

**UNIVERSIDADE FEDERAL DE SANTA CATARINA
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RAMIRO LUIZ CALZA

Prevalência de reabsorção radicular após autotransplante de dentes com rizogênese completa: uma revisão sistemática

Florianópolis
2021

Ramiro Luiz Calza

**PREVALÊNCIA DE REABSORÇÃO RADICULAR APÓS
AUTOTRANSPLANTE DE DENTES COM RIZOGÊNESE COMPLETA: UMA
REVISÃO SISTEMÁTICA.**

Trabalho de Conclusão do Curso de Graduação em Odontologia do Centro de Ciências da Saúde da Universidade Federal de Santa Catarina como requisito para a obtenção do título de Cirurgião-Dentista.

Orientadora: Prof^a. Dr^a. Cleonice da Silveira Teixeira.

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Este TCC foi julgado adequado para a obtenção do Título de “Cirurgião Dentista” e
aprovado em sua forma final pelo Curso de Graduação em Odontologia.

Florianópolis, 26 de agosto de 2021.

Prof^a. Gláucia Santos Zimmermann
Coordenadora do Curso de Graduação em Odontologia

Banca Examinadora:

Prof^a. Cleonice da Silveira Teixeira, Dr^a. (Orientadora)
Universidade Federal de Santa Catarina

Prof^o. Lucas da Fonseca Roberti Garcia, Dr.
Universidade Federal de Santa Catarina

Prof^a. Daniela Peressoni Veira Schuldt, MSc
Universidade do Sul de Santa Catarina

Aos meu *pais, familiares e amigos* que
estiveram sempre na torcida e entenderam
meus momentos de ausência.

Este trabalho é para vocês!

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APRESENTAÇÃO

Este Trabalho de conclusão de curso foi originalmente escrito como um artigo na língua inglesa, com o objetivo de ser submetido ao periódico *Clinical Oral Investigations*. Essa pesquisa foi realizada em parceria com os coautores que submeteram o protocolo junto ao PROSPERO.

RESUMO

Introdução: O autotransplante dentário é considerado um tratamento viável na resolução dos problemas oclusais após perdas dentárias localizadas. Entretanto, a ocorrência de reabsorção radicular (RR) pode ser causa de insucesso desse tratamento, principalmente quando o dente doador apresentar rizogênese completa. Diante disso, é importante que o cirurgião dentista conheça a prevalência da RR antes de indicar o autotransplante em sua prática clínica. **Objetivo:** Revisar sistematicamente a literatura acerca da prevalência da RR após o autotransplante de dentes com formação completa da raiz. **Materiais e Métodos:** Dois revisores pesquisaram a literatura de forma sistemática nas seguintes bases de dados: Cochrane Library, EMBASE, Literatura Latino-americana e do Caribe em Ciências da Saúde (LILACS), MEDLINE PubMed, Scopus e Web of Science. Adicionalmente, pesquisa complementar foi realizada na literatura cinzenta e incluiu as bases Google Scholar, OpenGrey e ProQuest teses e dissertações, eletronicamente e manualmente, para a identificação de estudos clínicos observacionais, prospectivos e retrospectivos, que verificaram a RR após o autotransplante dental. Foram excluídos estudos em dentes com rizogênese incompleta, relatos e série de casos com menos de 10 casos, revisões, estudos em animais e laboratoriais, ou que não investigaram a prevalência da RR após o autotransplante dental. Após a seleção dos estudos e extração de dados, a avaliação do risco de viés foi realizada por meio da lista de verificação JBI Critical Appraisal Checklist e JBI-MAStARI. A prevalência da RR e de seus subtipos foi calculada considerando efeito randômico. **Resultados:** Com a conclusão da busca e remoção dos duplicados, foram identificados 1979 estudos potenciais. Após a fase um de seleção (triagem de títulos e resumos), 81 estudos permaneceram para a fase dois (leitura de texto completo), sendo vinte e cinco finalmente incluídos. A maioria dos estudos foi considerado como sendo de médio ou alto risco de viés. A ocorrência de RR interna, superficial, inflamatória e substitutiva foi calculada especificadamente através da taxa de prevalência. Em geral, o tipo mais comum de RR relatado foi a RR inflamatória (23 estudos), seguido por RR de substituição (19 estudos), RR interna (6 estudos) e RR superficial (3 estudos). **Conclusões:** A prevalência geral de RR de dentes autotransplantados com rizogênese completa foi de 30% e 41% nos estudos prospectivos e retrospectivos, respectivamente. A reabsorção mais comum observada nos estudos foi a RR inflamatória.

Keywords: Reabsorção radicular. Autotransplante dental. Rizogênese completa. Revisão sistemática.

ABSTRACT

Introduction: Dental autotransplantation is considered a viable treatment for solving occlusal problems after single unit tooth loss. However, the occurrence of root resorption (RR) may be the cause of this treatment failure, especially when the donor tooth presents complete rhizogenesis. Therefore, it is important that the dental surgeon knows the prevalence of RR before indicating autotransplantation in their clinical practice. **Objective:** To systematically review the literature on the prevalence of RR after autotransplantation of teeth with complete root formation.

Materials and Methods: Two reviewers systematically searched the literature in the following databases: Cochrane Library, EMBASE, Latin American and Caribbean Health Sciences Literature (LILACS), MEDLINE PubMed, Scopus and Web of Science. Additionally, complementary research was carried out in the gray literature and included the bases Google Scholar, OpenGrey and ProQuest theses and dissertations, electronically and manually, to identify observational, prospective and retrospective clinical studies that verified RR after dental autotransplantation. Studies on teeth with incomplete rhizogenesis, case reports and series with less than 10 cases, reviews, animal and laboratory studies, or those that did not investigate the prevalence of RR after dental autotransplantation were excluded. After study selection and data extraction, the risk of bias assessment was performed using the JBI Critical Appraisal Checklist and JBI-MAStARI checklist. The prevalence of RR and its subtypes was calculated considering a random effect. **Results:** Upon completion of the search and removal of duplicates, 1979 potential studies were identified. After selection phase one (screening of titles and abstracts), 81 studies remained for phase two (full text reading), with twenty-five articles finally included. Most studies were considered to be at medium or high risk of bias. The occurrence of internal, superficial, inflammatory and replacement RR was specifically reported through the prevalence rate. In general, the most common type of RR documented for transplanted teeth was inflammatory RR (23 studies), followed by replacement RR (19 studies), internal RR (6 studies) and surface RR (3 studies).

Conclusions: The overall prevalence of root resorption of autotransplanted teeth with complete root formation was 30% and 41% in prospective and retrospective studies, respectively. The most common resorption observed in the studies was inflammatory root resorption.

Keywords: Root resorption. Tooth autotransplantation. Complete root formation. Systematic review

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LISTA DE ABREVIATURAS E SIGLAS

RS – *Revisão sistemática*

Do artigo em inglês:

GRADE - *The Grading of Recommendations Assessment, Development and Evaluation*

JBI – *Joanna Briggs Institute*

PRISMA - *Preferred reporting items for systematic reviews and meta-analysis*

PRISMA-P - *Preferred reporting items for systematic reviews and meta-analyses protocols*

n – *number of teeth with resorption*

N - *sample analysed*

NA - *Not applicable*

NI – *Not informed*

SR - *Systematic review*

RR - *Reabsorção radicular ou root resorption*

LPD - *Ligamento Periodontal*

PCT – *Estudos prospectivos ou prospective studies*

RCT – *Estudos retrospectivos ou retrospective studies*

AD – *Autotransplante dentário*

IRR - *Inflammatory Root Resorption*

LISTA DE SÍMBOLOS

% Percentual

± Mais ou menos

** Data calculated by authors.

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1 INTRODUÇÃO

O autotransplante dentário é realizado há décadas, mas sua popularidade variou muito ao longo dos anos devido aos resultados imprevisíveis que acompanhavam o procedimento cirúrgico realizado pela maioria dos cirurgiões dentistas (BOKELUND *et al.*, 2013). No entanto, com recentes avanços tecnológicos e melhor entendimento biológico, o autotransplante dental tornou-se mais previsível (BOKELUND *et al.*, 2013). Ainda assim, muitos dentistas não estão confiantes sobre essa técnica cirúrgica, em parte devido à falta de estudos sobre os resultados em longo prazo desses casos (BOKELUND *et al.*, 2013).

Desde os primeiros autotransplantes de terceiros molares em humanos, publicados por Apfel e Miller em 1950 (ANDREASEN *et al.*, 1990), vários aspectos pertinentes à realização do autotransplante vêm sendo descritos, principalmente quanto às técnicas cirúrgicas utilizadas e aos *feedbacks* satisfatórios dos procedimentos realizados (ANDREASEN; HJØRTING-HANSEN; JØLST, 1970; NAGORI *et al.*, 2014). Durante o final do século passado e início deste século, vários estudos têm sido publicados, incluindo estudos prospectivos e relatos de série de casos com transplantes de molares, pré-molares e caninos (ANDREASEN *et al.*, 1990b). Tais estudos esclarecem o prognóstico, os fatores de risco e alguns protocolos de procedimentos cirúrgicos do autotransplante dental (ANDREASEN *et al.*, 1990; NAGORI *et al.*, 2014).

