# GINGIVAL RECESSION IN CANINES ORTHODONTICALLY ALIGNED: A NARRATIVE REVIEW

## Recessão gengival em caninos ortodonticamente alinhados: uma revisão narrativa

| Access this article online | |
|---|---|
| Quick Response Code: | Website: https://periodicos.uff.br/ijosd/article/view/57027 |
| | DOI: 10.22409/ijosd.v3i62.57027 |

**Autores:**
**Cecília Fersura Farsoun**
M.Sc.; Fernando Pessoa University - Porto, Portugal

**Filipe Castro**
M.Sc.; Fernando Pessoa University - Porto, Portugal

**Anthony Farsoun**
M.Sc.; European Center of Postgraduation, Porto, Portugal

**Joseph Farsoun**
M.Sc.; Private Office, Ireland

**Juliana Campos Hasse Fernandes**
DDS; Private Office, Ann Arbor, MI, U.S.A.

**Gustavo Vicentis de Oliveira Fernandes**
M.Sc.; European Center of Postgraduation, Porto, Portugal
Ph.D.; Periodontics and Oral Medicine Department at the University of Michigan School of Dentistry, Ann Arbor, MI, U.S.A.

**Correspondence address:**
Gustavo Vicentis de Oliveira Fernandes
1011 North University Ave.
Periodontics and Oral Medicine Department – University of Michigan School of Dentistry
+1 (734) 736-2105
gustfernandes@gmail.com

## ABSTRACT

Background: The orthodontic traction of impacted canines represents a great challenge for Orthodontics. Surgical exposure of the impacted canine and the complex orthodontic mechanics applied to align the tooth back to the arch can lead to complications involving supporting tissues inducing gingival recession when the teeth are moved out of the alveolar bone. Aim: The aim of this study is to present an updated bibliographic review of the main periodontal results found in the literature after the clinical management of impacted canines and the prevalence of gingival recession. Materials and methods: Research in electronic databases PubMed, PMC, and MedLine until June 2020 and reference lists of relevant publications were used to identify studies that assessed the periodontal status of impacted and orthodontically tractioned canines. Controlled and randomized clinical trials, literature reviews, systematic reviews, studies in humans, meta- analyzes and text that had at least one occurrence relating to gingival recession, periodontal outcomes and impacted canines tractioned orthodontically, whether by buccal or palatal, superior and / or lower as the eligibility criteria. Results: 691 articles were found in a free search. After applying the eligibility criteria, 7 relevant articles were subtracted, and these results were more frequent for upper canines. Conclusion: Currently, there is no clear evidence to determine which surgical technique procedure is better to discover canines in terms of periodontal outcomes. The results found stated that clinically the evidence were insignificant when compared to teeth normally erupted.

**Keywords:** “Gingival Recession”; “Orthodontic Traction”; “Impacted Canine”.

## RESUMO

Introdução: O tracionamento ortodôntico de caninos inclusos representa um grande desafio para a Ortodontia. A exposição cirúrgica do canino impactado e a complexa mecânica ortodôntica aplicada para alinhar o dente de volta ao arco podem levar a complicações envolvendo os tecidos de suporte, induzindo recessão gengival quando os dentes são movimentados para fora do osso alveolar. Objetivo: O objetivo deste estudo foi apresentar uma revisão bibliográfica atualizada dos principais resultados periodontais encontrados na literatura após o manejo clínico de caninos impactados e a prevalência de recessão gengival. Materiais e métodos: Foram feitas pesquisas eletrônicas no PubMed, PMC e MedLine até junho de 2020 e uma listas de referência de publicações relevantes foram usadas para identificar estudos que avaliaram o estado periodontal de caninos impactados e tracionados ortodonticamente.

Ensaios clínicos controlados e randomizados, revisões de literatura, revisões sistemáticas, estudos em humanos, metanálises e textos que tiveram pelo menos uma ocorrência relacionada a recessão gengival, desfechos periodontais e caninos impactados tracionados ortodonticamente, seja por vestibular ou palatino, foram os critérios de elegibilidade. Resultados: Foram encontrados 691 artigos em busca livre. Após a aplicação dos critérios de elegibilidade, 7 artigos relevantes foram subtraídos, sendo esses resultados mais frequentes para caninos superiores. Conclusão: Atualmente, não há evidências claras para determinar qual técnica cirúrgica é melhor para descobrir caninos em termos de resultados periodontais. Os resultados encontrados afirmaram que clinicamente as evidências foram insignificantes quando comparadas a dentes normalmente erupcionados.

**Palavras-chave:** “Recessão Gengival”; “Tracionamento Ortodôntico”; “Canino impactado”.

## INTRODUCTION

The gingival recession refers to the exposition of the root surface caused by this article dislocation of the gingival border to the cement enamel, which may occur in a localized or generalized form, resulting in esthetical problems, and leading to dental hyper sensibility and root cavity. Amongst the main etiological factors are periodontitis, natural remission of the tissue through aging, traumatic dental brushing, tobacco and intraoral and perioral piercings, atypical dental morphology, bone width anatomically reduced or with thin gingival biotype (GEBISTORF et al., 2018; BAKER, 2020).

The orthodontic treatment can prevent the recession and even contribute to their treatment with or without an approach by the periodontist depending on the type and severity of the compromise of the gingival tissue. There is no evidence that the orthodontic treatment may induce, in a primary way, the gingival recessions, even though it may lead the concern teeth (commonly, the inferior incisive and the upper canines) to situations which act as predisposing factors so that the direct causes may act and reduce recessions - especially, when a very thin buccal bone plate is left, or even, with dehiscence influencing the progression of the recession (JATI et al., 2016; OZ & CIĞER, 2018).

The canines are the second most frequent cases of dental dislocation and impaction followed by the third molars. In general, they present an estimated prevalence, which varies from 1 to 4%. The impaction incidence is twice higher

in the maxilla if compared to the mandibular, reaching about 2% of the population and they are twice as common in female individuals then in male individuals. From all the patience, which presented affected upper canines, 8% have bilateral impactions. Furthermore, two thirds are affected by the palatine side, while only 1/3 involve impaction by buccal (SPUNTARELLI et al., 2015; CRUZ, 2019).

Several etiological factors were associated with the canine impaction such as: lateral incisive absence and or anomalies, ectopic position of the dental germ, presence of obstacles for the eruption or genetic factors. The impaction of an anterior tooth may lead to a functional or aesthetical compromise and, possibly, other complications, such as diastema, crowding, root reabsorption in adjacent permanent teeth and cysts (OZ & CIĞER, 2018). Therefore, it is necessary the early and precise diagnosis of an impacted canine, and the treatment is generally started straight by the elimination of any obstruction to the normal path for eruption, to provide enough space and adequate direction for the subjacent canine given the high aesthetical and functional value of the canines.

Several procedures for the management of the impacted canines are presented: early intercepting approach, surgical exposition of the crown followed by orthodontic orientation on the dental Arch or autogenous dental transplantation. If an abnormality is not be corrected solemnly by the interceptive treatment, the surgical and orthodontic approaches may be reached through two basic surgical techniques: closed technique or closed eruption technique (CT) and the open technique or open excisional technique (OT) (SMAILIENE et al., 2013; BOLLERO, et al., 2017; CASSINA, et al., 2018; CRUZ, 2019; LEE et al., 2019; IZADIKHAH et al., 2020; MAHARDAWI et al., 2020).

Therefore, when the surgical exposition of the crown of the canine and its orthodontic alignment is the treatment option, it may lead to different periodontal Health state and frequently be related to structural damage to the periodontal support. Such complications may be observed in the form of gingival recession, alveolar bone loss and/or attached gingiva, gingival inflammation, and periodontal illness (TORRES-LAGARES et al., 2015; CAPRIOGLIO et al., 2017; OZ & CIĞER, 2018; IZADIKHAH et al., 2020).

