

UNIVERSIDADE FEDERAL DO RIO GRANDE DO SUL  
FACULDADE DE ODONTOLOGIA  
CURSO DE ESPECIALIZAÇÃO EM ORTODONTIA

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**PREDITORES CLÍNICOS PARA O DIAGNÓSTICO DE CANINOS  
POTENCIALMENTE IMPACTADOS: UMA REVISÃO SISTEMÁTICA**

Porto Alegre

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Trabalho de conclusão de curso de especialização apresentado a Faculdade de Odontologia da Universidade Federal do Rio Grande do Sul como requisito parcial para a obtenção do título de Especialista em Ortodontia.

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## RESUMO

**Objetivo:** Revisar sistematicamente as características dentárias e morfológicas associadas a caninos potencialmente impactados (CPI), na fase de dentadura mista.

**Materiais e métodos:** Bases de dados digitais (Pubmed, Scopus, Web of Science e Cochrane Library) foram pesquisadas para recuperar artigos publicados até 02 de outubro de 2019, sem limites de idioma e data. Dois revisores analisaram independentemente os títulos e resumos relacionados. Os artigos que atendiam aos critérios de inclusão e exclusão foram lidos na íntegra. Os artigos selecionados foram avaliados quanto à qualidade metodológica.

**Resultados:** Três estudos de caso-controle foram incluídos na revisão. Todos relataram dimensões reduzidas do arco superior em crianças com CPI, como uma menor da largura intercaninos, menor comprimento do arco superior, menores área e volume do palato. Foi relatado também uma maior associação de CPI com a mordida cruzada.

**Conclusão:** Existem diferenças nas características dentárias e morfológicas do arco superior entre crianças com e sem CPI durante a dentição mista. Alguns fatores preditores de CPI envolvem dimensões reduzidas da arcada dentária superior, especialmente largura intercaninos e comprimentos da arcada dentária, além de área e volume do palato reduzidos.

## ABSTRACT

**Objective:** To systematically review the dental and morphological characteristics associated with potentially impacted canines (PIC), in mixed dentition stage.

**Materials and methods:** Digital databases (Pubmed, Scopus, Web of Science and Cochrane Library) were searched to retrieve articles published until October 2<sup>th</sup>, 2019, without language and date limits. Two reviewers independently reviewed the titles and abstracts related. The articles that met the inclusion and exclusion criteria were read in full. The selected articles were evaluated for methodological quality.

**Results:** Three case-control studies were included in the review. All reported reduced dimensions of the maxillary arch in children with PIC, such as a smaller intercanine width, shorter maxillary arch length, smaller palate area and volume. A greater association of PIC with crossbite has also been reported.

**Conclusion:** There are differences in the dental and morphological characteristics of the maxillary arch between children with and without PIC during mixed dentition stage. Some predictive factors for PIC involve reduced dimensions of the maxillary dental arch, especially intercanine width and dental arch length, as well as reduced palate area and volume.

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## 1 INTRODUÇÃO

A ectopia de caninos superiores possui uma prevalência de 1 a 3% (HASHEMIPOUR; TAHMASBI-ARASHLOW; FAHIMI-HANZAEI, 2013) e exige uma atenção especial, devido à grande importância estética e funcional destes dentes na oclusão (DALESSANDRI et al., 2017). Os caninos superiores seguem a mais difícil e tortuosa trajetória de erupção e as chances de alteração do seu curso normal aumentam proporcionalmente com a distância que o dente deve percorrer desde o início de sua formação até a oclusão final. O entendimento acerca do processo de erupção e da etiologia da ectopia de caninos superiores podem reduzir a incidência de caninos impactados, por meio do diagnóstico precoce e do tratamento interceptivo oportuno (SAJNANI, 2015).

O diagnóstico clínico de caninos impactados pode ser realizado por meio de exames de palpação e inspeção. Os sinais clínicos comumente associados são atraso na erupção do canino permanente, retenção prolongada de canino decíduo, ausência de abaulamento na tábua óssea por vestibular, presença de uma protuberância no palato e angulação distal da coroa do incisivo lateral adjacente (KANAVAKIS et al., 2015). O diagnóstico pode ser confirmado com o auxílio de exames de imagem como radiografias e tomografias.