O autotransplante dentário é considerado um tratamento viável na resolução dos problemas oclusais após perdas dentárias localizadas, principalmente pelo fato do dente transplantado suprir muito bem as funções normais do dente substituído, quando o procedimento for bem sucedido (SUGAI *et al.*, 2010).

Além de ser uma opção aceitável, o autotransplante restabelece a função mastigatória, possibilita estética apropriada e apresenta custo inferior em comparação ao tratamento com implantes dentários (KOKAI *et al.*, 2015). Além do mais, em contraste com a osseointegração de implantes, os dentes autotransplantados oferecem adaptação funcional e preservação do osso alveolar e das cristas alveolares (BAUSS *et al.*, 2004, KOKAI *et al.*, 2015).

O prognóstico do autotransplante dental é influenciado pelas condições existentes no pré e pós-operatório do paciente, dentre as quais podemos citar: presença ou a ausência de doenças prévias, hábito de fumar, tipo de dente doador, profundidade à sondagem,

estado de erupção, contato com o dente oposto, história de cárie dentária, história de restauração prévia, história do tratamento de canal, duração da ausência dos dentes e posição do dente no sítio destinatário (SUGAI *et al.*, 2010). Ainda, o protocolo de operação, número de raízes dos dentes doadores, fratura radicular dos dentes doadores, número de paredes ósseas do alvéolo, relação de posição do dente doador no local do destino, necessidade de ajustes e tipo de fixação (SUGAI *et al.*, 2010). Tudo isso vêm sendo apontado como fatores que influenciam no prognóstico (NIIMI *et al.*, 2011).

No pós operatório, sobretudo, pode-se ressaltar a importância de verificar o reparo inicial na radiografia periapical, a realização e duração do tratamento endodôntico, profundidade à sondagem, e atraso na regeneração óssea (SUGAI *et al.*, 2010). A longevidade e o prognóstico dos dentes autotransplantados podem variar de acordo com o grau de rizogênese do elemento dental submetido ao procedimento cirúrgico, tendo em média, taxas maiores de sucesso em dentes com rizogênese incompleta (SUGAI *et al.*, 2010). Por outro lado, taxas consideradas satisfatórias podem ser alcançadas com o seguimento e controle dos fatores prognósticos em dentes com rizogênese completa (ANDREASEN *et al.*, 1990; KRISTERSON, 1985; KVINT *et al.*, 2010).

Considerando os fracassos no autotransplante dental de dentes com rizogênese completa, os casos com menor longevidade geralmente estão relacionados às diversas complicações durante e após a cirurgia (KRISTERSON; LAGERSTRÖM, 1991). Nesses casos, a ocorrência de reabsorção radicular (RR) progressiva e anquilose após o autotransplante dental está fortemente relacionada à ocorrência de danos à superfície radicular durante os procedimentos cirúrgicos de extração e reimplante dental (ANDREASEN; KRISTERSON, 1981; TSUKIBOSHI; YAMAUCHI; TSUKIBOSHI, 2019). Por sua vez, o desenvolvimento de RR inflamatória dependerá da combinação entre o dano à superfície radicular e a presença de contaminação bacteriana, oriunda do ligamento periodontal (LPD) ou do espaço pulpar (ANDREASEN *et al.*, 1981; KRISTERSON, 1985; TSUKIBOSHI; YAMAUCHI; TSUKIBOSHI, 2019).

Os dois principais fatores que influenciam a taxa de sobrevivência do autotransplante dentário de dentes com rizogênese completa são: o período de início do tratamento endodôntico, se antes ou após o transplante (ANDREASEN *et al.*, 1990a), e o grau de preservação do cimento radicular durante os procedimentos cirúrgicos (TSUKIBOSHI; YAMAUCHI; TSUKIBOSHI, 2019). Outro fator que pode influenciar os resultados alcançados após o autotransplante dental é a forma e o tempo de espiantagem dos dentes após a cirurgia (AKIYAMA; FUKUDA; HASHIMOTO, 1998; NIIMI *et al.*,

2011). Além do mais, fatores relacionados ao tempo em que os dentes permanecem fora da loja óssea também parecem afetar o prognóstico (NIIMI *et al.*, 2011). O tipo de dente doador e a profundidade de sondagem no pré e pós operatório são outros fatores que podem interferir no prognóstico e aumentar as chances de RR (SUGAI *et al.*, 2010).

O tipo de procedimento reabilitador pós-cicatrização, seja ele ortodôntico ou protético, também pode influenciar nos desfechos do autotransplante dental (YOSHINO *et al.*, 2012; KOKAI *et al.*, 2015). O prognóstico para o autotransplante dentário depende também de como a técnica cirúrgica é realizada e da experiência do operador (YOSHINO *et al.*, 2012a).

O autotransplante de dentes com rizogênese completa requer tratamento endodôntico com início dentro de um prazo médio entre 1 a 3 semanas após o procedimento cirúrgico (SUGAI *et al.*, 2010). A realização da endodontia é necessária para evitar a infecção pulpar, o que pode acarretar maior inflamação perirradicular e subsequente reabsorção inflamatória dos tecidos dentários e ósseos, porque nesses casos a revascularização da polpa não é normalmente esperada (ANDREASEN *et al.*, 1990; MEJÀRE; WANNFORS; JANSSON, 2004; ARIKAN; NIZAM; SONMEZ, 2008;).

O tratamento endodôntico primário, quando realizado em até 4 semanas da operação, juntamente com a remoção da esplintagem, pode diminuir os riscos de trauma químico e mecânico e auxiliar no reparo tecidual após esse período (KOKAI *et al.*, 2015). Também tem sido relatado que o uso de curativo de demora com hidróxido de cálcio pode ser benéfico ao tratamento, pois aumenta o PH da dentina (8 a 10) e, portanto, inibe a atividade osteoclástica - o que reduz a ocorrência de processos inflamatórios e reabsortivos (TRONSTAD *et al.*, 1981; KOKAI *et al.*, 2015).

Alguns resultados sugerem que a presença do cimento é importante para a regeneração do LPD, então, um pré-requisito para um bom prognóstico é a extração atraumática (AKIYAMA; FUKUDA; HASHIMOTO, 1998). A cura favorável do ligamento periodontal (LPD) depende de quão viável as células são mantidas (PROYE; POLSON, 1982; TSUKIBOSHI; YAMAUCHI; TSUKIBOSHI, 2019).

As células do LPD, como resultado de várias condições extra-orais, podem ser danificadas, tanto mecânica quanto bioquimicamente, pois são facilmente lesionadas sob estresse de variações de pH, equilíbrio ósmótico, pressão e desidratação (TROPE; FRIEDMAN, 1992). Muitos estudos mostram a ocorrência de cicatrização óssea completa quando a técnica cirúrgica foi realizada de forma meticulosa, e se suficiente

remanescente do LPD foi preservados durante os procedimentos do transplante (KOKAI *et al.*, 2015)

Ainda, a forma e o tempo de esplintagem dos dentes após a cirurgia podem também influenciar os resultados alcançados após o autotransplante dental (YOSHINO *et al.*, 2012b). Após a abertura do retalho o dente transplantado é imobilizado usando suturas ou fios de contenção flexíveis e/ou rígidos ou uma combinação dos dois (fios e suturas) (YOSHINO *et al.*, 2012b). A ausência de esplintagem pode acelerar a instabilidade e prejudicar a cicatrização, bem como a escolha incorreta do tipo e tempo de esplintagem pode levar a processos de anquilose dental (YOSHINO *et al.*, 2012a).

No geral, após o autotransplante dental, diversos estudos têm demonstrado taxas cumulativas de anquilose e de RR inflamatória bastante heterogêneas (JANG *et al.*, 2016; ANDREASEN *et al.*, 1990a). Porém, em sua grande maioria, os estudos relataram o transplante de dentes com rizogênese incompleta, onde o foco analisado era baseado em fatores como desenvolvimento e erupção, estágio do dente doador, cicatrização pulpar e RR do dente transplantado (KOKAI *et al.*, 2015)

Investigações em autotransplantes dentários com rizogênese completa demonstraram taxas de RR na ordem de 55% (NIIMI *et al.*, 2011). Outros estudos taxas de 4,05% ou 6,75 % (LUNDBERG; ISAKSSON, 1996). Evidencia-se assim, grandes discrepâncias. Até mesmo revisões sistemáticas já publicadas sobre autotransplantes não focaram no quesito RR, seja ela inflamatória ou substitutiva (SUGAI *et al.*, 2010). Dessa forma, não trouxeram nenhuma conclusão de evidência sobre o assunto (CHUNG *et al.*, 2014).