The literature is not completely clear, and it still is a controversial subject for the periodontal results may depend on the impact location if it is by palatine or buccal; the level of depth of the impaction and the surgical technique which was employed. Beyond that, there are controversial findings regarding the periodontal results after surgical exposition and subsequent orthodontic alignment; Therefore, noticing the relation between the guided eruption of the

impacted maxillary canines and the periodontal results will be the base for this review (INCERTI-PARENTI et al., 2016; BOLLERO, et al., 2017; MUMMOLO et al., 2018; LEE et al., 2019).

## MATERIALS AND METHODS

### Study classification

It is a literary review, which aims to investigate whether the gingival recession is or is not associated with the orthodontic traction meaning of canines.

### Inclusion criteria

The construction of this review was made based on our research from June 2020, having English articles published in the last five years included in it. From the several articles researched these ones were selected by title, then by reading the abstract and finally by reading the complete article (Table 1).

### Exclusion criteria

The exclusion criteria were the ones, which did not fulfil the relevant information for the topic, the ones in languages different from the ones previously defined or the ones, which were not available in full, duplicated articles, editor letters, opinion articles, simple reviews, and animal studies (table 1).

**Table 1.** Selection of Studies Criteria

| Inclusion criteria | Exclusion criteria |
|---|---|
| Last five years - language: English - full text available; clinical studies;<br>Controlled and randomized clinical studies;<br>Studies in Humans;<br>Systematic Reviews; Meta-Analysis;<br>Comparative studies; Original studies: prospective and retrospective; case reports; studies of impacted upper canines; buccal or palatalized; Tractioned with or without surgical technique which contain periodontal results to verify the gingival recession. | Studies older than 5 years;<br>Not available in full;<br>Duplicated articles;<br>Letter to the editor;<br>Opinion articles;<br>Simple Reviews; Animal Studies;<br>Articles in a different language;<br>Studies, which also include other teeth than upper canines and do not approach each group of teeth separately and do not contain clinical results. |

### Research instruments

The bibliographic database chosen to support this paper were: PubMed/MedLine and PMC. The following key words were used: “gingival recession”, “orthodontic traction"; “impacted canine”. For a better search efficiency, controlled vocabulary was used so that, to answer to this reality, it

was not limited only to the MeSH (Medical Subject Headings) and to the DECs (Descriptors in Health Sciences). The construction happened in the following way: Gingival recession is the qualifying term: "gingival recession"[MeSH Terms]; Orthodontic tractioned canines, is the main subject, using the terms: “orthodontic traction”, “impacted canine”, “impacted tooth”. The search strategy was constructed also using the descriptors "periodontal index"; "orthodontic*"; "tooth, impacted" and "cuspid*" To meet the research objective as shown on table 2:

**Table 2.** Search Strategy

| PubMed/MedLine and PMC | | |
|---|---|---|
| Nº of the Research | The research included the keywords [MeSH Terms]: "periodontal index"; "gingival recession"; "orthodontic*"; "tooth, impacted"; "cuspid*". | Items Found (Free Research) |
| 1 | ("periodontal index"[All Fields] OR "gingival recession"[All Fields] OR "orthodontics"[All Fields]) AND ("tooth, impacted"[MeSH Terms] OR ("tooth"[All Fields] AND "impacted"[All Fields]) OR "impacted tooth"[All Fields] OR ("impacted"[All Fields] AND "tooth"[All Fields])) AND ("cuspid"[MeSH Terms] OR "cuspid"[All Fields] OR ("canine"[All Fields] AND "tooth"[All Fields]) OR "canine tooth"[All Fields]) | 639 |
| 2 | ("gingival recession"[MeSH Terms] OR ("gingival"[All Fields] AND "recession"[All Fields]) OR "gingival recession"[All Fields]) AND (orthodontic[All Fields] AND ("traction"[MeSH Terms] OR "traction"[All Fields])) AND (("tooth, impacted"[MeSH Terms] OR ("tooth"[All Fields] AND "impacted"[All Fields]) OR "impacted tooth"[All Fields] OR "impacted"[All Fields]) AND ("humans"[MeSH Terms] OR "humans"[All Fields] OR "canine"[All Fields])) | 52 |

## RESULTS

The results obtained were 691 articles from a free search. In order to identify the studies that would contemplate these results, at first titles, abstracts and keywords were read. Consequently, titles that did not match the eligibility criteria were excluded. After reading them in full, 7 articles were subtracted, from a more detailed analysis to obey the Eligibility criteria - Table 2. It is worth noting that from these 7 articles the types of studies were considered: controlled and randomized clinical studies, Literature reviews, systematic reviews, human studies, meta-analysis, and texts which had at least one occurrence related to gingival recession, periodontal an impacted canines orthodontically tractioned, may it be by buccal or Palatine, Upper and / or inferior. However, the results had bigger occurrences for Upper canines - table 3. Other studies were identified and included on topic II.I. Discussion, due to the importance based on evidence for the topic.

**Table 3.** Results found.

| Research | 10 years | 5 years | Title Reading | Abstract Reading | Reading in Full |
|---|---|---|---|---|---|
| 1 | 177 | 83 | 19 | 9 | 5 |
| 2 | 44 | 28 | 8 | 4 | 2 |

**Table 4.** Excluded articles after reading in full text.

| |
|---|
| (SCHUBERT *et al*., 2016): Addresses a little about periodontal problems due to ortho-surgical tractioning. Clinical case which also includes results about other teeth than canines. |
| (NOWZARI & RODRIGUEZ, 2019): The study includes other teeth than canines; 80% of the cases were canines but differentiated as to the location of impact if palatine or buccal; other results than only periodontal. |
| (ZADEH *et al.*, 2019): Subperiosteal tunnel technique of vertical incision (VISTA) without periodontal results. |
| (VIWATTANATIPA & CHARNCHAIRERK, 2018): Results only for the conventional canine retraction. |
| (TORRES-LAGARES *et al.*, 2015): Presents only histological results comparing with the adjacent premolar not mentioning the clinical periodontal results without relevance for gingival recession. |
| (CASSINA *et al*., 2018): Compares the open surgical exposition of impacted canines with the closed approach for results in the treatment length, post-operative pain, and ankylosis risk without mentioning any periodontal results. |

**Table 5.** Selected articles (last 5 years).

| (INCERTI-PARENTI *et al.*, 2016) | | | |
|---|---|---|---|
| Type of Study | Systematic review: search for relevant studies which evaluate the periodontal status of the Buccaly Impacted canines (BICs) Orthodontically tractioned submitted to the closed eruption technique or closed technique (CT) and the open technique or open excisional technique (OP).<br>This review found results only for the OT and its different approaches. Research date: January 2015. | | |
| Participants<br>*n* (% male) | (BOYD, 1984): 24 (33%)<br>(TEGSJÖ et al., 1984): 50 (44%)<br>(KIM et al., 2007): 20 (-) | | |
| Interventions | **(BOYD, 1984):** Applied techniques: Radical exposition (RE) - window techniques: when the impact happens above the line of the attached gingiva, the canine is palpable and wrapped by a thin mucosa that coats it. A circular incision is then performed and exposes all the vestibular aspect of the crown (BECKER & CHAUSHU, 2015). Partial exposition (PE) - apically positioned flap technique (APF): Open flag keeping 2 to 3 mm of keratinized tissue. Comparisons between the two techniques and between the techniques themselves and the two techniques with the control group (CG).<br>**(TEGSJÖ et al., 1984):** Applied techniques: ER - Removal of the alveolar bone and mucosa and APF: with keratinized gingiva removal included. Both with Surgical dressing for one week and orthodontic traction. Comparison between the two techniques with each other and with the CG.<br>**(KIM et al., 2007):** APF technique; surgical dressing for 1 week; orthodontic traction. Comparison between the surgical technique and the CG.<br>The contralateral side not treated was used as CG. When the two surgical techniques were compared, no CG not treated was taken into consideration. | | |
| Duration of the study / Observational period | (BOYD, 1984): 6-24 months after the removal of the orthodontic appliances<br>(TEGSJÖ et al., 1984): 30-56 months after the surgery.<br>(KIM et al., 2007): 12 months after the surgery | | |
| Outcomes | (BOYD, 1984):<br>24 Canines evaluated 12 (RE) e 12 (PE/APF).<br>Gingival Index (GI), Plaque Index (PI), Gingival Bleeding Tendency (GBT), Gingival Recession (GR), Periodontal Probing Sac Depth (PD), Gingival Adherence Loss (GAL), And Adherent Gingiva Width (AGW). | (TEGSJÖ et al., 1984):<br>50 Canines evaluated 21 (RE) and 29 (APF). Gingival Bleeding Index (GBI), GR, PD and Keratinized Gingiva Width By buccal (KGWb). | (KIM et al., 2007):<br>23 Canines: (PE/APF) in comparison with the CG.<br>PI, GI, PD, AGW, Clinical Crown Lenght (CCL) and Bone Loss. |