Um diagnóstico clínico preciso e precoce é fundamental, sendo de grande importância sua implementação na rede pública de assistência odontológica, reduzindo assim problemas dentários mais complexos e severos como a reabsorção dos incisivos laterais e centrais. Além disso, tratamentos tardios apresentam um maior custo biológico, são mais demorados e dispendiosos.

Contudo, não há evidências científicas suficientes para nortear os dentistas no diagnóstico clínico precoce de caninos potencialmente impactados. Diante disso, este estudo visa realizar uma revisão sistemática para investigar as características clínicas associadas aos caninos potencialmente impactados, em pacientes na faixa etária entre 7 a 12 anos de idade.

## **2 OBJETIVOS**

### **2.1 Objetivo geral**

Verificar se há evidências de que os caninos potencialmente impactados podem ser diagnosticados por meio de preditores clínicos em crianças na fase de dentadura mista, por meio da realização de uma revisão sistemática.

### **2.2 Objetivos específicos**

- a) Testar a seguinte hipótese nula: Não há diferença nas características clínicas entre crianças com e sem caninos potencialmente impactados, na fase de dentadura mista.
- b) Descrever diretrizes clínicas para o diagnóstico precoce de caninos superiores ectópicos em crianças na rede pública de assistência odontológica.
- c) Descrever as características dentárias e morfológicas relacionadas com caninos potencialmente impactados.



### **3 ARTIGO CIENTÍFICO**

O presente artigo científico será submetido a publicação no periódico “The Angle Orthodontist”.

**Title: Clinical predictors for diagnosis of potentially impacted canines: a systematic review**

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## **ABSTRACT**

**Objective:** To systematically review the dental and morphological characteristics associated with potentially impacted canines (PIC), in patients aged between 7-12 years.

**Materials and methods:** Digital databases (Pubmed, Scopus, Web of Science and Cochrane Library) were searched to retrieve articles published until October 2<sup>th</sup>, 2019, without language and date limits. Two reviewers independently reviewed the titles and abstracts related. The articles that met the inclusion and exclusion criteria were read in full. The selected articles were evaluated for methodological quality.

**Results:** Three case-control studies were included in the review. All reported reduced dimensions of the maxillary arch in children with PIC, such as a smaller intercanine width, shorter maxillary arch length, smaller palate area and volume. A greater association of PIC with crossbite has also been reported.

**Conclusion:** There are differences in the dental and morphological characteristics of the maxillary arch between children with and without PIC during mixed dentition stage. The predictive factors for PIC involve reduced dimensions of the maxillary dental arch, especially intercanine width and dental arch length, as well as reduced palate area and volume.

## **INTRODUCTION**

The canine plays important functional and esthetic roles in humans and altered eruption of these teeth is a great interest to the orthodontic literature<sup>1</sup>.

Maxillary canines follow the most difficult and tortuous eruption path, with more probability of disarrangement during its long eruption<sup>2</sup>. Awareness the eruption process and etiology of maxillary canine ectopia can reduce the incidence of impacted canines through early diagnosis and timely interceptive treatment<sup>3</sup>.

Clinical diagnosis of impacted canines can be performed by palpation examination and inspection. The most commonly associated clinical signs are delayed permanent canine eruption, prolonged retention of deciduous canine, absence of buccal bone bulging, presence of a palate protuberance, and distal angulation of the adjacent lateral incisor crown. The diagnosis can be confirmed with the aid of imaging exams such as radiographs and CT scans<sup>4</sup>.

Brazilian public dental care doesn't provide users with access to radiographic examination. Accurate and early clinical diagnosis is essential and its implementation in the public dental care reduce more complex and severe dental problems such as root resorption of the lateral and central incisors. Late treatments have a higher biological and financial costs and longer. Therefore, dentists should be concerned about some of the clinical features mentioned above, especially in the period of 8-9 years old.

However, there is insufficient scientific evidence to guide dentists in early clinical diagnosis of potentially impacted canines. Therefore, this study aims to conduct a systematic review to check for evidence that potentially impacted canines can be diagnosed through clinical predictors in children in mixed dentition.

## **MATERIALS AND METHODS**

### **Protocol registration**

This systematic review was registered in the international database PROSPERO and was conducted in accordance with PRISMA statement ([www.prisma-statement.org](http://www.prisma-statement.org)). There was no funding and no conflict of interest for this systematic study.

### **Information Sources**

A computerized systematic search of studies published up to October 2<sup>nd</sup>, 2019 was conducted without restrictions on language or year of publication, using the strategy

illustrated in Table 1, in the following electronic databases: PubMed, Cochrane Library, Web of Science and Scopus. The electronic search was coupled with manual searching.