Além do mais, como a ocorrência de reabsorção inflamatória e substitutiva estão relacionadas como causas de insucesso dos reimplantes e transplantes dentais, é importante que estudos sejam feitos a fim de responder qual a prevalência desses processos nos autotransplantes de dentes com rizogênese completa.

O autotransplante dentário é considerado um tratamento viável na resolução dos problemas oclusais após perdas dentárias localizadas, principalmente pelo fato do dente transplantado suprir muito bem as funções estéticas e funcionais do dente substituído (SUGAI *et al.*, 2010). Com o aprimoramento dos protocolos cirúrgicos e melhores prognósticos do tratamento, estudos clínicos de autotransplantes dentais em humanos vêm sendo realizados com muita frequência, sendo importante que tais resultados sejam conhecidos e avaliados (YANG; JUNG; PANG, 2019; YOSHINO *et al.*, 2012b). Apesar dos bons resultados, observa-se que a ocorrência de RR pode ser causa

de insucesso desse tipo de tratamento, principalmente quando o dente doador apresentar rizogênese completa (KVINT et al., 2010; MENDOZA-MENDOZA et al., 2012; LUCAS-TAULÉ et al., 2021). Diante disso, é importante que o cirurgião dentista conheça a prevalência da RR antes de indicar o autotransplante em sua prática clínica. Assim, há necessidade de que sejam avaliadas as técnicas e conhecimentos biológicos utilizados para minimizar a ocorrência e a gravidade da RR após autotransplante de dentes com rizogênese completa. Por serem técnicas cirúrgicas dependentes de muitas variáveis, com grande potencial de complicações quando o dente doador já tiver raiz completamente formada (MEJÀRE; WANNFORS; JANSSON, 2004; LUCAS-TAULÉ et al., 2021), não há ainda consenso na literatura acerca da prevalência da RR em tais casos, o que justifica o estudo do presente tema.

2 OBJETIVOS

2.1 OBJETIVO GERAL

Responder sistematicamente à pergunta de pesquisa: Qual é a prevalência da RR após o autotransplante de dentes com rizogênese completa?

2.2 OBJETIVOS ESPECÍFICOS

1. Realizar a busca sistemática na literatura com base em critérios de elegibilidade pré-definidos e selecionar os estudos com maior nível de evidência disponíveis;
2. Avaliar o risco de viés dos estudos publicados na literatura e incluídos na Revisão Sistemática (RS);
3. Identificar a prevalência de RR após o autotransplante de dentes com rizogênese completa;
4. Investigar, isoladamente, a prevalência dos diferentes tipos de RR em dentes que foram autotransplantados após terem formação completa da raiz.

3 ARTIGO

Title Page

Prevalence of root resorption in autotransplanted tooth with complete root formation: a systematic review

Ramiro Luiz Calza¹, Cleonice da Silveira Teixeira^{1*}

¹Department of Dentistry, Health Science Center, Federal University of Santa Catarina, Florianópolis, Santa Catarina, Brazil.

***Corresponding author:**

Department of Dentistry - Endodontics Division, Health Sciences Center, Federal University of Santa Catarina. Address: Campus João David Ferreira Lima, Trindade, Florianópolis, Santa Catarina, Brazil.

CEP: 88040-900, Telephone: +55 48 3721-5840; +55 48 3721-9520

E-mail: cleonice.teixeira@ufsc.br / cleotex@uol.com.br

Short Title: Resorption after transplant of formed teeth

Keywords: autotransplantation, complete root formation, prevalence, root resorption, systematic review.

Conflict of interest:

The authors deny any conflict of interest related to this study

Contribution Statements

All authors contributed to the study conception and design, especially Cleonice Silveira Teixeira and Ramiro Luiz Calza. Material preparation, data collection and analysis were performed by Cleonice da Silveira Teixeira and Ramiro Luiz Calza. The first draft of the manuscript was written by Cleonice da Silveira Teixeira and Ramiro Luiz Calza. All authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

ABSTRACT

Objectives: This systematic review (SR) aimed to analyze in the literature the prevalence of root resorption (RR) after autotransplantation of teeth with complete root formation.

Material and Methods: Six databases were searched (Cochrane, EMBASE, Latin American and Caribbean Health Sciences (LILACS), PubMed (including Medline), Scopus and Web of Science. Additionally, the gray literature (Google Scholar, OpenGrey, and ProQuest) was searched electronically and manually to identify observational, prospective, and retrospective studies that assessed RR after dental autotransplantation. After study selection and data extraction, the risk of bias assessment was performed using the JBI Critical Appraisal Checklist and JBI-MAStARI.

Results: Among 4462 identified studies, 25 articles (13 prospective and 12 retrospective) remained for final analysis. The studies were considered at medium and high risk of bias. The occurrence of internal, superficial, inflammatory and replacement RR was specifically reported through the prevalence rate. The highest rates of RR prevalence were observed in older studies, where the surgical protocol for autotransplantation was less meticulous. In general, the most common type of RR documented for transplanted teeth was inflammatory RR (23 studies), followed by replacement RR (19 studies), internal RR (6 studies) and surface RR (3 studies).

Conclusions: The overall prevalence of root resorption among autotransplanted teeth was approximately 30% and 41% in the prospective and retrospective studies, respectively. The most common resorption presented was the inflammatory external root resorption.

Clinical relevance: Dental autotransplantation is considered a viable treatment for resolving occlusal problems after localized tooth loss. However, the occurrence of root resorption (RR) may be the cause of failure of this treatment. Therefore, it is important that the dental surgeon knows the prevalence, causes and advance care of RR before indicating autotransplantation in their clinical practice.

Keywords: autotransplantation, complete root formation, prevalence, root resorption, systematic review.

INTRODUCTION

Dental autotransplantation is a clinical procedure in which a tooth is surgically removed from its socket and transplanted to another alveolar site in the same oral cavity from which it was removed [1, 2]. This procedure has been commonly used as a way to replace missing teeth, but its popularity has varied over the years, mainly due to the unpredictable results that accompanied autotransplantation, due to root resorption and periodontal attachment loss of the dental element [2, 3]. However, with recent technological advances and newer biological knowledge, dental autotransplantation has become more predictable and presents better prognosis [2]. Still, many dentists are not confident about this surgical procedure, in part due to the lack of long-term clinical studies on the outcomes of these cases [2, 4].

Dental autotransplantation is considered a viable treatment for solving occlusal problems caused by localized tooth loss or absence [5]. This is due to the fact that the transplanted tooth supplies the normal functions of the replaced tooth very well, when tooth transplantation is successful [6]. In addition of being an acceptable option, autotransplantation restores masticatory function, enables appropriate aesthetics and has a lower cost compared to treatment with dental implants [1].

Considering failures in autotransplantation of teeth with complete root formation, cases with shorter longevity are usually related with several complications during and after surgery, which lead to reabsorptive processes [7]. In these cases, the occurrence of root resorption (RR) by replacement is strongly related due to the damage caused to the root surface during tooth extraction and reimplantation surgical procedures [8, 9]. In turn, the development of inflammatory RR will depend on the combination of root surface damage and bacterial contamination, that may come from the periodontal ligament or pulp space [8–10].

Some of the main factors studied, which can change the prognosis and influence the survival rate of dental autotransplantation, includes the period of endodontic treatment beginning [8] and the form and time of teeth splinting after [4, 11]. Still, the operation protocol and the number of roots of the donor teeth (considering their morphology) seems to be important factors for better surgery outcome [4].

As the occurrence of RR has been related as one of the dental autotransplants failure causes, it is important that studies are carried out in order to answer the prevalence of this process after autotransplantation of teeth with complete rhizogenesis. Reviews on

RR in dental autotransplants have already been carried out, however, in addition to being the result of literature searches performed more than 5 years ago, such reviews did not clearly specify the RR prevalence rate [12] or did not delimit the study in teeth with complete root formation [13]. As a result, new systematic reviews are important for understanding the risks and benefits that involve this technique. Therefore, the aim of this systematic review (SR) was to answer the following focused question: “What is the prevalence of RR in autotransplanted tooth with complete root formation?”

MATERIAL AND METHODS

Protocol and Registration

This SR was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta Analyses (PRISMA) checklist [14]. A systematic review protocol based on PRISMA-P guidelines [15] was performed and registered at the International Prospective Register of Systematic Reviews (PROSPERO) under the code CRD42020141516.

Eligibility criteria

Inclusion criteria

This SR was conducted using the acronym PICOS, in which the participants (P) were permanent human teeth; intervention (I) was represented by autotransplantation of a tooth with complete root formation; and the outcome (O) was the prevalence of general root resorption, prevalence of external RR (surface RR, inflammatory RR, replacement RR / ankylosis) and Internal RR; and studies (S) were observational studies (prospective, retrospective and case series studies). As this study is a prevalence study, it does not have a comparison group (C).

