associate professors' categories. These evidence were likewise remarkable considering citations and h index parameters. Considering a previous study, an increase of 5.66% the academics has been reported (7).

The comparative evaluation of the h index parameters reported a consistent increase of the total documents, citations and h index that seems to reflect an intense transversal activity of the scientific production of the categories included in the present investigation. On the other hand, the present investigation did not distinguish the contributions of the researchers affiliated in public and private universities, that could be an interesting point of view for further investigation.

The h-index and citation amounts are common indicators of quality that could be sensibly affected by a systematic bias (7, 16, 17). In fact, no correction indicators regarding the academic age has been applied, while younger researchers could be significantly disadvantaged by this approach (7, 16, 17). In addition, the MED/28 academic scientific category groups a wide range of dental specializations including oral surgery, orthodontics, prosthodontics, restorative dentistry, paedodontics.

Theoretically, the presence of different sub-categories could potentially affect the quality and quantity of bibliometric indicators that could be separately approached (18). In this way, the introduction of more dynamic approaches and indicators is necessary to investigate equally the different classes. Another limit of the investigation was the continuity of publication, which was not an object of the present study.

The recent increase in open-access indexed journals represents a notable turning point for the research activity and the continuous education of clinicians (19, 20). The free access to a wider range of scientific products is able to elevate exponentially the knowledge in all medical fields. Still, the current bibliometric system is not able to detect the impact of the science system and its clinical relevance in the medicine and dentistry community. At the same time, the common indicators, including citations and h index, remain the reference for all basic science fields (19).

## CONCLUSIONS

Within the limits of the present exploratory investigation, the present bibliometric report revealed the transversal trends and the scientific impact of the activity of Italian researchers in dentistry. A consistent increase of the quality and quantity indicators has been detected for all academic groups considered.

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Review

## BURNING MOUTH SYNDROME: DIAGNOSIS AND THERAPY

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### ABSTRACT

Burning mouth syndrome (BMS) is an oral chronic pain disorder denoted by burning, stinging, or itching the oral cavity without any organic disease. Symptoms can involve the tongue, with or without extension to the lips and oral mucosa. The etiopathogenesis is complex: local, systemic, and psychological factors are involved in causing oral burning and painful symptoms. The major challenge for the clinician is the treatment: identifying the possible causative factors for the BMS is the first step since treating or eliminating these factors could lead to a significant clinical improvement of oral burning and pain symptoms. Considering the growing incidence of BMS in older people, further research is required to determine the efficacy of current management strategies for patients with this disorder. This review aims to report the most recent data concerning BMS to give the clinician a more comprehensive idea of the disease.

**KEYWORDS:** *pain, oral cavity, neuron, disease, Burning Mouth Syndrome*

### INTRODUCTION

Burning mouth syndrome (BMS) is an oral chronic pain disorder denoted by burning, stinging, or itching of the oral cavity without any organic disease. Symptoms can involve the tongue, with or without extension to the lips and oral mucosa (1, 2). Moreover, dysgeusia (distortion in the sense of taste) and subjective xerostomia can be present. Its beginning is spontaneous, and the syndrome has an apparent predisposition in the geriatric patient, primarily women (3, 4).

BMS can be primary or secondary. Primary BMS, also named essential or idiopathic BMS, is a condition where organic local or systemic causes cannot be identified and is likely to have a neuropathological cause.

Secondary BMS is a variant resulting from local or systemic pathological conditions like lichen planus, candidiasis, coeliac disease, hormonal disturbances, psychosocial stressors, vitamin or nutritional deficiencies, diabetes, dry mouth, contact allergies, galvanism, parafunctional habits, cranial nerve injuries (5, 6). Evidence suggests a neuropathic mechanism of disease (7). Oral mucosa biopsies of patients with BMS demonstrated decreased density of epithelial nerve fibers and axonal derangement, indicating a potential role for peripheral small-fiber sensory neuropathy (8).