### Search Strategy

The strategy made use of Boolean operators with different Mesh terms and entry terms. The Mesh Terms included “Child”, “Dentition Mixed”, “Tooth Eruption”, “Ectopic”, “Tooth, Impacted”, “Tooth”, “Unerupted”, “Cuspid”, “Maxilla”, “Anodontia”, “Hypodontia” “Malocclusion”, “Tooth Abnormalities”, “Dental Arch”, “Dental Models” (Table 1).

**Table 1. Search Strategy in Different Databases**

Key Words	Databases	Number of Articles
(child OR children OR paediatric OR pediatric OR boys OR girls OR Mixed Dentition OR Mixed Dentitions) AND (Cuspid OR Cuspids OR Canine Tooth OR Canine Teeth) AND (Impacted OR impaction OR retained OR unerupted OR ectopia OR eruption OR displaced OR malpositioned) AND (Transverse maxillary deficiency OR Transverse maxillary discrepancy OR maxilla OR palate OR occlusal features OR dental features OR Lateral incisor OR tooth abnormalities OR dental abnormalities OR anodontia OR hypodontia OR clinical predictors OR etiology OR dental models OR dental arch OR malocclusion).	Pubmed	1192
	Web Of Science	294
	Scopus	964
	Cochrane Library	80

### Eligibility Criteria

The inclusion and exclusion criteria were established based on participants, exposure, comparisons, outcomes, and study designs (PECOS). P (participants) = child in mixed dentition stage; E (exposure) = clinical predictor factors; C (comparison) = children with normal occlusion; O (outcomes) = ectopic canine diagnosis, impacted maxillary canine; S (study designs) = observational studies.

Details of inclusion and exclusion criteria are given in Table 2.

**Table 2. Inclusion and Exclusion Criteria Inclusion**

<b>Inclusion Criteria</b>	<b>Exclusion Criteria</b>
Observational, case-control, or cohort studies;	Case report, case series or literature review;
Studies evaluating children with potentially impacted canines	Studies evaluating children over 12 years old
Studies evaluating children in the mixed dentition phase, between 7 and 12 years old	Studies evaluating clinical features only on radiographs
Studies that evaluate the dental and morphological characteristics of the maxilla	Studies evaluating only treatment modalities;
Studies evaluating occlusion in clinical examination or plaster casts	Studies evaluating children with craniofacial syndromes or anomalies

### **Study Selection and Methodological Quality Criteria**

Calibration for interexaminer reproducibility was carried out for two reviewers (FCN and BH). Both reviewers independently reviewed the titles and abstracts of the articles for inclusion in the present systematic review. Disagreements about the inclusion of certain articles were resolved by a third researcher (KC).

A customized data extraction form was developed, which included the following items: authors and year of publication, study design, characteristics of the groups as number and age, methods used to evaluate exposure of interest, and to measure the outcomes, statistical analysis used, outcomes observed.

The JBI critical appraisal checklist for case-control studies was applied to assess the methodological quality of reviewed articles<sup>5</sup> The quality of the selected articles was independently assessed by the two authors who selected the studies (FCN and BH). In case of disagreement, a consensus was reached after discussion with a third author (KC). Studies were considered of low quality if they received between 0 and 3 “YES”, of medium quality between 4 and 7 “YES”, and of high quality between 8 and 10 “YES”.

## RESULTS

### Study selection

The flow diagram in Figure 1 illustrates the PRISMA process that was used to identify, screen, and select studies for inclusion in the present review. Searching through PubMed, Web of Science, Scopus and Cochrane Library retrieved about 2,530 articles. Duplicate articles (875) were removed. Titles and abstracts of 1,655 articles were read and those found unrelated to the topic of research were excluded, which led to the exclusion of 1,621 articles. This resulted in selecting 34 articles for complete reading, and the inclusion and exclusion criteria were applied to these papers. Four articles met the inclusion and exclusion criteria. During data extraction, one article was excluded due to absence of control group. Finally, three articles had the methodological quality evaluated<sup>6-8</sup>.