The prevalence of different types of RR was observed in teeth with complete root formation undergoing dental autotransplantation, and with a minimum follow-up period of at least 6 months after transplant surgery. In these studies, any mean of radiographic imaging assessment was accepted to detect the presence of RR. External RR (superficial, inflammatory, replacement or ankylosis) and internal RR rates were analyzed. The timing of endodontic treatment, the method and duration of splinting, orthodontic treatment and the morphology of the donor tooth were also described. Furthermore, the interference of

RR on the success rate (SR) was evaluated. Means used for RR prevention or treatment were also included. No restrictions based on age, sex and ethnicity were made. To reduce the risk of publication and retrieval bias, no limitation on dates or publication status were done. Only articles written using the Latin (Roman) alphabet were accepted.

Studies were excluded using the following criteria: 1) Studies that did not report RR related to dental autotransplantation in permanent teeth with complete root formation; 2) Studies previously included in this review; 3) Studies in which the full text copy was not available; 4) Animal studies, reviews, case reports, conference abstracts, letters, opinion articles, books, case series with less than 10 teeth; 5) Studies that received additional therapies, such as cryotherapy or two stage surgery; 8) Studies that did not report RR prevalence or in which the data presented could not be evaluated; 9) Studies published in another alphabet than the Latin (Roman) one.

Information sources and study selection

The literature search was performed on July 6, 2019 and was updated on April 19, 2021. Two independent authors (CST, RLC) performed the electronic and manual literature searches using key words in different combinations and Medical Subject Heading (MeSH) terms (see [Appendix 1](#)). The search was conducted using the following electronic data bases: Cochrane, Embase, LILACS, PubMed (including Medline), Scopus and Web of Science. An additional search in the gray literature (Google Scholar, OpenGrey, and ProQuest), as well as manual searches across included studies references lists, were performed. In order to locate additional studies, experts were also consulted. The reference manager software (EndNote X7, Thompson Reuters, Philadelphia, PA) was used to collect references and remove duplicate articles. The two authors (CST and RLC) independently examined the titles and abstracts, using the electronically available application, Rayyan QCRI (Qatar Computing Research Institute - Data Analytics, Doha, Qatar). Next, these authors read the full text of potential articles. Disagreements were resolved after consensus by both reviewers or by consulting a third reviewer (JCR).

Data Collection process

The characteristics of the included studies were collected by two independent reviewers (CST and RLC), and the information was compiled after consensus among them, in order to ensure the collected data integrity. Descriptive characteristics were recorded and the results were grouped according to the first author last name, year of

publication, country, study design, population (gender, mean age), type of donor tooth, surgical procedures, average of follow-up (in years), exams used for RR observation, types and percentages of RR, average time and type of splinting used, additional treatments (orthodontics, endodontics and prosthesis), survival rates, and the main study conclusion.

Risk of bias (RoB) in the included studies

RoB in the included studies was independently assessed by two reviewers (CST and RLC). RoB of quasi-randomized clinical trials was assessed using the Joanna Briggs Institute Critical Appraisal Checklist for Studies Reporting Prevalence Data tool [16]. For the retrospective studies and case series the JBI-MAStARI Critical Appraisal Checklist for Descriptive/Case Series studies tool was used [16]. RoB was categorized as high when the study achieved up to 49% of a “yes” score, moderate when the study achieved a 50% to 69% “yes” score, and low when the study achieved more than 70% of a “yes” score. A conference between the two reviewers was held, and any disagreements were discussed and decided with the third reviewer. Figures were generated using RevMan 5.4 softwares (Review Manager 5.4, The Cochrane Collaboration).

Summary measures and synthesis of results

Quantitative analysis of the results was performed considering the general prevalence of RR in autotransplanted teeth with complete root formation as the primary outcome, measured by relative or absolute frequencies and their 95% confidence intervals (CI). The prevalence of types of RR was considered as a secondary outcome.

A meta-analysis (MA) of proportions and graphs was performed using Jamovi software (The Jamovi Project, Version 1.6, retrieved from <https://www.jamovi.org>). The size and impact of heterogeneity were measured with Tau^2 and I^2 , respectively, with a significance level set at 5%. A random effect model was used for the analyses, as the articles included covered a wide range of studies with different methodologies. Forest plot were used to graphically represent the results of the meta-analysis.

Results

Study selection

The initial search strategy identified 4,462 citations that, after removing duplicates, resulted in 1,979 studies. Another 100 additional studies from Google Scholar, 04 from OpenGrey and 19 from ProQuest were identified. After applying the eligibility criteria, 81 studies were selected for full text review. After thorough reading and analysis, 56 of these studies were excluded ([Appendix 2](#)), which resulted in the final inclusion of 25 studies for qualitative and quantitative syntheses. The study selection procedure, the number of excluded studies, and the corresponding reasons for exclusion are provided in the flow diagram of literature search and selection criteria ([Figure 1](#)).

Characteristics of the studies

The results regarding the characteristics of the included studies are summarized in [Table 1](#). Among the twenty-five studies included [[1, 3, 21–30, 4, 31–35, 8, 10, 11, 17–20](#)] 13 studies are prospective (PCT) and 12 are retrospective (RCT). The studies were organized and information were synthesized into author and year, origin country, dental arch and dental group of the transplanted tooth, gender and mean age of patients, follow-up time, type of exam used in the RR evaluation and the main conclusion of each study ([Table 1](#)).

All studies were published between 1978 and 2021, and were written in English. Regarding the country of origin, five studies were from Japan [[1, 4, 11, 27, 30](#)] and other five studies were from Sweden [[10, 17, 22, 26, 27](#)]. Denmark, Australia, South Korea and China were the countries of two studies origin each. The other countries appeared only in one study each.

As for the sample data, the mean age of the included participants ranged from 16.8 years [[30](#)] to 44.1 years [[34](#)]. The dental group most frequently included in the studies was the molar group, with 12 studies [[1, 4, 34, 35, 11, 22, 25–27, 29, 32, 33](#)] followed by canines, which was used in 10 studies [[4, 17–23, 26, 28](#)]. The other dental groups, premolars [[1, 4, 10, 22, 26, 33, 36](#)] and incisors [[1, 34](#)] were used less frequently. Most of the studies reported the use of a standardized surgical protocol. The mean follow-up time for cases ranged from 0.5 years [[11](#)] to 14.5 years [[28](#)].

As main conclusions, many studies highlight the need for care during surgical procedures so as not to damage periodontal support tissues, which play an important role in improving the autotransplantation prognosis [3, 10, 11, 17, 19, 24]. Studies also reported the importance of performing endodontic treatment as soon as possible [19, 21, 22].

Data regarding autotransplanted teeth with complete root formation survival and resorption can be seen in Table 2 (PCT studies) and Table 3 (RCT studies). Summary data for internal RR, surface RR, inflammatory RR and replacement RR, and numbers of teeth followed are provided in Table 4. The number of autotransplanted teeth per study ranged from 16 teeth [10] to 559 teeth [34] (Table 4). Among the different types of RR evaluated (internal RR, surface RR, inflammatory RR and replacement RR) it was possible to verify that inflammatory RR was the most prevalent (Table 4), being mentioned in 22 of the 25 studies. Replacement resorption was cited in 18 studies.

Results of individual studies

To facilitate the results interpretation, the studies were grouped into 4 groups according to the subtype of resorption evaluated (internal RR, surface RR, inflammatory RR and replacement RR) and the prevalence rates were reported according to each study, and only when data was available. Calibration and agreement between evaluators of periapical radiographs or other forms of radiographic assessment were not reported or were insufficiently reported in the included studies. Consequently, some studies in which the RR was not properly classified by the authors were excluded from the quantitative analysis.

Internal RR

Internal RR was found in six studies [8, 17, 18, 22, 24, 28] (Table 4). Ahlberg et al. [32] investigated the prevalence of RR. The authors followed all resorption subtypes in a total of 33 teeth over an average period of six years. It was observed that, in the sixth year of follow-up, 51.5% of the evaluated teeth had Internal RR. In two other prospective studies, the mean rates of IR prevalence after autotransplantation of teeth with complete root formation were 7.14% [18] and 13.89% [22], after follow-ups 1.5 years and 4.6 years, respectively. Retrospective studies showed rates of 28.3% [36] 10.2% [24] after 3.4 years,

and 8.82% [28] after 14.5 years of follow-up. The prevalence of internal RR was between 14% to 15%.

Surface RR

Surface RR was found in 6 studies [8, 17–21] (Table 4). The prevalence rates of surface RR related to autotransplantation ranged from 3.12% to 72.7% [32, 34] Altonen et al. [33] and Ahlberg et al. [32] evaluated in their studies maxillary canines, and both studies obtained results above 60% of surface RR prevalence. In retrospective studies conducted by Andreasen et al. [8] in premolars, the mean rates of Surface RR prevalence after autotransplantation of teeth with complete rhizogenesis were above 3.7%, whereas in the prospective study carried out by Arikan et al. [34], in maxillary canines (n = 32), the mean prevalence rate of surface RR was 3.12%. Eliasson et al. [18] demonstrated in their study of 36 autotransplanted teeth a prevalence of surface RR about 27.8%.