| | |
|---|---|
| Methods of outcome Assessment | **Eligibility criteria**: Ortho Surgical treatment of the BICs, with no restriction of age, malocclusion, or type of orthodontic retreatment employed. Surgical techniques: opening or open exposition (OT), closed (CT) apically positioned flap (APF). For comparison purposes, when a technique was considered, the contralateral side not treated had to be used as control and when two surgical techniques were compared, no control group not treated was necessary.<br>Study designs: randomized controlled trials, controlled clinical trials, and observational studies (cohort and case-control studies)<br>**Intended outcomes:** The plaque index (PI), by (SILNESS & LOE), scored with a 4-point scale (0-3); Gingival inflammation (visual inspection): Gingival bleeding index (GBI); Gingival bleeding tendency (GBT); gingival recession (GR): Periodontal probing depth (PD); gingival adherence level; keratinized gingiva width (KGW); attached gingiva width (AGW); crestal bone loss (CBL).<br>**Excluding criteria:** Studies including simultaneous buccal and palatal impactions were excluded due to the anatomical differences in the keratinized tissues between the labial and Palatine mucosa. Studies including incisives and canines were excluded due to the differences in etiology of impaction.<br>**Closed eruption technique (CT):** none of the included studies compared the periodontal outcomes between canines uncovered with the closed eruption technique and untreated canines.<br>**Outcomes of the studies which obeyed the eligibility criteria:** (BOYD, 1984); (TEGSJÖ et al., 1984); (KIM et al., 2007) |

| Results by Study | (BOYD, 1984) | (TEGSJÖ et al., 1984) | (KIM et al., 2007) |
|---|---|---|---|
| | The RE group seemed to have more gingival inflammation, gingival recession, and adherence loss than the CG and PE.<br>It failed in not differentiating the two surgical techniques (excisional opening and APF) for both are similar techniques and could be included in the "partial Exposition" group; therefore, it was not possible to conclude about the periodontal state after the apically positioned flap approach in comparison to the non-treated canines. | The APF group, when compared to the CG, didn't show significant differences. The opening technique RE resulted in worse periodontal results then the APF (the gingival inflammation was more pronounced and the KGW was more reduced). It also showed less favorable results when compared to the CG. | Canine exposed by the APF technique compared to the GP, did not present significant relevant values. |

| | |
|---|---|
| Overall Results | The excisional discovery (RE) resulted in worse periodontal results than the APF technique; the gingival inflammation was more Pronounced with the gingival bleeding index (RE: 29%; APF: 7%), and the KGW was more reduced (RE: mean, 2,6mm; PD, 1,4; and APF: mean 4,3mm; PD, 1,8). As stated above," radical exposition versus partial exposition" in the study by Boyd could not be considered as "excisional discovery *versus* apically positioned flap", since the "partial exposition" included partial excisional discovery as well as an APF. The size of the samples was very small and none of the included studies provided a calculation in advance for the size of the simple; this may cause an Increased risk of false negative results. The operators' experience wasn't evaluated. |
| Conclusion | The current literature is insufficient to conclude which surgical procedure is better for the periodontal health of the BICs. It was reported that the excisional discovery (RE) of CIBs had periodontal results less favorable; while the CIBs discovered by APF seemed to show periodontal results comparable to the non-treated teeth; none of the included studies examined the periodontal result of the CT. Therefore, there's a definite need for more projected research, especially in what concerns the comparison between the CT and the APF. |

## (OZ & CIĞER, 2018)

| | |
|---|---|
| Type of Study | Prospective Clinical case: Evaluate the root reabsorption of the incisive and compare vestibular bone width and the periodontal status of the BICs versus contralateral canines. |
| Participants | The study included 20 patients (9 women and 11 men) between 13,1 and 17.4 years of age (mean 15.3 ± 1.5 years old). |
| Interventions | Two sets of two-dimensional images (2D and computerized tomography (CBCT) were taken for each patient. The first (T0) was taken before beginning the orthodontic treatment and the second (T1) three weeks after the orthodontic treatment. The criteria for the employed surgical technique were not used. |
| Duration of the Study / Observational Period | After three weeks of orthodontic treatment. |
| Outcomes | - Incidence and levels of root reabsorption of the adjacent incisives;<br>- The depth of the periodontal pocket (PD) in canines;<br>- Width of the buccal alveolar bone post-treatment. |

| | |
|---|---|
| Methods of outcome Assessment | - The reabsorption of the incisives was evaluated according to the level of severity described by Ericson & Kurol, (2000)<br>- The PD was measured from the gingival margin. 6 places per tooth were probed and the mean values were registered.<br>- The bone width was measured on the vestibular, Buccal, palatine, and distal surfaces of canines previously impacted and contralateral on the images of computerized tomography (CBCT). All measures were taken twice, and the mean values were registered. The results were compared to contralateral canines Chi-square statistical analysis. The surgery was performed by one operator only and the bone loss minimized.<br>Patients with severe crowding or sagittal discrepancies which affected treatment timer and periodontal health were excluded from the study. |
| Results | - There is no severe root resorption Associated to the BICs.<br>- 40% of the lateral incisors were affected by resorption. However, the CBCT images taken after the orthodontic treatment showed that the areas with light resorption were resolved and those with more severe resorption had improved to light resorption. Indicate that the roots were reconstructed when did physiological pressure produced by the impacted canines was removed.<br>- The width of the vestibular bone on the apical extremity of the roots of the posteriorly impacted canine was higher than the contralateral canines due to the torque difficulty.<br>- The evaluation of the periodontal state showed that the mean PD was deeper in Palatally Impacted Canines (PICs) (2,13 mm in comparison to the contralateral canines (1.64 mm). A significant difference in alveolar bone loss was observed on the mesio, distal and palatine region of the PICs versus contralateral canines.<br>The results confirmed that the orthodontic treatment of PICs is associated with periodontal support loss. The mean PD did not exceed 3 mm and may be considered of smaller clinical importance. However, the bone loss, especially in the palatine surface of canines, may be a risk factor for the increase of PD and GR over time. |
| Conclusion | -Root resorption of the incisive resulting from impacted upper canines heals when the impacted tooth is moved with surgical orthodontic treatment.<br>- The CBCT exams provide a more detailed visualization of the resorption than other radiographic methods. The periodontal tissues are affected by the ortho surgical surgery of discovery PICs. A follow-up is recommended |