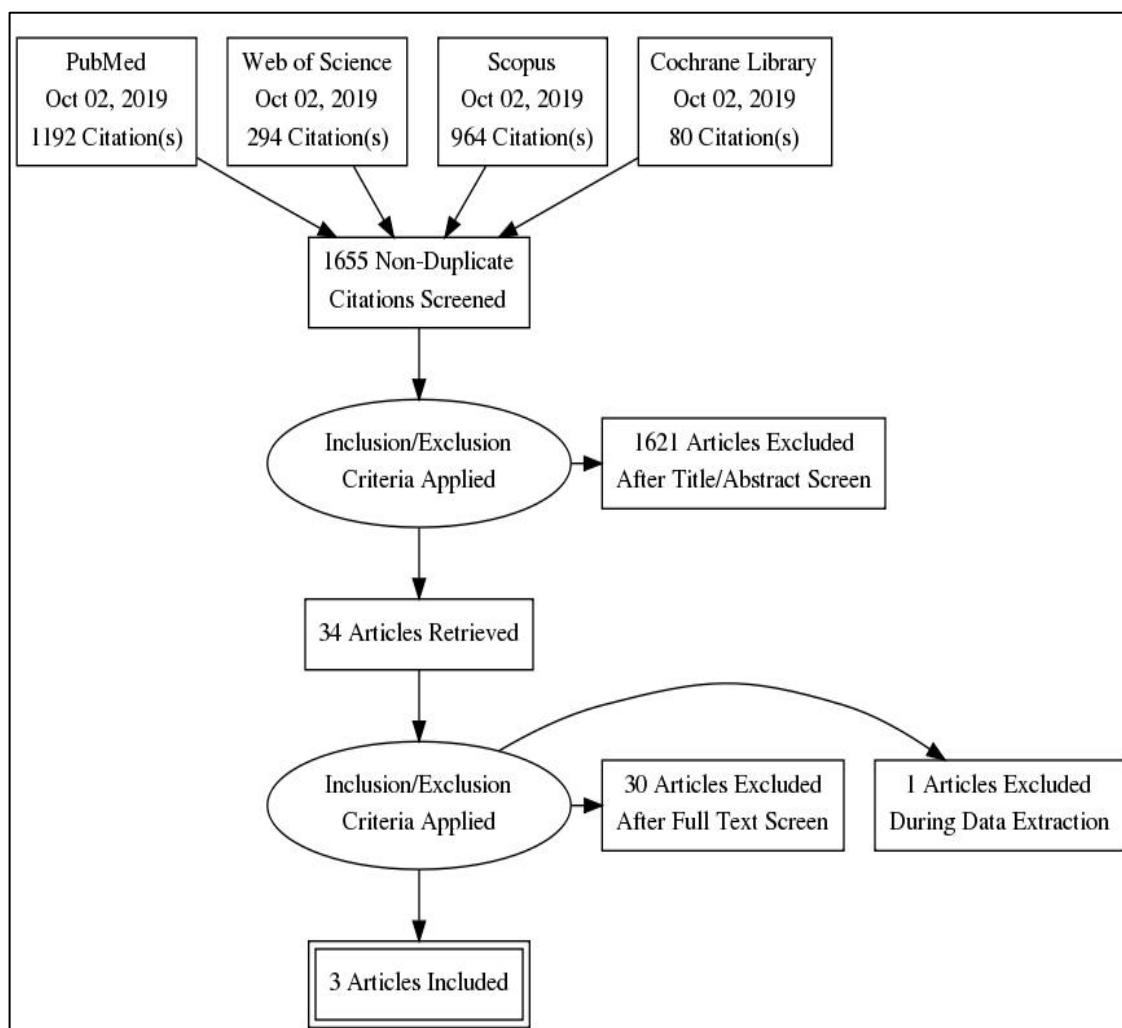


Figure 1 – Flow diagram.

### **Characteristics of the Included Studies**

The three selected articles<sup>6-8</sup> are observational case-control studies and their methodological characteristics are summarized in Table 3. Clinical factors associated with potentially impacted canines were investigated on these three articles. One article evaluated dental arch length<sup>7</sup> and the other two studies<sup>6,8</sup> investigated the transversal widths of maxillary dental arch. One study<sup>6</sup> also evaluated the palatal area and volume. All studies showed smaller maxillary measurements in children with potentially impacted canines. Bizzarro et al.<sup>6</sup> found reduced widths of intercanine maxillary arch and smaller palatal surface area and volume in the impacted canine group than in the normal canine group. Chalakkal et al.<sup>7</sup> showed a shorter arch length on the displaced canine side than in normally positioned canines. Schindel & Duffy<sup>8</sup> found 53.6% of children had an impacted canine in the crossbite group, whereas 19% had an impacted canine in the group without crossbite.