Inflammatory RR

Only two studies, out of the total included, did not study or did not report inflammatory RR [17] and [11]. Inflammatory RR data ranged from 3.12% [34] to 50% [18]. In retrospective studies the prevalence rate ranged from 5% to 55% [30, 31]. Note, in the study conducted by Lundberg & Isaksson [22], a low prevalence of inflammatory RR (4%), with transplants performed in 9 premolars, 55 third molars and 10 canines with follow-up of up to 5 years. The prevalence of Inflammatory RR was 15% and 19% in the prospective and retrospective studies, respectively.

Replacement RR

Among the studies that analyzed RR, several did not report or did not assess the prevalence of replacement RR [4, 11, 23, 32, 34, 38]. The study conducted by Chambers et al. [17] showed a prevalence of 42.85% of teeth affected by RR by replacement. In other studies, the prevalence rates of replacement RR ranged from 0% [19] to 40.58% [33]. The prevalence of replacement RR was calculated as 11% and 20% for prospective and retrospective studies, respectively (Table 4).

RoB assessment

The methodological quality criteria were not completely fulfilled by any of the included studies. In the prospective studies group, and according to the JBI Critical Appraisal Checklist for quasi-experimental studies, 3 studies were considered as low risk of bias [4, 29, 35], two studies were assessed as high risk of bias [19, 23] and the others had moderate risk. In evaluating the retrospective studies, according to the MASTARI checklist for descriptive studies, four studies were considered to have low RoB [1, 3, 24, 26] and the others were considered as moderate. Detailed information regarding RoB in the included studies is provided in Fig. 2, Fig. 3, and Appendix 3.

Synthesis of results

Considering that the included studies presented high heterogeneity among themselves, the statistical analysis was performed according to the random effects, since not all resorption subtypes: internal, superficial, inflammatory and replacement root resorption were reported in all studies. The meta-analysis was performed to verify RR prevalence in general RR and in its subtypes, with the data presented in Table 4, according to the evaluated studies (prospectives and retrospectives). Overall, the prevalence of RR after transplantation of teeth with complete root formation was between 30% in the prospective studies, and 41% in the retrospective ones. Among the subtypes, inflammatory resorption had 15% and 19% prevalence, and replacement resorption had 11% and 20% prevalence, in prospective and retrospective studies, respectively. As for internal RR, its prevalence was quite similar in both assessments, being 14% in the prospective and 15% in the retrospective studies. Surface resorption was the least evaluated among the studies, and it was not possible to be calculated in the retrospective group.

RoB among studies

The main methodological limitations among the studies were related to the lack of standardization of the results. Not all studies followed the same surgical protocol. In particular, the types of RR were not clearly reported, and this increased the RoB in pooled data analysis. Some studies evaluated teeth with complete and incomplete root formation

in a non-specific way, which made it difficult to extrapolate the data for the present study. On the other hand, some studies did not clearly report the qualitative results, which led to the frequent recording of 'unclear' observation.

Level of evidence

As this is a prevalence study, the quality of evidence was assessed by the meta-analysis performed for each type of resorption (general RR, internal RR, superficial RR, inflammatory RR and replacement RR) and in each group of studies (retrospective and prospective). In general, retrospective studies, as they deal with a convenience sample, have a lower quality of evidence than prospective studies, which participate in the intervention and follow-up of the patients. In addition, the great heterogeneity among the studies should be considered, where most meta-analyses performed found very high levels of inconsistency with I^2 values above 90%, both in the assessment of overall RR resorption and in its subtypes.

Discussion

Dental autotransplantation is a procedure often used in dentistry to replace a missing tooth, especially in children and adolescents, as implants and other prosthetic replacements are not well indicated in young patients [2, 24, 32]. Therefore, this surgical procedure has been one of the indications for transplanting impacted teeth to their normal position (transalveolar transplantation), and also in cases of tooth agenesis, tooth loss caused by oral cavity diseases, or due to traumatic injuries [24, 33].

According to the literature, autotransplantation offers one of the fastest and best results in rehabilitation of young patients, in a more economical and efficient way, when compared to other procedures [24, 25, 34]. Awareness of the prevalence of RR after tooth transplantation is useful for dentists, in order to minimize the risk and severity of its occurrence, as a late diagnosis of RR can limit treatment alternatives and results in the transplanted tooth loss [3, 4].

In this SR, we investigated the available evidence on the prevalence of different types of RR after autotransplantation of teeth with complete root formation, with the inclusion of 25 eligible studies. To facilitate data interpretation, we grouped them according to the type of RR. Our results showed that after autotransplantation of teeth with closed apex, there is an overall prevalence of RR between 30% and 41%, as observed in prospective and retrospective studies, respectively. This high prevalence may be due to several factors. Previous studies have shown that the occurrence of internal, superficial, inflammatory and replacement resorptions are mainly associated with necrotic tissue present inside the root canal and with traumatic damage to the periodontal ligament (PDL) on the external root surface, which results from the surgical autotransplant procedure [23, 35].

It is important to mention that the reabsorption process and the clinical importance of this pathology varies among the types of RR [25]. Each type of injury has peculiar characteristics that affects the surgical treatment outcome [8, 33]. In general, internal RR originates from pulp inflammation process [38] which requires immediate endodontic treatment, whereas superficial RR is the milder form of external RR, which in most cases can only be detected microscopically [38]. Inflammatory RR is associated with infection and depends directly on periodontal damage caused at the time of trauma [38], by bacterial presence in the root canal and, occasionally, induced by bacteria from the periodontal sulcus [8]. In turn, RR by replacement, which often leads to tooth loss, is

caused by PDL cells necrosis, resulting in tooth fusion to the alveolar bone [39]. It is mentioned that replacement RR occurs in teeth with damaged cementum, suggesting that cementum is important for PDL regeneration, therefore, ligament preservation of the autotransplanted tooth is a fundamental step to avoid replacemete RR [32].

Appropriate indication, treatment planning and, in particular, adequate follow-up, are important to achieve a favorable result and, consequently to reduce the chances of being affected by RR [6, 33]. For the prevention and treatment of RR, a meticulous endodontic protocol is necessary, from the pulp removal, through use of calcium hydroxide dressing before definitive root canal filling with gutta percha and appropriate restoration [8, 27]. Scholars indicate that endodontic treatment should be performed early to reduce the chances of involvement by RR and eventual loss of the transplanted tooth [2, 34, 40]. Even though, in general, radiographic signs of RR-related infection can be observed between 1 to 2 months after dental autotransplantation or reimplantation [8, 28]. Futher, it is considered that in teeth with complete root formation and closed apex, the root canal treatment must be carried out before surgery, or started between 1 to 2 weeks after surgery [32, 41].

Still regarding the choice of endodontic treatment moment (when indicated), it should be noted that its performance during the surgical procedure requires additional time during the surgery, which increases the time outside the implantation alveolus of the donor tooth [42]. This results in a greater chance of PDL cell necrosis and also in greater chance of dentinal tubules bacterial contamination [6]. The performance of endodontic treatment in appointment after surgery reduces these negative facts [6]. However, the pulp chamber and dentinal tubules with necrotic tissue remain vulnerable to postoperative bacterial contamination before the root canal filling completion [43].

Another factor that may be directly related to the occurrence, to a lesser or greater degree, of RR is the type of donor tooth, especially regarding the number and morphology of its roots [1]. According to the study by Kokai et al. [1], root morphology affects the prognosis of autotransplanted teeth, and the success rate of autotransplanted molars was approximately 64.3%. In a study conducted by Niimi et al. [4], the atypical shape of the root, when divergent, curved and hypertrophic, was significantly more frequent in cases of RR by substitution. These results are due to the difficulties encountered during extraction, recipient bone site preparation, management of a healthy PDL and correct endodontic treatment, all considered difficult in teeth with multiple roots, such as molars [44]. However, autotransplantation when performed on single-rooted teeth presents a low

risk of damage to PDL cells during surgery and, consequently, treatment success rate is higher compared to teeth with multiple roots [1, 31].

The presence of masticatory function on the donor tooth, prior to dental transplantation, seems to be a factor related to the lower prevalence of RR [45]. In other words, a higher risk of RR has been observed in hypofunctional patients, that is, those who have teeth without occlusal contact [46]. Previous studies observed that hypofunctional teeth have a narrowing of the LPD, [45] which results in less protein in its matrix [47] and less blood circulation in the LPD [48] than other teeth. It is possible that the hypofunctionality of teeth is more likely to atrophy the LPD compared to normal teeth [1]. Teeth with an atrophic LPD are more easily damaged during surgery and have a higher risk of RR [1]. As a response to such complications, it was reported in an animal study that applying orthodontic forces to hypofunctional teeth before transplantation can increase LPD width and prevent RR after transplantation [49].