## (MUMMOLO *et al.*, 2018)

| | |
|---|---|
| Type of Study | Clinical study observational and investigative: differences in the periodontal health variables between the BICs and PICs after surgical orthodontic treatment with the OT |
| Participants | 10 Patients with unilateral BICs being (5 males, 5 females; mean age between 18.50 ± 1.96 years old) and 9 patients with unilateral PICs (4 males, 5 females; mean age from 19.44 ± 2.40 years old). |
| Interventions | The periodontal measurements were recorded using the World Health Organization (WHO). Radiographic evaluation to locate the impact (BIC or PIC): Orthopantomogram and CBCT.<br>In the BIC and PIC groups, a mucoperiosteal flap of full width repositioned apically (APF) and ulectomy were used respectively to expose the impacted canine. Button fixed to the dental surface and elastics changed every 15 days. |
| Duration of the Study / Observational Period | The mean time for the orthodontic eruption was about 5.5 ± 1.4 months for the BIC group and 5.7 ± 1.1 for the PIC group. Periodontal evaluation after 12 months after the removal of the appliance. |
| Outcomes | Primary: differences in the PD and keratinized tissue (KT) between the BIC and PIC and their respective contralateral canines in normal eruption (CG).<br>Secondary: the differences in PD and KT values between the BIC and the PIC. |
| Methods of outcome Assessment | Two periodontal variables were recorded and analyzed in treated canines (CIB and PIC) And the one in normal eruption - control group (CG). The PD was registered as usual in six places: mesiobuccal (MB), midbuccal (MdB), distobuccal (DB), mesiopalatal (MP), midpalatal (MdP), and distopalatal (DP) in each of the treated canines and control.<br>In addition, the PD was registered in the lateral upper adjacent incisive (distal) and first premolars (mesial) side of the case (BIC and PIC) and adjacent (CG) The keratinized gingiva (KG) was measured from the gingival margin to the mucogingival junction, in the mid position of the vestibular face of the crown.<br>All periodontal measurements were performed by the same specialist operator, who was unaware of the objectives of the study.<br>Mann-Whitney U test. Statistical significance was defined as a value P<0,05. Post hoc power analysis was performed for the primary outcome. |

| | |
|---|---|
| Results | In the present study, the periodontal outcome after orthodontic eruption was significantly worse in the BIC group than in<br>physiologically erupted contralateral canines. The BIC group had a 1 mm lower mean KT, and the adjacent lateral incisors had a 0.75 mm higher PD.<br>Analysis of periodontal variables in the PIMC group showed no differences between treated canines and the contralateral untreated control group. With respect to the present primary outcomes, direct comparison of the 2 treatment groups showed that BIC had a significantly worse post-treatment KT, about 0.9 mm less than that of PIMC. Moreover, the BIC adjacent lateral incisor at the distal site had a 0.9 mm significantly greater PD than that of the PIC adjacent lateral incisor. Thus, BIC appear to be associated with worse periodontal outcomes. |
| Conclusion | The present results indicate that clinicians should be aware that when BIC are surgically exposed with OT and erupted with orthodontic traction, they will likely lose about 1 mm of KT, as compared to physiological eruption. Moreover, the adjacent lateral incisor will develop an attachment loss of about 0.75 mm. This information is useful for determining periodontal prognosis after orthodontic treatment of BIC. In contrast, PIC periodontal outcomes appear to be unchanged. |

## (SAMPAZIOTIS *et al*., 2018)

| | | | | |
|---|---|---|---|---|
| Type of Study | Systematic Review: compare the effectiveness of two different (OT and CT) in PICs regarding periodontal outcomes, duration of surgical treatment and canine's eruption, patient's inconvenience, aesthetics, and orthodontic treatment complications. Search strategy resulted in 159 articles and nine articles were selected for the final analysis. It is worth noting that to meet the objective of this study in paper the only periodontal results considered will be (WISTH *et al*., 1976), (PARKIN *et al*., 2013), (SMAILIENĖ *et al.,* 2013a); (SMAILIENĖ *et al.*, 2013b). | | | |
| Participants | **(WISTH *et al*., 1976):** OT: 34 patients (19 F, 15 M), Age: 15 Years and 9 months / CT: 22 patients - Age: 16 years and 2 months.<br>**(PARKIN *et al*., 2013):** OT: 40 patients (27 F, 13 M), Age: 14.3 / CT: 41 patients – 25 F, 16 M, Age: 14.1 Years<br>**(SMAILIENĖ *et al.*, 2013a):** 43 patients (35 F, 8 M), Age: 15.81 Years. OT: 22 patients - Age: 18.6 years (end of treatment) CT: 21 patients – Age: 19.7 years (end of treatment).<br>**(SMAILIENĖ *et al.*, 2013b):** 43 patients (35 F, 8 M). OT: 22 patients, Age on the day of the surgery: 15.46 ± 3.28 / CT: 21 patients, age on the day of the surgery: 16.15 ± 2.79. | | | |
| Interventions | **(WISTH *et al*., 1976):** OT Group: (radical opening/Complete) + orthodontic traction after 1 week and CT Group: (moderate) + immediate traction.<br>**(PARKIN *et al*., 2013):** OT Group: + traction after adequate amount of enamel was present and CT Group: followed by immediate traction.<br>**(SMAILIENĖ *et al.*, 2013a):** OT Group: + free eruption and CT Group: + traction 1 week after surgery.<br>**(SMAILIENĖ *et al.*, 2013b):** OT Group: + Free eruption. Surgery done 1.55 months before the placement of fixed appliances. CT Group: initiation of traction 1 week after surgery. Surgery done 3.67 months after bonding of fixed appliances. | | | |
| Duration of the Study / Observational Period | **(WISTH *et al*., 1976):** OT:18 months / CT: 22 months<br>**(PARKIN *et al*., 2013):** Exam after 3 months from the removal of the appliance<br>**(SMAILIENĖ *et al.*, 2013a):** Final exam after 4.19 months after the removal of the appliance.<br>**(SMAILIENĖ *et al.*, 2013b):** *Follow-up* after ± 4.19 ±1.44) after the removal of the appliance. | | | |
| Outcomes | **(WISTH *et al*., 1976):** | **(PARKIN *et al*., 2013):** | **(SMAILIENĖ *et al.*, 2013a):** | **(SMAILIENĖ *et al.*, 2013b):** |
| | Measurement of PD, Loss of gingival attachmentl, Loss of bone support. | Gingival attachment level, GR, CCL, bone support and measurement of the difference between normal canines and contralateral. | Measurement of PD, bone support, GR, aesthetic appearance. | Measurement of PD, GR, KGW, measurement of the bone support and time for the canine eruption. |
| Methods of outcome Assessment | Measurement of PD, GAL, Radiological evaluation (distance between CEJ and bone margin). | Clinical examination: GR, GAL, CCL, Radiographic evaluation<br>of bone probing levels. | Measurements: PD, GR, Radiographic evaluation<br>(Distance between CEJ and bone margin). | Measurements: PD, KGW, gingival recession and Radiographic evaluation<br>(Distance between CEJ and bone margin). |

| | | | | |
|---|---|---|---|---|
| Results | CT has better periodontal results, but the difference is small comparing to OT. | Non-significant differences in periodontal results between the two techniques. | Non-significantly differences between the two groups. | Similar periodontal results in both groups. In the OT group, the canine extrusion was performed in a shorter time. |
| Conclusion | The retrospective study of (WISTH *et al.*) concludes that CT provides with better periodontal results as loss of gingival attachment was found to be greater for the canines treated with OT especially on their palatal side. On the other hand, the results from the two articles of (SMAILIENE *et al.*) show that there is no statistical difference for periodontal outcomes in terms of PD, GR, bone probing level, and KGW between CT and OT. The statistical tests of Parkin's *et al.* work, proved that there is no statistical difference between the mean CT and OT. Although there are conclusions for periodontal outcomes of high risk of bias in the articles by (WISTH *et al.*), (SMAILIENĖ *et al.*, 2013a, 2013b), only the article by Parkin *et al.* was in low risk of bias regarding the post-treatment periodontal condition, showing better evidence. | | | |