### **Quality Assessment of Selected Studies**

Table 4 presents the evaluation of the methodological quality of the three studies included in the present systematic review. Two articles<sup>6,8</sup> were considered high quality studies and the other article<sup>7</sup> as a medium quality study. They failed in relation to confounding factors which were not identified and no strategies to deal with confounding factors were stated, including some risk of bias. Other problems occurred at methodological description and statistical analysis.<sup>7</sup>

**Table 3 - Summary of the Characteristics of Included Studies.**

<b>Author, Year</b>	Bizzarro et al., 2011	Chalakkal et al., 2010	Schindel; Duffy, 2007
<b>Study design</b>	Case-control	Case-control	Case-control
<b>Groups, Age</b>	Experimental group (22F, 8M): 30 subjects with BDC, with mean age of $9.04 \pm 1.66$ years. Control group: 30 untreated non-BDC subjects (22F, 8M), with mean age of $9.26 \pm 1.48$ years.	36 subjects (20F, 16M) with unilateral PDC Range: 10-12 years Experimental: 36 sides with PDC. Control: 36 contralateral sides	Experimental group 84 subjects (42F, 42M) with maxillary transverse discrepancy. Mean age: 9.5 years. Control group 100 subjects (54F, 46M) without maxillary transverse discrepancy. Mean age: 9.9 years.
<b>Methods / Measurement</b>	Panoramic X-ray, lateral cephalograms for classification of canine sector, angle and location. Digital models for 3D evaluation of maxillary dental arch (transversal dimensions) and palate morphology (depths, area and volume).	Panoramic and perapical X-ray for canine location. Maxillary study casts for measurement of dental arch length of both sides.	Panoramic X-ray for canine sector classification. Dental casts for intermolar width measurements.
<b>Statistical analysis</b>	Mean, SD, ICC and Cohen's kappa (for intraexaminer and inter-examiners error assessment) with 95% CI, ANOVA and Student t test (for groups comparison).	Mean, SD, 95% CI, Student t test.	Frequency, percentage and Chi-square.
<b>Outcomes</b>	BDC group had a reduced intercanine widths, a narrower shape of the anterior portion and smaller palatal area and volume, while intermolar widths and depths are similar between groups.	Experimental side had smaller arch length. Experimental side: $31.38 \pm 1.98$ mm (95% CI, 29.30 to 33.45). Control side: $32.86 \pm 2.28$ mm (95% CI, 30.48 to 35.24).	Patients with a transverse discrepancy are more likely to have an impacted canine (53.6%) than are patients without a transverse discrepancy (19%).

F= female. M= male. BDC=buccally displaced canine. SD= Standard deviation. ICC= Intraclass correlation coefficient. CI= Confidence interval. PDC= Palatally displaced canine.



**Table 4 – Quality assessment of included studies according to JBI critical appraisal.**

	Bizarro et al., 2011	Chalakkal et al., 2010	Schindel; Duffy, 2007
1. Were the groups comparable other than the presence of disease in cases or the absence of disease in controls?	Yes	Yes	Yes
2. Were cases and controls matched appropriately?	Yes	Yes	Yes
3. Were the same criteria used for identification of cases and controls?	Yes	Yes	Yes
4. Was exposure measured in a standard, valid and reliable way?	Yes	No	Yes
5. Was exposure measured in the same way for cases and controls?	Yes	Yes	Yes
6. Were confounding factors identified?	Yes	No	Yes
7. Were strategies to deal with confounding factors stated?	Unclear	No	Unclear
8. Were outcomes assessed in a standard, valid and reliable way for cases and controls?	Yes	Yes	Yes
9. Was the exposure period of interest long enough to be meaningful?	Not applicable	Not applicable	Not applicable
10. Was appropriate statistical analysis used?	Yes	No	Yes

## DISCUSSION

Canine ectopic is a common occurrence, and clinicians must be prepared to manage it<sup>10</sup>. Many potentially impacted canines are not detected at an early age because clinicians do not know how to early detect this ectopia based only on dental arch and palatal characteristics. Panoramic radiographies are the most common record used to detect canines ectopia, but children should not receive radiation routinely, just when suspect of canine impaction.