The non-occurrence of dental resorption has been related to several other factors, among which it is important to mention the care during surgical procedures regarding the handling of transplants, especially regarding the time the tooth remains outside the alveolus, the storage medium during recipient site preparation [18, 31] and the type and time of splinting used [1, 31].

An important factor to be evaluated when performing autotransplantation is the choice of method and splinting time [31]. In the studies compiled in this SR, the splinting methods most frequently reported were those using metallic wire adhered to the dental elements with adhesive resin materials, by brackets when the patient was undergoing orthodontic treatment, or even by suturing the dental element in its alveolus after reimplantation [33]. Furthermore, in the study conducted by Eliasson et al. [18], twenty-three transplants were stabilized using acrylic plates and the remaining teeth were stabilized with orthodontic wire or surgical cement. The splinting time reported by the studies ranged from one to ten weeks [20, 34]. The RR was characteristically higher in cases of transplanted teeth for which the splinting used was the bracket orthodontic [31]. Splinting with metallic wire and resin, when used for long periods, is a risk factor for replacement RR [50, 51]. In contrast, splinting via suture provides acceptable physiological healing of the periodontal space of the reimplanted tooth [50, 51].

Not least, extraction of the donor tooth, when not fully erupted, proved to be a risk factor in relation to the occurrence of inflammatory RR, when compared with extraction of already erupted tooth [1]. This is because the trauma that occurs during extraction is

greater in cases of impacted teeth, when compared to which occurs in the extraction of fully erupted teeth, which causes greater damage to the LPD and tooth cementum [1]. Difficulties encountered during the surgical procedure are indicators of lower success rates for autotransplantation [40]. In the study conducted by Kokai et al. [1], most maxillary molars with multiple roots were transplanted to the mandible. It has been reported that when a maxillary tooth is moved into the mandible, the buccolingual width of the maxillary tooth is often greater than the receiving area of the mandible [52]. Thus, excess bone must be removed in most cases. Self-transplanted teeth to the mandible negatively influence the success rate [44]. In surgical protocols, the clinician, after evaluating the predisposing factors of each type of RR, can consider strategies to reduce, or even prevent, the occurrence of this pathology [8, 28].

The results of the present study showed that the most cited RR subtype in the studies was inflammatory RR, followed by replacement RR, internal RR and superficial RR. These results are in line with previously published studies that also found that inflammatory RR is the most prevalent [8, 28]. In cases of autogenous dental transplantation in teeth with complete root formation, the primary indication is endodontic treatment within two to three weeks after performing the surgical protocol [34]. After endodontic treatment, clinical and radiographic controls in periodic follow-ups are also necessary, in order to make a diagnosis of the health of dental and periodontal tissues over time, and thus increase the success rate of autotransplants [24].

Limitations

A multivariate analysis of all variables that influence the occurrence of RR would be a gold standard. However, data heterogeneity and ill-defined variables in the included studies did not allow for such analyses. In addition, in most of the studies included in this SR, the RR was evaluated in periapical radiographs, and this may have resulted in an underestimation of the overall prevalence due to the inherent limitations of the two-dimensional image, particularly in the initial observation period [25, 33]. Another important limitation was the lack criteria standardization such as the moment and type of treatments performed, which may have affected the results. In addition, some studies have limited sample sizes or provided little information about the type of resorption evaluated.

With regard to the statistical grouping of data, high heterogeneity among the studies should be highlighted, which limits the results evidence achieved regarding the prevalence of overall RR and in its subtypes. The lack of randomized clinical trials limited

and diminished the certainty of the evidence. However, the authors of this SR acknowledge that other sources of heterogeneity (such as root resorption classification criteria) may also have contributed to some of the variability observed between studies. New studies with larger samples and standardized methods are recommended to achieve more accurate results. In addition, the cumulative evidence (GRADE) was not performed because this SR is a prevalence study. However, as the risk of bias analysis showed, none of the studies respected all the questions evaluated, which increases the probability that the reported prevalence does not reflect the real prevalence. A standardized and validated methodology should be used in other clinical studies.

Conclusion

In conclusion, our findings showed that RR has a prevalence of 30% to 41%, depending on the type of study in which this pathology was evaluated. Inflammatory RR and replacement RR had a prevalence of 11% to 20%, and 15% to 19%, respectively. Internal RR, on the other hand, had a prevalence between 14% and 15%. Superficial RR was less reported in the studies, mainly due to the difficulty of being evaluated radiographically.

Compliance with ethical standards

Conflict of interest: The authors declare no conflict of interest.

Ethical Approval: This article does not contain any studies with human or animal participants performed by any of the authors.

Informed consent: For this type of study, formal consent is not required.

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Table 1. Summary of characteristics of included studies

Study characteristics		Sample details				Follow up		Main Conclusion
Author, year	Country	Study Design	Patients (M/F); teeth (n)	Mean age in years old (range)	Tooth type (arcade)	Mean follow up in years (range)	Types of exams	
Ahlberg et al. (1983)	Sweden	PCT	29 (17/12); 33	27.5 (16-54)	Mx canines	6 (1-6)	Clinic and radiographic	Careful surgical procedure and early endodontic treatment seem improve prognosis. Four transplants extracted because of IRR and poor bone regeneration.
Akiyama et al. (1998) ¹¹	Japan	PCT	23(12-13);25	29.6 (20-54)	Max 3 rd molars: 9 Mand 3 rd molars: 16 To max 1 st molar: 6 To max 2 nd molar: 4 To mand 1 st molar: 4 To mand 2 nd molar:11	NA (0.5-1.5)	Clinic and radiographic	Atraumatic extraction of donor teeth is another prerequisite for a good prognosis.
Altonen et al. (1978)	Finland	PCT	22 (NA/NA); 28	22.5 (14-47)	Mx canines	1.5 (0.5 – 3.1)	Clinic and radiographic	Poor or non-existent bone regeneration were mostly responsible for the failure of the transplant as were the cases with poor periodontal condition.
Andreasen et al. (1990)	Denmark	RCT	NA(NA/NA);53	NA	Premolars	NA(0.4-5.0)**	Clinic and radiographic	The tooth with abnormal position in contrast to normal position before eruption significantly increased the risk of RR.
Arikan et al. (2008)	Turkey	PCT	30 (9/21);32	34.32 (25-55)	Mx canines	5.87 (2-8)	Clinic and periapical radiographic (long cone)	Favorable prognosis if the treatment is performed with a meticulous surgical technique and appropriate postoperative control, followed by endodontic and restorative procedures.
Azaz et al. (1988))	Israel	RCT	31(10/21);37	NA (13-36)	Mx canines	NA (2-7)	Clinic and radiographic	The autotransplantation in young patients is more promising. There are individual unknown factors which difficult prognosis of autotransplanted impacted maxillary canines.
Chambers et al. (1988)	Australia	RCT	35 (13/22); 41	22(11-42)	Mx canines	1 st Rev 2 (0.7-5.3) 2 nd Rev (4.75-8.4)	Clinic and radiographic	Inflammatory resorption was significantly reduced in those transplanted teeth treated by early post-operative endodontic therapy.
Eliasson et al. (1988)	Sweden	PCT	34 (14/20);36	27.5(19-47)	Mx canine s:11 Premolars:3 Molars:22	4.6 (1-10)**	Clinic and periapical radiographic	Teeth with completed root formation can be transplanted with good prognosis. Early-stage endodontic treatment seems to be important for successful autotransplantation.