## (BOLLERO *et al.*, 2017)

| | |
|---|---|
| Type of Study | Systematic and Observational Review: The aim is to evaluate the periodontal *status* of BICs and PICs exposed with CT, and compare them with the controlateral canines that served as control teeth as well as to compare them to each other. |
| Participants | 28 patients: 14 patients (8 females, 6 males) with PIC and 14 patients (7 females, 7 males) with BIC.<br>Age: The mean age of the patients at the beginning of the treatment was 13 years 5 months ± 1 year 4 months and 16 years 4 months ± 1 year 6 months at the end of the treatment. The mean age of subjects who underwent the periodontal<br>evaluation was 18 years 7 months ± 2 years. |
| Interventions | - CT without the tunnel for the PICs.<br>- CT with flap exposure to the mucogingival junction level for the BICs. The extent of surgical exposure involved the removal of enough bone to allow for the complete curetting of the follicular sac of the unerupted tooth and was performed for all the treated cases. The surgical technique was performed by the same operator, as well as the orthodontic treatment. |
| Duration of the Study / Observational Period | Mean treatment duration was found to be 2 years 10 months ± 1 year 3 months (3 years 2 months ± 1 year 8 months for PIC, 2 years 8 months ± 8 months for BIC). Mean *recall* observational period was 2 years 4 months ± 1 year 1 month after the end of active orthodontic treatment. |
| Outcomes | - PD: DB, MidB, MB, DL, MidL e ML - on each of the treated teeth.<br>- KGW: from the gingival margin to the mucogingival junction, it was measured on the medial position of the buccal aspect of the crown.<br>- Gingival thickness (GT): a point 2 mm apical to the gingival margin. It was pierced with a sharp and calibrated wire with 1 mm increments perpendicular to both the mesiodistal and coronoapical planes of the root surface, under local anesthesia.<br>- PI: the mesial, distal, buccal, and palatal surfaces were scored on a scale of 0 to 3, according to the method described by (*Loe e Silness*).<br>- GBI, bleeding after gentle probing: at the same surfaces were scored as for the plaque index on a scale of 0 to 3, according to the method of (*Loe e Silness*).<br>- GR: if any, it was measured as the distance from the CEJ to the gingival margin on the buccal midpoint of the crown. |
| Methods of outcome Assessment | Data of the impacted canines (BIC and PIC) were compared with their controlateral, Control Group (CG). Descriptive statistics were calculated as mean for all the examined (metric) variables.<br>Parametric Data: paired-samples t-test to compare PD, KGW, GT;<br>*Wilcox-on-rank Test*: Nonparametric data PI, GBI, GR.<br>The paired t-student test was used for the comparison of the parametric data between BIC and PIC.<br>The Mann-Whitney U-test was used for the comparison of the nonparametric data. The difference was statistically significant when $p < 0.05$ for all tests.<br>Reproducibility of the measurements was assessed by repeating the periodontal evaluation of 20 subjects 1 month after the first examination by 1 operator. Correlation between these two sets of measurements was assessed with *Pearson* correlation analysis. |
| Results | PICs: significant greater PD on the ML site compared to their controlaterals ($p < 0.05$). No statistically significant differences were found regarding the PD on the other sites and to the KGW and GT, PI, GBI and GR between the PICs and palatally impacted canines and their CGs.<br>BICs had significant increased KGW compared to their contralaterals ($p < 0.05$).<br>No statistically significant differences were found regarding PD, GT, IP, GBI, and GR between the BICs and their GPs.<br>PICs had significant PD on the midbuccal site and on all the palatal sites when compared to the BICs ($P<0.05$). No significant differences were found in the KGW, GT, PI, GBI and GR in the comparison |

| | |
|---|---|
| | between PICs and BICs. |
| Conclusion | - After surgical-orthodontic treatment of PICs, there were no significant differences in post-treatment periodontal *status* regarding CG.<br>- The PICs, when compared to BICs, evidenced a greater PD by palatine than the BICs. Therefore, the overall consequences of the BICs exposed with CT seem better than PICs.<br>- The general changes observed in the periodontal *status* of impacted canines, although statistically significant, did not reach clinical significance. |

## (Lee *et al.*, 2019)

| | |
|---|---|
| Type of Study | Retrospective e comparative: CT for the BICs can lead to a shorter root length and GR with respect to the alveolar bone and gingiva. |
| Participants | 21 male patients and 33 female patients; mean age, 12.85 years ± 3.50 years.<br>**The inclusion criteria** were Buccally impacted Canines - Impaction Group (IG) that were exposed by the Closed Eruption Technique (CT); existence of a normally positioned contralateral maxillary canine, which was served as a control CG; the presence of a panoramic radiograph before treatment (T0); and the availability of treatment records after orthodontic treatment (T1) including a periapical radiograph and periodontal examinations for both the GI and GC.<br>**The exclusion criteria:** a missing tooth adjacent to the canine, open contacts against the adjacent lateral incisor or first premolar at T1, considerable distortion between the right and left sides on the initial panoramic radiograph, and a gingival index (GI) score of 2 or 3.13. |
| Interventions | All canines were exposed by CT followed by orthodontic traction and orthodontic treatment. All patients were submitted consecutively to the same treatment strategy pattern and performed by the same operator. |
| Duration of the Study / Observational Period | (T0): for BIC was 12.74 ± 7.74 months.<br>(T0 to T1) was 30.30 ± 10.78 months.<br>The periodontal outcomes were assessed from radiographic and clinical examinations that had been performed approximately 1 month after removal of the orthodontic appliance. |
| Outcomes | - Comparison between IG and GC between the Nolla stages and pretreatment positions of the upper canines.<br>- Comparisons of post-treatment periodontal outcomes between the impaction and control groups.<br>- Comparison between variables for the periodontal results, Nolla stages and S-sector IG and CG.<br>- Comparison of the periodontal variables post-treatment among the Nolla Stage, d-depth, α-angle, and s-sector. |
| Methods of outcome Assessment | **Before Treatment (T0):** A periapical radiograph was obtained with a 0.016 x 0.022-inch stainless steel guide wire 10 mm in length to compensate for changes in the axis of the x-ray beam. To identify the cementoenamel junction (CEJ), alveolar crest (AC), and root apex of the canine. The mesial and distal distances between the CEJ and AC (CEJ-AC) were measured parallel to the long axis of the tooth. Root length was measured as the perpendicular distance from the root apex to a line connecting the mesial and distal CEJs. The (distance between the apex and AC) / root length ratio was calculated to determine the percentages of bone support on the mesial and distal sides.<br>**Orthopantomograph:** to measure the following parameters: 1) the Nolla stage to indicate tooth developmental stages, and 2) Impaction Analysis with criteria by (ERICSON & KUROL, 1988): Depth: – *d (Impaction depth)*: perpendicular distance from the cusp tip to the occlusal plane; α-angle: canine angulation, and S-sector: MD displacement; McNemar Test or Paired T-tests were used to compare both groups.<br>**Periodontal Examinations (T1):** Gingival Index (GI), sulcus-probing depth (SPD), bone probing depth (BPD), clinical crown length (CCL), clinical crown length (CCL) and attached gingiva width (AGW), which were performed on all patients with an impacted tooth by using a periodontal probe based on the clinical protocol of the study hospital. The SPD and BPD were measured in the MB, MidB, DB, ML, MidL, and DL regions of the canine. For BPD measurements, the probe tip was forced through the connective tissue under local anesthesia until definite resistance was obtained. The CCL was measured on the buccal tooth surface from the incisal edge to the deepest point on the curvature of the vestibular gingival margin parallel to the long axis of the tooth. The KGW was measured at the midbuccal point as the distance from the free gingival margin to the CEJ and the AGW was calculated by subtracting the SPD at the midbuccal point from the KGW. The IG and the CG were compared using paired T-tests. |
| Results | There were significant differences in post-treatment periodontal parameters between the IG and CG ($p < 0.05$), except for SPD and BPD. On periapical examinations, the IG exhibited a longer CEJ-AC distance, shorter root length, and lesser bone support than the CG ($p < 0.05$). The SPD and BPD values were similar between the two groups ($p > 0.05$), except for the DL BPD. In the IG, the CCL was longer ($p < 0.01$) and the KGW and AGW were significantly shorter than in the CG ($p < 0.05$).<br>A simple regression analysis revealed that the d-depth and α-angle had significant relationships with the CEJ-AC distance and bone support on the distal side ($p < 0.05$) in T1. The d-depth also had a significant relationship with the DB BPD ($p < 0.05$).<br>A multiple regression analysis demonstrated that the s-sector was not related to the periodontal outcomes ($p > 0.05$). The Nolla stage negatively affected root length ($p < 0.05$), which indicates that the root length is likely to be short, as the root of the<br>impacted canine is more developed. The d-depth and α-angle affected the CEJ-AC distance and bone support on the distal side ($P < 0.05$); the d-depth affected the MB, DB, and MidL ($p < 0.05$). This indicates that the |