Blink reflex abnormalities, suggesting brainstem pathology or peripheral trigeminal neuropathy, as well as sensorial modifications such as hypoaesthesia, probably due to peripheral small-fiber neuropathy, have also been described in patients with BMS (9). Lin et al. (10) reported that BMS patients had higher hemoglobin, iron, and vitamin B12 deficiency frequencies, abnormally elevated blood homocysteine levels, and serum gastric parietal cell antibody positivity compared to healthy control individuals. Psychological and psychiatric disorders are present in up to 85 % of

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BMS patients, with anxiety, depression, cancerophobia, hypochondria, and insomnia being the most common diagnoses (11, 12).

Sleep dysfunction may also have a role in BMS (13). A cross-sectional, case-controlled study demonstrated that patients with BMS report more sleep disturbances than age and sex-matched controls with various oral conditions. The authors suggest that sleep dysfunction may be a risk factor and a possible target for treating BMS (14).

Literature reports that patients affected by BMS also presented gastroesophageal reflux disease, hypertension, hypercholesterolemia, autoimmune disorder, thyroid disorder, and anemia (15). Lately, evidence for chorda tympani hypofunction in BMS has been proposed (16), supporting the hypothesis that the tonic inhibition of the sensory pathways of gustatory activity is dysfunctional in BMS patients (17). Grushka et al. (18) suggested that BMS could be linked to hyperactivity of the trigeminal nerve's sensory and motor components due to a loss of central inhibition due to taste damage in the chorda tympani and the glossopharyngeal nerves. The consequence might be higher activity in the mastication and intrinsic tongue muscles. Further studies into the dopaminergic pathway of central pain modulation are essential.

Hagelberg (19) showed decreased endogenous dopamine levels in the putamen in BMS patients. These data are coherent with a theory of presynaptic dysfunction of the nigrostriatal dopaminergic pathway of central pain modulation in BMS. Moreover, thermal stimulation in BMS patients was likened to increased cerebral blood flow, as detected in functional magnetic resonance imaging (20).

In addition, it seems that estrogens work as neuroprotectants of the nigrostriatal dopaminergic system (21, 22), explaining the correlation between menopause and BMS.

This review aims to report the most recent data concerning the diagnosis and treatment of BMS to able to give the clinician a more comprehensive idea of the disease.

### *Diagnosis*

Based on the symptom's framework, clinical classification of BMS has been proposed (23, 24). Three types have been recognized: Type 1 is represented by a pain-free wake-up, with a burning sensation slowly growing in severity during the day and reaching its extreme intensity by the evening. This type affects about 35% of patients and is connected to systemic disorders like nutritional deficiency and diabetes mellitus. In Type 2, symptoms are constant throughout the day. Patients fall asleep with difficulty and usually have psychological disorders. Type 3 BMS is characterized by discontinuous symptoms, with pain-free daytime periods. Commonly, these patients constitute 10% of total patients and show allergic reactions (23, 24).

Current diagnostic criteria consist of constant daily pain in the mouth with normal oral mucosa after excluding local and systemic diseases (25). The International Headache Society first categorized it as a distinct disease in 2004, which described primary BMS as "an oral burning sensation for which no medical or dental cause can be found".

The burning mouth symptoms or pain should be felt deep within the oral mucosa for at least 4-6 months, almost daily. They are never aggravated but almost always are alleviated by eating or drinking. Other symptoms such as xerostomia, oral dysgeusia, a spontaneous metallic taste, abnormal sensory/chemo-sensory, mood changes, and specific personality traits of patients may also help identify the BMS. In addition, patients with BMS show no clinical sign of objective basis of any pathology of the oral mucosa (26). Therefore, the clinical diagnosis is based on thoroughly examining the patient's medical history and carefully analyzing the data obtained from physical and laboratory examinations.

### *Therapy*

The treatment aims mainly to manage the disease as a type of chronic neuropathy (25). As a first step, in a patient affected by BMS, it is essential to exclude different possible causes like local or systemic causes (galvanic current, parafunction, mechanical irritation, allergic reactions, anemia, mineral or nutritional deficiencies, drugs and metabolic, infections, genitourinary, gastrointestinal, neurological, psychiatric disorders).

Following a consultant, it would also be advisable to replace drug therapies that may interfere with the onset of BMS (such as ACE inhibitors). The cure for BMS, however, remains difficult despite the different classes of drugs attempted. The variable response rate to medical therapy is most likely related to the idiopathic BMS.