Hall & Reade, 1983	Australia	PCT	113(33/80);141	20.0(13-43)	Mx canine:141	NA(0.5-9.0)	Clinic and periapical radiographic	All the lost teeth had extensive or gross root resorption. The failed teeth (14) showed signs of RR in a mean period of 7 to 8 months, and in all occurred within the first 2 years post-operatively.
Jang et al.(2016)	South Korea	RCT	96(NA/NA);105	NA	NA	NA (1-12)	Clinic and tomographic Imaging, Periapical Radiographs	Required to reduce the surgical trauma during extraction of the donor tooth, especially for mandibular molars. In this regard, the application of the CARP model is recommended to minimize the extraoral time in tooth autotransplantation
Kallu et al. (2005)	Belgium	RCT	NA	NA	NA	3.8 (0-11)	Clinic, periapical and panoramic radiographs	Root resorption and ankylosis after transplantation were strongly related to damage to the root surface during surgical procedure and infection of the pulp
Kokai et al. (2015) ¹	Japan	RCT	89(20/69);100	29.1(12.3-58.1)	Incisors:3 Mx & Md 3rd molars:39 Premolars:51	5.8(1.9-14.7)	Clinic and radiographic	The application of an early orthodontic force may increase the success rate of autotransplanted teeth; There was a higher risk of root resorption in hypofunctional teeth.
Kristerson et al. (1985)	Sweden	PCT	NA(NA/NA);16	NA	Premolars:	6.3(3-18)	Clinic and radiographic	At stage 7 the periodontal healing had diminished to 37%. The causes of root resorption were probably difficulties in removal of the teeth with accompanying severe damage to the periodontal ligament.
Lucas-Taulé et al. 2021	Spain	RCT	36(12/24); 24	30.2 (14-61)	Max (66,6%) & Mand molars (33.33%)	29.42 ± 14.56 months 2.45 ± 1.21 y	Clinic and radiographic Response to a questionnaire of outcomes	Autotransplantation of third molars is a predictable mode of treatment for the replacement of extracted teeth with hopeless prognosis and missing teeth in young patients. Neither success nor survival was influenced by recipient site integrity or root development
Lundberg & Isaksson (1996)	Sweden	PCT	74(23-52);74	32.8(±12.9)	Mx & Md premolars:9 Mx 3rd molars & Md 3rd molars:55 Mx canines:10	NA (0.5-5)	Clinic and periapical radiographic (long cone)	Eighty-four percent of the transplanted teeth were successful, with no signs of resorption or mobility and healthy periodontal tissues.
Mejare et al. (2004)	Sweden	PCT	NA(NA);47	36.7(21-66)	Mx 3rd molars: 20 Md 3rd molars: 30	4(1-10)	Clinic and radiographic	Seven transplants were lost during follow-up, 4 due to marginal periodontal pathosis and 3 due to root resorption. In one case the root resorption was of an external replacement type and in the other 2 cases an invasive cervical root resorption occurred.

Niimi et al. (2011) ⁴	Japan	PCT	109(41/68);117	38.9(11-75)	Mx canine: 1 Mx 1st premolars: 9 Mx 2nd premolars: 2 Mx 2nd molars: 5 Mx 3rd molars: 35 Md 1st premolars: 12 Md 2nd premolars: 3 Md 2nd molars: 2 Md 3rd molars: 48	1-NA	Clinic and periapical radiographic (long cone)	There were 97 transplants in the successful group (82.9%), while 20 transplants were unsuccessful (17.1%). Thirteen transplants were lost (11.1%).
Patel et al. (2011)	UK	RCT	49(NA); 63	21.8 (13-42.1)	Mx canines	14.5 (1.4-27.8)	Clinic and periapical radiographic (long cone)	Thirty eight per cent of transplanted canines were successful with no signs of resorption or mobility and sound periodontal tissues, while 83% of the teeth were still <i>in situ</i> .
Shinde; Deshmukh1; Khairnar (2018)	Índia	PCT	42(NA)	NA(22-50)	Third molars	1,0	Clinic and periapical radiographic	Immediate autogenous transplantation of the impacted third molar is a good alternative to replace nonrestorable molars with prosthesis which requires cutting of noncarious adjacent teeth
Schwartz et al. (1985)	Denmark	RCT	NA(NA);107	16.8(NA-NA)	NA	9.6 (1-25.7)	Clinic and radiographic	Root resorption was found to be the most relevant complication of autotransplanted human teeth.
Watanabe et al. (2010)	Japan	RCT	32 (NA/NA);38	24.1 (10.8-43.2)	NA	9.2(6.1-14.5)	Clinic and periapical radiographic (long cone)	The success of autotransplantation of a tooth with complete root formation is affected by the quality of root filling.
Yan et al. (2010)	China	PCT	34(6/28);19	24(16-39)	Md 3rd molars	5.2(1-11)	Clinic and periapical radiographic (long cone)	Two closed-apical donor molars were extracted for progressive root absorption, and the remaining donor molars were fixed in the socket without discomfort and with satisfactory chewing
Yang et al. (2019)	South Korea	RCT	82(42/40);69	22.5(13-51)	Mx anterior:11 Mx premolars:9 Mx 3rd molar:23 Md anterior:9 Md premolars:5 Md 3rd molar:25	4.15(0.2-9.3)	Clinic and tomographic Imaging, Periapical Radiographs	Fully erupted donor teeth and a bounded recipient site were significantly associated with longer tooth survival.

Yoshino_et al. (2012)	Japan	RCT	552(273/279);559	44.1(17-79)	Md 3rd molar:259 Mx 3rd molar:283 Md Incisors: 28 Mx Incisors: 42	5.2(0-19.7)	Clinic and periapical radiographic (long cone)	Autotransplantation of teeth, in cases where suitable donor teeth are available, may be a plausible treatment option for dealing with missing teeth in dental clinics.
Yu et al. (2017)	China	PCT	60(28/32); 65	33.1(19-55)	Mx & Md 3rd molars: 65	9.9(7-13)	Clinic and radiographic(Panoramic radiographs)	Mature third molar autotransplantation in both fresh extraction sockets and surgically created sockets is associated with good long-term outcomes.

NA= not applicable or not available; n= number of teeth with resorption; N= sample analysed; IRR= Inflammatory Root Resorption; RR= Root Resorption;
 **Data calculated by authors. PCT= Prospective study; RCT: Retrospective study;

Table 2. Rates of survival and root resorption in the prospective studies included

Study	Additional Treatments n (N), %				Root Resorption (RR)				Survival rates	Main Conclusion
	Author, year	Donor site/ Recipient site (Time out)	Surgical Protocol	Splinting Type (N)/ Duration* (weeks)	Orthodontic (Ortho) Endodontic (Endo) Antibiotics (ATB) Prosthesis (Prost)	Follow up in years (RR%)				
					Internal Years (%RR)	Surface	Inflammatory	Replacement (R) Ankylosis (A)		
Ahlberg et al. (1983)	Max/ Max (NA)	Teeth with palatal locations with difficult access; Recipient site made with bur; tooth stored in saline solution.	Splint with wire or band/ *5 weeks With silk sutures (2) or adhesive resin (10) or light polymerizing resin (7) or temp bridge (2) or circumferential wiring (3) or wire splint (1) *1-6 weeks (mean of 30.4 days)	Ortho: NA Endo: 23 (33), 69.7% ATB: NA Prost: NA	1(0%) 2(6.1%) 3.5 (24.4%) 6(51.51%)	NA	NA	NA	100% at 1Y 2 (100%) 3.5 (87.88%) 6 (87.88%)	Four extraction related root resorption or poor bone regeneration
Akiyama et al. (1998)	(Max/Max; Mad/Mad) (NA)	Recipient site made with bur; tooth stored in saline solution.		Ortho: NA Endo: 25 (25),100% ATB: 25 (25),100% Prost: 25 (25),100%	NA	NA	0	NA	0-1.5 (100 %)	All postoperative treatment is performed within 8 weeks
Altonen et al. (1978)	Max/ Max (5-15min)	All teeth with palatal locations with difficult access; Recipient site made with bur; tooth stored in saline solution (0-15min)	Splint with: wire or band (2) acrylic Resin (2) Schuchardt's arch bar (24) *6 weeks (\pm 1.9)	Ortho: 2 (28), 7.1% Endo: 9 (28), 32.1% ATB: NA Prost: NA	2 (7.2%)	NA	14(50.0%)	R-6(25%)	0.5-3.1 (85.7%)	The four transplants that were extracted had advanced vertical bone resorption
Arikan et al. (2008)	Max/ Max (15min)	Teeth with palatal locations with difficult access; Recipient site made with bur; Tooth stored in saline solution.	Light polymerizing composite resin and orthodontic wire/ 4 weeks	Ortho: 32(32);100% Endo: 32 (32), 100% ATB: S Prost: metal porcelain crown, and 2 treated with light-curing composite resins.	NA	1 (3.25%)	1 (3.25%)	A (0%)	1 (100%) >5(93.5%)	Common reason for tooth loss after transplantation is progressive root resorption. Preserving calcium hydroxide in the canal for up to 1 year could be effective in preventing early root resorption.
Eliasson et al. (1988)	NA	Recipient site made with bur; tooth stored in its original alveolus or in saline solution while new alveolus was prepared.	Acrylic splint (23) or orthodontic arch wire(10) or surgical cement/ 3.8 (1-10)	Ortho: 10 (36), 27.7% Endo: 36 (36), 100% ATB: 36 (36), 100% Prost: NA CH filling: 17.3(5-42) weeks	5(13.9%)	10 (27.8%)	3 (8.3%)	2 (5.5%)	Survival rate: 5-10 (89%)* Success rate: 5-10 (67%)	It was presumed that IRR and Internal RR resulted from traumatic damage to the periodontal ligament or to cementum.
Hall & Reade, 1983	Max/Max	Great number of teeth with palatal locations. After extraction, the tooth relocation was made in a surgically prepared site.	Splinting by wire/6 weeks.	Ortho: NA Endo: 44(141) 31% ATB: NA Prost: NA	NA	NA	28/35(80%)	28/35(80%)	0.5-9.0 (90%)	The authors speculated that early post-operative root canal treatment might reduce the incidence of RR of autotransplanted teeth.
Kristerson et al. (1985)	(Max/Max; Mad/Mad) NA	Recipient site made with bur; tooth stored in saline solution.	NA	Ortho: NA Endo: NA ATB: NA Prost: NA	NA	NA	4(25%)*	6(37.5%)*	NA	Three teeth in function at stage 7 were transplanted and no sign of root resorption was seen after 5 and 8 years.