| | |
|---|---|
| | alveolar crests are reduced when the canine is impacted deeply and that the distal bone crest is likely to be reabsorbed as it is angled. |
| Conclusion | After performing the CT for BICs, the IG exhibited a longer CCL, shorter AGW, shorter KGW, shorter root length, less bone support, and lower AC on the mesial and distal sides compared to the CG. The comparison indicates that IG had greater gingival recession, less attachment, and more coronally positioned CEJs.<br>The T1 root length was influenced by the Nolla stage, and the AC level and bone support on the distal side were influenced by the depth and angle in T0 of the IG.<br>Finally, the CT exhibited slightly worse periodontal conditions with respect to the alveolar bone, root length, and gingiva than the CG. However, the difference was less than 1 mm, most of which can be considered clinically insignificant. Some parameters such as the CCL and AGW require clinical follow-up over a long duration. A higher root developmental stage and mesially angulated deeply impacted canines may aggravate and worsen periodontal conditions. |

## (Caprioglio *et al.*, 2019)

| | |
|---|---|
| Type of Study | Retrospective study: Evaluate the influence of the initial position in the periodontal health on posttreatment of PICs treated by a combined surgical-orthodontic approach using closed flap technique (CT). |
| Participants | Adolescents: 13.8 ± 1.2 (mean age)<br>Initial screening: 438 PICs. Final screening: 293 PICs of 271 patients which satisfied the inclusion and exclusion criteria. |
| Interventions | All the canines were exposed using CT and orthodontic traction was applied using the (JACOBY, 1979) device followed by fixed appliance treatment.<br>All the patients underwent consecutively the same standardized treatment strategy and performed by the same operator. |
| Duration of the Study / Observational Period | Treatment Start - (T1): After exposure of the PICs overall mean orthodontic treatment duration of 23.12 ± 6.2 months.<br>End of treatment - (T2): examination of the periodontal status health 4 weeks after fixed appliance removal. |
| Outcomes | - Periodontal outcomes regarding the level of impaction severity: S-sector, *α-angle, and d-depth*.<br>- Mean of Probing depth (PD), Bleeding Index (BI).<br>- Replicated method of (CRESCINI *et al.*, 2007) but with higher sample of patients and using a different traction device. |
| Methods of outcome Assessment | T1: Orthopantomography image analysis and evaluation of the periodontal *status* and classic orthodontic records (plaster models, pictures, panoramic X-ray, lateral cephalometry). The root length and the alveolar bone level (buccal and palatine) were evaluated in computerized tomography (CBTC). The comparison of alterations in root length and alveolar bone level between groups was evaluated applying the paired t-test, with significance level of 5% ($p < 0.05$).<br>Impaction analysis based on the criteria by (ERICSON & KUROL, 1988): *Sector - S:* Sector 1: between the inter-incisor median line and the long axis of the central incisor– it is related to the time the canine will need to be tractioned; Sector 2: between the long axes of the lateral and central incisors; sector 3: between the long axes of the lateral incisor and the first premolar. The impaction in sector 1 may demand more time of active orthodontic traction when compared to impaction in sector 3; α-Angle: the angle formed between the long axis of the impacted canine and the inter-incisor median line; Distance (d): the distance between the peak of the impacted cuspid and the occlusal plane.<br>T2: (PD): (Williams probe to an accuracy of 0.5 mm) - the mean at six sites (MB, MidB, MP, MidP, DP); (BI): the buccal surface was scored on a scale of 0 to 1.<br>After the measurements, all the canines included in the study were divided into three groups according to the PD: PD ≤ 2mm (group 1); PD > 2mm (group 2); and CEJ visible (group 3). |
| Results | - Six patients exhibited CEJ visible due to recession.<br>- α-Angle and d-distance seem to not influence the periodontal outcome of the treated impacted canine regardless of the amount of gravity (relating to the path that the PIC needs to cover to come into occlusion).<br>- The S-sector (distribution of the medial position in the 3 sections): significant differences<br>- BI: not significant for all groups. |
| Conclusion | - Radiographic variables α-Angle and d-distance seem to not influence the periodontal outcome of the treated impacted canine regardless of the amount of gravity;<br>- S-sector might cover a significant role when higher rates of gravity are present suggesting the possibility in few cases for periodontal damage at the end of treatment. |

## DISCUSSION

The location of the impacted tooth plays a crucial paper in the determination of the Feasibility of the adequate access to the surgical approach and to the adequate Direction for the Orthodontic strength application in order to ensure the periodontal results. As to the location, the results found were buccaly impacted maxillary canines (BICs) and palatally impacted canines (PIC). The impaction of the BIC is less frequent than the impaction of the PIC and is usually caused by insufficient lengths of the arch. There are three surgical techniques more common for the discovery of the impacted canine: open technique or excisional open technique (OP) and closed eruption technique or closed technique (CT) and apically positioned flap technique (APF). The Chosen technique must consider Access easiness, feasibility to dental movement and minimize the periodontal results (EVREN et al., 2014; CAPRIOGLIO et al., 2017; DA SILVA et al., 2017; BOLLERO, et al., 2017; LEE et al., 2019).

The OP consists in the canine exposure through gingivectomy or ulectomy, placing addressing recurring to a periodontal cement and approximately 10 days later, installing an orthodontic traction accessory (PARKIN et al., 2017; MUMMOLO et al., 2018).

On the other hand, the contemporary CT happens when a complete Mucoperiosteal flap is raised and reflected to discover the impacted tooth. It is generally followed by the bone removal in order to expose the clinical part of the crown and attached and an orthodontic tractioning accessory. Subsequently, the flap is repositioned, and strength is applied after the initial healing, until the canine erupts in the oral cavity and, subsequently, is guided to the dental arch (CASSINA, et al., 2018).

The APF technique is utilized when there is not enough keratinized gingiva around the canine, they impacted tooth is below the mucogingival junction. This technique has the advantages being less invasive, facilitating orthodontic control, requiring a shorter treatment., which prevents marginal bone loss and gingival recession (HUANG et al., 2016; INCERTI-PARENTI et al., 2016).

The choice of which technique is to be applied is based on a thorough evaluation of the buccal lingual positioning, The vertical position towards the mucogingival junction, The Mazzio's distal position of the impacted tooth regarding the lateral incisive and the quantity and type of gingiva around the affected tooth (KOKICH, 2004; INCERTI-PARENTI et al., 2016; PARKIN et al., 2017; CASSINA, et al., 2018; MUMMOLO et al., 2018; MAHARDAWI et al., 2020).