BMS treatments can be topical and/or systemic. Several topical treatments have been evaluated to treat BMS. Capsaicin acts on the sensory afferent neuron, and topical capsaicin can be used as a desensitizing agent or an analgesic to treat oral mucosal burning (26). However, capsaicin is difficult to accept because of its taste. Furthermore, it generally causes an increase in the burning sensation at the beginning of the therapy (27). In a prospective study with 30 subjects with BMS, a capsaicin rinse (0.02 %) significantly reduced VAS from baseline over placebo (13). Nevertheless, there were seven drop-outs, which may suggest limitations to the treatment due to side effects (28).



Clonazepam is an agonist of butyric acid gamma-amino (GABA). Local application of clonazepam may reduce the sting, despite its systemic adverse effects (26). Lozenges clonazepam is efficacious in patients with predominantly peripheral BMS. Barker et al. (29) noted that a higher percentage of patients reacted to clonazepam (71.4%), but patients also responded to diazepam (55.1%), and there were no statistical differences between the two treatments. Lidocaine and 0.15% benzydamine hydrochlorate have anesthetic effects and are anti-inflammatory. Both are used as a mouthwash to reduce pain or burning symptoms. In any case, they cannot be applied as an effective therapy because of the short duration of the analgesic effect (30).

Aloe vera gel application, combined with a tongue protector, has effectively reduced burning and pain when applied three times daily (31).

It has been observed that systemic capsaicin (0.25%, three times a day, for 30 days) significantly improves pain symptoms compared to a placebo group (26). However, it cannot be used in long-term therapy because, after four weeks of treatment, 32% of patients reported gastric pain (32).

Systemic clonazepam (0.5 mg/day) has effectively reduced BMS symptoms. Amos et al. (33) used combination therapy with clonazepam topical and systemic. Patients were asked to dissolve the tablet clonazepam (0.5 mg/tablet, three times daily) orally before swallowing and were followed for six months. 80% of patients obtained more than a 50% pain reduction during the treatment period. One-third of the patients had complete pain resolution, suggesting the combined treatment's effectiveness.

The alpha-lipoic acid is a powerful antioxidant with a mitochondrial coenzyme neuroprotective effect. It is also an antioxidant that can increase intracellular glutathione levels and eliminate free radicals. Authors (34) have tried alpha-lipoic acid in the 600 mg daily dose for more than two months in treating patients with BMS. Other studies concluded that alfa lipoic acid is inefficient in BMS treatment.

A study by Maina et al. (35) explored the effectiveness and tolerability of Amisulpride (50 mg/day) and selective serotonin reuptake inhibitors (paroxetine 20 mg/day, sertraline 50 mg/day) in BMS treatment for eight weeks. All three treatments were effective in reducing pain and burning, with Amisulpride showing the best results in a shorter time and better compliance. Cognitive-behavioral therapy, when combined with drug therapy in weekly one-hour sessions lasting 12-15 weeks, significantly reduced BMS symptoms in comparison to placebo control (36).

However, it is crucial to note that some studies report high placebo response rates (10). Well-designed prospective multicenter studies are imperative to establishing the efficacy of BMS treatments. These studies should incorporate a substance placebo, a standardized protocol for instructions, and a long-term follow-up analysis to determine the treatment's effectiveness compared to a placebo (7).

## CONCLUSIONS

BMS is a reasonably common chronic intraoral pain disorder in peri/post-menopausal women, classically described by intractable burning that may be linked with dysgeusia and xerostomia.

The etiology of BMS is multifactorial, and a secondary form of BMS should be diligently sought for and treated. The etiopathogenesis of BMS is complex: local, systemic, and/or psychological factors are involved in causing oral burning and painful symptoms. BMS has also been found to be associated with either peripheral nerve damage or dopaminergic system disorders.

The major challenge for the clinician is the treatment of BMS: identifying the possible causative factors for the BMS is the first step since treatment or elimination of these factors could lead to a significant clinical improvement of oral burning and pain symptoms. This condition, however, often is idiopathic; in this case, drug therapy should be instituted. In addition, psychotherapy and behavioral feedback may also help eliminate the BMS symptoms. In conclusion, further research is required to determine the true efficacy of current management strategies for patients with this disorder.

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