In public health, where panoramic radiograph is not required routinely, mainly in children, be aware about predictive factors for canine impactions might avoid many future problems. There should be a clinical guideline for diagnosis potentially impacted

canines without radiographic images. When predictor factors are present, a panoramic x-ray should be required to confirm the diagnosis. Clinical predictors should alert dentists that something is wrong. Since the impacted canines can be early detected, dentists might be able to prevent them through clinical diagnosis, radiographic evaluation and timely interceptive treatment<sup>10</sup>.

In literature, many factors are associated to canine impaction, such as maxillary dental arch dimensions, palatal morphology, lateral incisor characteristics. According to available evidence, the maxillary measurements are reduced in cases of potentially impacted canines. Bizzarro et al. found a smaller intercanine width in patients with impacted canine cases. However, no difference was observed at intermolar width in their study. On the other hand, Schindel & Duffy found association between maxillary transverse discrepancy and potentially impacted canines, showing that those who have a posterior cross bite are about 54% likely to have an impacted canine.

A shorter dental arch length was also related to impacted canines but the authors<sup>7</sup> use a split-mouth comparison, a no reliable measurement method with only one examiner and an unappropriated statistical analysis. All these factors increase the risks of bias of their research.

No study performed sample size calculations. For the clinical diagnostic of potentially impacted canine, the selected studies used radiographic examinations. Bizzarro et al. evaluated canine position in panoramic X-ray and lateral cephalograms, Chalakkal et al. used periapical and panoramic radiographs, Schindel & Duffy used only panoramic x-ray. To classify canines location, two studies<sup>6,8</sup> cited well-known methods.

The exposures of interest were assessed by means of maxillary model casts in all studies. Only one study<sup>6</sup> digitalized the models and use a 3D evaluation program to measure the variables. Two studies<sup>6,8</sup> have the variables measured by two independent examiners. Bizarro et al. reported a high rate of reproducibility of measurements in their study. The measurements were blinded in all studied, so the examiners did not know which was case or control group/side. All studies treated statistically the data collected.

One study<sup>11</sup> was not included in the present systematic review because it had no control group. However, authors mentioned the use of palpation examination of buccal alveolar

bone surface to early detect impacted canines. This is a simple and easy exam that may help clinicians according patients age.

Many studies were not selected because of patient ages. Despite containing patients with early ages, the sample also contained patients with older ages and therefore could not be included in this review. This was a limitation of this study, but it was pretend to detect predictors factors in early age.

## Conclusions

On the basis of this review, it can be concluded that there are differences in the dental arch characteristics between children with and without potentially impacted canines in the mixed dentition stage.

Some predictor factors of potentially impacted canines involve smaller dimensions of maxillary dental arch, specially intercanine widths and dental arch lengths, and reduced palate area and volume.

More high-quality studies should be conducted to describe more predictor factors of potentially impacted canine that involve only dental arch aspects. Since those factors were detected, the clinician may require a panoramic to confirm the diagnosis and follow with properly and timely intercept treatment.

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## CONSIDERAÇÕES FINAIS

Os inúmeros prejuízos causados pela impacção de caninos permanente superiores, desperta nos ortodontistas e nos pesquisadores da área um olhar atento e cauteloso e a busca de evidências científicas para um diagnóstico precoce de uma possível impacção. A literatura apresenta muitos estudos de diagnóstico precoce de caninos potencialmente impactados. Porém em sua maioria, o diagnóstico é baseado em radiografias panorâmicas. A radiografia é um excelente recurso, e fundamental para confirmar o diagnóstico, no entanto esse recurso não está presente para toda a população. No Brasil, por exemplo o Sistema único de Saúde (SUS), não disponibiliza nas Unidades Básicas de Saúde, local onde ocorrem os atendimentos Odontológicos, o equipamento para

realizar o exame, o que leva a falta de controle/diagnóstico dessa alteração, e consequentemente complicações futuras.

Outro aspecto importante é que a faixa etária em que se pode observar e acompanhar uma possível impacção de caninos permanentes superiores, os pacientes são bastante jovens e o excesso de exposição à radiação deve ser cauteloso e baseado em sinais clínicos para sua solicitação.