The advantages of the OP include direct vision and visual control of the canine movement during the treatment, less time for the surgery. Few reprocessing cases, better hygiene as well as a faster eruption and smaller risk of ankylosis. However, this method is frequently Associated to several Periodontal problems, such as gingival recession, bone loss, Reduction of the keratinized gingiva width, Delay on the periodontal healing and gingival inflammation (PARKIN et al., 2013; EVREN et al., 2014; CASSINA, et al., 2018). The CT on contrary, always Involves the elevation of a complete mucoperiosteal flap to expose the canine crown with the connection of an orthodontic accessory. In some cases, the simultaneous removal of the decidual canine may be performed with the objective of creating a tunnel through where the impacted canine may be easily conducted. The CT is strongly recommended as the treatment of choice when the tooth is impacted around the upper third or alveolar medium, in the proximity of the anterior nasal Spine. As this approach reproduces the natural eruption of the tooth, it is likely to provide the best aesthetical and periodontal results. The intraoperative bleeding reduction and the better comfort for the patient during the processes of healing were suggested as the benefits of the CT (KOKICH, 2010; DERSOT, 2017; CAPRIOGLIO et al., 2019; CRUZ, 2019).

In case an osteoplasty is needed it is recommended to avoid unnecessary removal, for the more bone is initially removed, the bigger the bone loss after the orthodontic treatment. The extensive bone removal may involve inadvertently the cement-enamel Junction (CEJ) and must be avoided. The patients treated with the more extensive bone removal had a mean 5.4% less bone support then those treated with a less extensive bone removal (EVREN et al., 2014).

The authors (INCERTI-PARENTI et al., 2016) learned that when an excisional opening (gingivectomy), BICs showed worse results: higher inflammation and recession and gingival adherence loss. No exposition made by the APF technique, demonstrated having better results namely in quantity of keratinized gingiva and smaller gingival bleeding index. The authors have not found consistent results for the closed technique (CT). The study was observational in a critical analysis and the clinical evidence found is not clear. Although the literature found was insufficient and the approach led to citation bias, the associations were supported by the most relevant articles about the topic.

Other authors (BOLLERO et al., 2017) compared results from the BICs and PICs when submitted to CT. The BICs showed an Increase in keratinized gingiva width where the PICs had higher probe depth by the palatine side. The BICs on their turn presented an increase on the keratinized gingiva width in comparison to the contralateral, while statistically meaningful differences were

not found in relation to the Probing pocket depth, gingival width, as well as the plaque index, gingival bleeding index and gingival recession between the BICs and their contralateral. This fact may be associated to deeper location in the bone plate and above the mucogingival junction; the CT was performed together with the APF since the bone and follicular pocket removal was necessary.

A systematic study (SAMPAZIOTIS et al., 2018) in an updated analysis of relevant articles, concluded that although there are Outcomes for the periodontal results the CT provided the best Periodontal results and the most part of studies found did not mention statistical difference between the two techniques. Only one study reported that the PICs had a bigger loss of gingival adhesion, especially in the palatine side by the OT.

On the other hand, as a way of result comparison or the PICs uncovered by the OP pass with APF and bone removal, we resorted to an excluded study by (TORRES-LAGARES et al., 2015) Which compared in a histological analysis the PICs with their adjacent premolars (CG). They found better results as to the level of non-keratinized epithelium and the conjunctive tissue for the PICs. The alterations in the keratinized epithelium level were minimal. This difference was statistically significant in adjacent premolars. They concluded that this difference refers to the time in the orthodontic treatment length between the two groups and the anchoring and support necessary which the premolars had to provide to the traction of the upper canines; higher time of exposition of the premolars in the buccal environment then than PICs and the exposition to bacterial plaque. It can be assumed that the extended orthodontic treatment Exerts a higher negative impact on the gingival architecture of the natural Dental movement, not assisted and physiological. This study validates (CAPRIOGLIO et al., 2019) who stated that the time taken by the canine traction will influence the periodontal results.

(MUMMOLO et al., 2018) compared the differences of the probing depths and the keratinized tissue amount between the BICs and PICs and their contralateral canines (CG), by the APF technique with ulectomy. The BICs lost approximately 1 mm of keratinized tissue in comparison to the PICs and the contralateral physiologically erupted. Overall, the BICs presented worse results than the PICs.

The initial position and the canine impaction index before the treatment may have worse periodontal results. (CAPRIOGLIO et al., 2019) and (LEE et al., 2019) analyzed if the mesiodistal distance, angle, and depth The canine must travel to be in the occlusal plane would influence in the periodontal results. (LEE et al., 2019) had a bigger focus on periodontal results with attention to the

gingival recession. They also evaluated the Nolla Stage of BICs and found worse results related to the depth and the angle of impact for they affected the CEJ, the bone support. The deeper the impact the more the distal bone crest will be reabsorbed. The impacted BICs had higher recession and gingival adherence, Higher Crown compromise and smaller root length. These results were attributed to the CET and to the Nolla stage of dental development. The Mesiodistal distance did not influence the results. (CAPRIOGLIO et al., 2019), On the other hand, evaluated the PICs and found worse results in relation to the mesiodistal distance due to the long way the palatine canines must travel until they arrived at the occlusal plane. Besides the angle and the depth, they evaluated the bleeding index. The surgical technique employed was the CT.

It is evident that some bone characteristics demonstrate that the BICs may present higher index of gingival recession and periodontal results more severe than the PICs, due to the buccal Bone Plate Characteristically thinner than the palatine (JATI et al., 2016). However, in the study by (OZ & CIĞER, 2018), They concluded that although the thickness of the buccal bone in the apical extremity of the PICs were augmented in relation to the contralateral, in terms of periodontal results it was evident there is a substantial bone loss by the palatine side with an indication of probing depth increase and consequently a longer-term leading to gingival recession.

(BOLLERO et al., 2017) stated that the BICs presented an increase in the keratinized gingiva width in comparison to the contralateral, while no differences statistically meaningful were found in relation to the pocket probing depth, gingival width, as well as to the plaque index, gingival bleeding index and gingival recession between the BICs and their contralateral when performing the CT.

Finally, the most-cited references about this topic are the (KOKIC's, 2004, 2010) studies. The author stated that, if there is enough gingiva to provide at least 2 to 3 millimeters of attached gingiva over the canine Crown after its eruption, any of the three techniques may be used; if the gingiva insufficient, the only technique which will presumably produce more gingiva is in APF. However, without a recommendation based on evidence, the method of choice to uncover canines with labial impact remains each professional's discretion. (SMAILIENE et al., 2013; INCERTI-PARENTI et al., 2016; PARKIN et al., 2017; OZ & CIĞER, 2018).

## CONCLUSION

Within the limitations of this study, it was possible to conclude that the time taken by the impacted canines to arrive at the dental arch may worsen the periodontal results; the root development stage, the depth, the angle of the pre-treatment may influence the gingival recession, but the differences are clinically insignificant if compared to contralateral physiologically erupted; the impacted BICs had higher gingival recession, smaller gingival adherence, and higher compromise of the crown. These results were attributed to the alveolar buccal bone width; the surgical technique for the discovery of the BICs is controversial and there is not a technique which seems to obtain better Periodontal results and smaller gingival recession; the PICs may present higher probing depths, increase in the bleeding index, loss of adherence by the palatine side which on a long term may result in gingival recession; Nowadays, there is no clear evidence that favors any surgical technique to discover canines in terms of periodontal results. The results found states that clinically the evidence is insignificant when compared to normally Erupted teeth. Both the OP and CT for impacted canines may show light gingival recession in comparison to physiologically erupted teeth. The APF technique seems to provide better results when associated to OP; while the CT showed to provide even better periodontal results if compared to the OP. The method of choice to discover impacted canines remains each professional's discretion.

## REFERENCES

1. Baker, P. (2020). Gingival Recession - Causes and Management. Primary dental journal. NLM (Medline), 8(4), pp. 40–47.

2. Becker, A. and Chaushu, S. (2015). Surgical Treatment of Impacted Canines: What the Orthodontist Would Like the Surgeon to Know. Oral and Maxillofacial Surgery Clinics of North America. Elsevier Inc, 27(3), pp. 449– 458.

3. Boyd, R. L. (1984). Clinical assessment of injuries in orthodontic movement of impacted teeth. II. Surgical recommendations. American Journal of Orthodontics. Am J Orthod, 86(5), pp. 407–418.

4. Caprioglio, A. et al. (2017). Root length and alveolar bone level of impacted canines and adjacent teeth after orthodontic traction: A long-term evaluation. Dental Press Journal of Orthodontics. American Association of Orthodontists, 2017(1), pp. 75–81.

5. Caprioglio, A. et al. (2019). Effects of impaction severity of treated palatinoly displaced canines on periodontal outcomes: A retrospective study. Progress in Orthodontics. Springer Berlin Heidelberg, 20(1).

6. Cassina, C., Papageorgiou, S. N. and Eliades, T. (2018). Open versus closed surgical exposure for permanent impacted canines: A systematic review and meta-analyses. European Journal of Orthodontics, 40(1), pp. 1–51.

7. Crescini, A. et al. (2007). Orthodontic and periodontal outcomes of treated impacted maxillary canines: An appraisal of prognostic factors. Angle Orthodontist, 77(4), pp. 571–577.

8. Cruz, R. M. (2019). Orthodontic traction of impacted canines: Concepts and clinical application. Dental Press Journal of Orthodontics, 24(1), pp. 74–87.

9. Dersot, J. M. (2017). Periodontal surgery of the maxillary impacted canine for orthodontic purposes: Proposal for a surgical decision tree. International Orthodontics. Elsevier Masson SAS, 15(2), pp. 221–237.

10. Ericson, Sune and Kurol, J. (1988). Early Treatment of Palatinoly Erupting Maxillary Canines by Extraction of the Primary Canines - PubMed. European Journal of Orthodontics, 10(1), pp. 283–295.

11. Ericson, S. and Jü Ri Kurol, ; (2000). Incisor Root Resorptions Due to Ectopic Maxillary Canines Imaged by Computerized Tomography: A Comparative Study in Extracted Teeth. Angle Orthodontist. Allen Press.

12. Evren, A. D. et al. (2014). Periodontal status of ectopic canines after orthodontic treatment. Angle Orthodontist, 84(1), pp. 18–23.

13. Gebistorf, M. et al. (2018). Gingival recession in orthodontic patients 10 to 15 years posttreatment: A retrospective cohort study. American Journal of Orthodontics and Dentofacial Orthopedics. Mosby Inc., 153(5), pp. 645–655.

14. Huang, Y. S. et al. (2016). Surgical considerations and management of bilateral labially impacted canines. Journal of Dental Sciences. Elsevier Taiwan LLC, 11(2), pp. 202–206.

15. Incerti-Parenti, S. et al. (2016). Periodontal status after surgical-orthodontic treatment of labially impacted

16. Recessões Gengivais em Caninos Tracionados Ortodônticamente: Revisão Bibliográfica

17. canines with different surgical techniques: A systematic review. American Journal of Orthodontics and Dentofacial Orthopedics. Mosby Inc., 149(4), pp. 463–472.

18. Izadikhah, I. et al. (2020). Different management approaches in impacted maxillary canines: An overview on current trends and literature. Journal of Contemporary Dental Practice, 21(3), pp. 326–336.

19. Jacoby, H. (1979). The “ballista spring” system for impacted teeth. American Journal of Orthodontics. Am J Orthod, 75(2), pp. 143–151.

20. Jati, A. S., Furquim, L. Z. and Consolaro, A. (2016). Gingival recession: Its causes and types, and the importance of orthodontic treatment. Dental Press Journal of Orthodontics, 21(3), pp. 18–29.

21. Kokich, V. G. (2004). Surgical and orthodontic management of impacted maxillary canines. American Journal of Orthodontics and Dentofacial Orthopedics, 126(3), pp. 278–283.

22. Kokich, V. G. (2010). Preorthodontic Uncovering and Autonomous Eruption of Palatinoly Impacted Maxillary Canines. Seminars in Orthodontics, 16(3), pp. 205–211.

23. Lee, J. Y. et al. (2019). Labially impacted maxillary canines after the closed eruption technique and orthodontic traction: A split-mouth comparison of periodontal recession. Journal of Periodontology, 90(1), pp. 35–43.

24. Mahardawi, B. et al. (2020). Judgement in artificial eruption of embedded teeth from an oral surgery perspective: Review article. Journal of the Korean Association of Oral and Maxillofacial Surgeons. Korean Association of Oral and Maxillofacial Surgeons, pp. 12–18.

25. Mummolo, S. et al. (2018). Periodontal status of buccally and palatinoly impacted maxillary canines after surgical-orthodontic treatment with open technique. Journal of Oral Science, 60(4), pp. 552–556.

26. Nowzari, H. and Rodriguez, A. E. (2019). Impacted teeth: Closed flap surgery. Journal of Esthetic and Restorative Dentistry, 31(3), pp. 233–239.

27. Oz, A. Z. and Ciğer, S. (2018). Health of periodontal tissues and resorption status after orthodontic treatment of impacted maxillary canines. Nigerian Journal of Clinical Practice, 21(3), pp. 301–305.

28. P. Bollero, C. Danesi, M. R. Ricchiuti, A. M. (2017). Long-Term Periodontal Status of Canines After Closed Surgical- Palatinoly And Buccaly Impacted Orthodontic Approach. Oral Implantology (Rome), pp. 162–171.

29. Parkin, N. et al. (2017). Open versus closed surgical exposure of canine teeth that are displaced in the roof of the mouth. Cochrane Database of Systematic Reviews, 2017(8).

30. Parkin, N. A. et al. (2013). Periodontal health of palatinoly displaced canines treated with open or closed surgical technique: A multicenter, randomized controlled trial. American Journal of Orthodontics and Dentofacial Orthopedics. Am J Orthod Dentofacial Orthop, 144(2), pp. 176–184.

31. Sampaziotis, D. et al. (2018). Open versus closed surgical exposure of palatinoly impacted maxillary canines: comparison of the different treatment outcomes-a systematic review. European journal of orthodontics, 40(1), pp. 11–22.

32. Schubert, M., Proff, P. and Kirschneck, C. (2016). Successful treatment of multiple bilateral impactions - a case report. Head and Face Medicine. Head & Face Medicine, 12(1), pp. 1–11.

33. Silva, A. C. et al. (2017). Root length and alveolar bone level of impacted canines and adjacent teeth after orthodontic traction: A long-term evaluation. Journal of Applied Oral Science, 25(1), pp. 75–81.

34. Smailiene, D. et al. (2013). Palatinoly impacted maxillary canines: Choice of surgical-orthodontic treatment method does not influence post-treatment periodontal status. A controlled prospective study. European Journal of Orthodontics, 35(6), pp. 803–810.

35. Spuntarelli, M. et al. (2015). Combined orthodontic-surgical approach in the treatment of impacted maxillary canines: Three clinical cases. ORAL and Implantology, 8(2–3), pp. 63–67.

36. Tegsjö, U., Valerius-Olsson, H. and Andersson, L. (1984). Periodontal conditions following surgical exposure of unerupted maxillary canines--a long term follow-up study of two surgical techniques. undefined.

37. Torres-Lagares, D. et al. (2015). What Are the Histologic Effects of Surgical and Orthodontic Treatment on the Gingiva of Palatino Impacted Canines? Journal of Oral and Maxillofacial Surgery. Elsevier Ltd, 73(12), pp. 2273–2281.

38. Viwattanatipa, N. and Charnchairerk, S. (2018). The effectiveness of corticotomy and piezocision on canine retraction: A systematic review. Korean Journal of Orthodontics, 48(3), pp. 200–211.

39. Zadeh, H. et al. (2019). Vestibular Incision Subperiosteal Tunnel Access (VISTA) for Surgically Facilitated Orthodontic Therapy (SFOT). Contemporary Clinical Dentistry. Wolters Kluwer Medknow Publications, 10(3), pp. 548–553.