A presente revisão sistemática constatou que muitos fatores estão associados à impacção de canino, como por exemplo, alterações nas dimensões da arcada dentária superior e na morfologia palatina. Além disso, os estudos associam as anomalias dos incisivos laterais aos caninos ectópicos. A identificação destes fatores clínicos não radiográficos pode gerar um guia para uso nas redes públicas de atendimento odontológico. Um estudo sugere ainda o uso do exame de palpação da superfície óssea alveolar vestibular para detectar precocemente caninos impactados. Este é um exame simples e fácil que pode ajudar os dentistas de acordo com a idade dos pacientes.

Uma vez identificados estes fatores, o clínico pode solicitar uma panorâmica para confirmar o diagnóstico e seguir com o tratamento interceptivo adequado e oportuno.

Diante disso, podemos concluir que é possível realizar um diagnóstico adequado para uma possível impacção do canino. Com um diagnóstico clínico preciso, as radiografias panorâmicas serão utilizadas apenas para a confirmação e localização desses dentes e não um recurso em larga escala “para todos os pacientes”. Além disso, pacientes que frequentam a rede pública também terão esses benefícios, e o sistema público de saúde terá uma diminuição nos custos de tratamentos futuros desses pacientes.

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## ANEXO A – NORMAS DE PUBLICAÇÃO REVISTA

### The ANGLE ORTHODONTIST Review Process on Allen Track

After the editor assigns potential reviewers, the automated system sends an e-mail to the reviewer containing a link to the manuscript. Cut and paste the link into your web browser and the Review Manuscript Instructions, Screen 1, will appear.

#### Screen 1

Screen 1, where you are now, provides Review Manuscript Instructions. Please consider the originality of the scientific work and evaluate whether it is appropriate for publication in *The Angle Orthodontist*.

Please focus your attention on the scientific merit of this article. We have technical people to manage the grammar, spelling, etc. questions that may be present. What we need most from you is your expert opinion as to the scientific merit of the article and whether the article contains:

- A clearly stated goal or objective or working hypothesis at the start of the ABSTRACT and in the article text.
- An INTRODUCTION briefly focusing on the background necessary to place the study in perspective in the area of interest.
- A METHODS AND MATERIALS that clearly describe the universe and how the sample is sequential or truly randomly derived from the universe as well as the criteria used to include or exclude the sample. The METHODS AND MATERIALS should enable the reader to potentially replicate the study described. Anything less than this should be brought to the author's attention.
- A RESULTS section that gives the reader readable data that specifically address the original objective or hypothesis of the study. The RESULTS should not be a prosaic presentation of all the incidental data in the tables or figures that occurred in the study.
- A DISCUSSION that relates the findings of the present study to previous information in the field and speculates on the importance or application of the data derived from this study.
- A CONCLUSION section that clearly states the conclusions reached in the study. This section should not contain a repeat of the METHODS or DISCUSSION.
- A REFERENCE list limited to those necessary to support the study.
- Individual files for each TABLES and FIGURE with the total number limited to those directly relevant to the study.

If you recommend a revision of the manuscript, the author will appreciate all the guidance you can offer in what revisions are needed.

If you recommend rejection of the manuscript, please provide some rationale for your decision.

If the manuscript is a Case Report, it would be most helpful if you would indicate not only the quality of the case write-up, but the value of the treatment described in terms of its uniqueness and/or contributions. A case report must show more than a well treated routine case. A case report should provide some information regarding what is unique or possible in treatment.

When you are ready, click on the button at the bottom of the page that says Start Review and you will be presented with Screen 2, and access to the PDF manuscript.

#### Screen 2

Screen 2 is where the review process starts. It contains summary manuscript information and provides access to the manuscript. Click on merged file PDF, and you will download the manuscript. You may print out the PDF manuscript or you may read it on screen. You may go back or stop at any time and return at time later as necessary. The manuscript will continue to be accessible.

When you are ready to proceed, click on Review Manuscript, at the bottom of the page and you will be presented with Screen 3.

#### Screen 3

Screen 3 presents the review form which requires an entry for each item. All drop-down menus also need to be completed.

At the bottom of the form is a box for comments. If you prefer to work offline, you may draft your remarks using your word processor and cut/paste the review into the reviewer remarks box on this screen. You may also enter your comments directly into the box. Your comments may be as lengthy as is required for the manuscript.

The reviewer can leave and return to the manuscript at any time by using the link in the original e-mail or by going to the reviewer's Home Page.

The reviewer completes the review by clicking on the Submit Recommendation button and the review will be sent to the editor.

After the review is submitted, the system will send an automated e-mail acknowledgement of receipt of the review to the reviewer.