Lundberg & Isaksson (1996)	(Max/Max; Mad/Mad) NA	Recipient site made with bur; tooth stored in saline solution.	Suture (58)/ 2 weeks orthodontically splinted (16)/ 1-3 weeks	Ortho: 16 (74), 21.6% Endo: 36 (36), 100% ATB: 74(74), 100% Pros:NA	NA	0(0%)	3 (4.0%)	12(16.21%)	5-10 (84%)	Root resorption was more common in the closed apex group.
Mejare et al. (2004)	(Max/Max; Mad/Mad) NA	Recipient site made with bur; tooth stored in saline solution. Suitable tooth replicas were used for final adjustment of the recipient sites	Luxatemp ® (DM6, Hamburg, Germany) (10) Or Sutures/ 1 week	Ortho: NA Endo: 117 (117), 100% ATB: 117(117),100% Pros: NA	NA	NA	5/47(10.63%)*	NA	1: 97.9% 2: 95.1% 3-5: 81.4% 5-10: 81.4%	A statistically significant correlation was found between the presence of root resorption and the presence of gingivitis.
Niimi et al. (2011) Same data from Sugai et al 2010	(Max/Max; Mad/Mad) NA	Based on surgical protocol described by Andreasen et al. (1990). Recipient site made with bur; tooth stored in saline solution.	Orthodontic wire and resin/ 3 weeks or 4-0 silk sutures/1 week	Ortho: NA Endo: 117 (117), 100% ATB: NA Pros:NA	NA	NA	5(4.27%)	22(18.8%)	Survival rate: (88.9%)* Success rate: (82.9%)	Progressive root resorption after tooth transplantation was associated with abnormal root shape, deep periodontal pocket, dental caries, restoration and RCT of donor teeth.
Shinde; Deshmukh; Khairnar, (2018)	(Max/Max; Mad/Ma) 18 min	Recipient site from extraction was complemented with bur; donor tooth stored in saline solution if adjusts in the new socket were necessary.	Crossover suturing with 3-0 silk. Fixation with wire for mobile tooth.	Endo: 42 (42) 100% ATB: 42 (42) Pros: NA	0	NA	8(17.77%)	1 (2,22%)	78%	Case selection is very important in transplantation of completely developed impacted third molar, which are usually difficult to extract from their sockets. The teeth transplanted were either vertical or mesioangular in position and easy to extract without sectioning.
Yan et al. (2010)	(Max/Max; Mad/Mad) NA	Recipient site made with bur; tooth stored in saline solution. Radiography was used to determine the adaptability between the donor molars and the recipient sites.	Wire or Suture/ 1Week	Ortho: NA Endo: 19(19), 100% ATB: 100% Pros:NA	NA	NA	2(10.52%)	NA	NA	Immediate autotransplantation of the mandibular third molar is a reasonable and alternative treatment to replace a nonrestorable tooth.
Yu et al. (2017)	(Max/Max; Mad/Mad) 15 min Prepared socket (Bone graft (GBR): (21) No bone graft (no GBR): (15) Fresh socket (FS): (29)	Recipient site made with bur; tooth stored in saline solution. For patients with bone loss at the site, the graft was performed after transplantation with Bio-Oss and Bio-Oss Collagen (Geistlich Pharma AB, Wolhusen, Switzerland) and some chips collected during the osteotomy, after placing a resorbable membrane (Bio-Gide; Geistlich Pharma).	Sutures/ 2-3weeks	Ortho: NA Endo: NA ATB: 65(65)100% Pros:NA	NA	NA	GBR 3(14.3%) No GBR 1(6.7%) FS 3(10.3%) Overall: 10.77%	NA/ A GBR (9.5%) No GBR (6.7%) FS 3(10.3%) Overall (9.23%)	Survival rate:90.8%	Endodontic treatment was performed if the transplanted tooth was found to react negatively to electrometric pulp testing. The final endodontic treatment was performed at around a year postoperatively.

NA= not applicable or not available; n= number of teeth with resorption; N= sample analysed; RCT= root canal treatment; *Data calculated by authors.

Table 3. Rates of survival and root resorption in the retrospective studies included

Study	Additional Treatments n(N), %		Root resorption n(%)						Survival rates (%)	Main Conclusion
			Splinting Type/ Duration (weeks)	Orthodontic (Ortho) Endodontic (Endo) Periodontal Dressing (PD) Antibiotics (ATB)	Internal	Surface	Inflammatory	Replacement/ Ankyloses		
Andreasen et al. (1990)	Donor site/ Recipient site (Time out) Max/Max; Mad/Mad NA	Surgical Protocol Recipient site made with bur; tooth stored in saline solution.	no splinting suture flexible rigid/ NA	Orthodontic (Ortho) Endodontic (Endo) Periodontal Dressing (PD) Antibiotics (ATB) Orthod: NA Endo: NA PD: NA ATB: 53(53), 100%	15(28.30)	2 (3.77%)	7(13.21%)	A: 9(16.98%)	5 (62.26%)	Orthodontic treatment was related to a significant increase of SRR and decrease of IRR; A narrow alveolus and pulp necrosis were related to increase of inflammatory RR
Azaz et al. (1978)	Max/Max (25 min)	Single step procedure and atraumatic technique. Recipient site made with bur; tooth stored in saline solution.	Surgical or orthodontic arch/ 10 weeks	Orthod: NA Endo: 37 (37) 100% during the surgery PD: NA ATB: 37(37), 100%	NA	NA	9 (20.0%)	12(26.66%)	2-5 (83.78%)** >5 (70.27%)**	The critical period to verify pathologic changes of autotransplanted teeth is the first 2 years following autotransplantation.
Chambers et al. (1988)	Max/Max (NA)	Single step procedure and atraumatic technique. Recipient site made with bur; tooth stored in saline solution.	Splinted with an Essig-type wire splint which/ 6 weeks	Orthod: NA Endo:41(41) 100% PD: NA ATB: NA	FR (NA) SR (NA)	NA NA	FR 06(18) 33% SR 03(15) 20%	13(28) 72% 15(15) 100%	0.75-5.4 (94%) 32(34)	The post-operative endodontic therapy significantly decreases the IRR and improves the prognosis of autotransplanted maxillary canine teeth.
Jang et al.(2016)	(Max/Max; Mad/Mad) (NA)	A computer-aided rapid prototyping (CARP) model confirmed the suitability of the donor tooth in the recipient site and its interocclusal relationship. Single step procedure and atraumatic technique. Recipient site made with bur; Either saline or Hank's balanced salt solution (HBSS)	Periodontal pack (1 week) Resin-wire splint (2 Weeks)	Orthod: NA Endo: 105(105)100% PD: NA ATB: 105 (105) 100% In several cases, RCT was performed by root-end resection, ultrasonic root-end preparation, and root-end filling under Operating microscope	NA	NA	3 years: 12 (12.1%) 12 years: 16 (17.1%)	A: 30(28.57%)	3 (88.1%) 12 (68.2%)	Considerations are required to reduce the surgical trauma during extraction of the donor tooth, especially for mandibular

Kallu et al. (2005)	NA	NA	Orthodontic wire and resin/6-8 weeks or silk sutures/2-3 weeks	Orthod:NA Endo: NA PD: NA ATB:NA	4(10.26%)	0	4(10.26%)	8(20.5%)	NA	Root resorption and ankylosis were the major reasons for transplant failure in the study.
Kokai et al. (2015)	(Max/Max; Mad/Mad) (NA)	Single step procedure and atraumatic technique. Recipient site made with bur; tooth stored in saline solution.	Composites and cobalt chromium wires/ 8 weeks	Orthod: 100(100)100% Endo: 100(100)100% PD: NA ATB: 100(100)100%	NA	NA	13 (13%)	A: 19(19%)	Success rate: 71% Survival rate: 93% Cumulative Survival rate: 96.4% at the 5-year mark and 89.5% at 10 years	Donor teeth without occlusal contacts were significantly predisposed to resorption, ankylosis, pocket formation, and inflammation after Transplantation.
Lucas-Taulé et al. 2021	(Max/Max; Mad/Mad) (NA)	Single step procedure and atraumatic technique. Recipient site made with bur; tooth stored in saline solution.	Suture + wire Only suture Others/ 2 weeks	Endo: 24(24), 100% ATB: 24(24), 100%	NA	NA	0	1 (24) 4,17%	Success rate: 100% Survival rate: 96%	Further, neither success nor survival was influenced by recipient site integrity or root development
Patel et al. (2011)	Max/Max (NA)	Single step procedure and atraumatic technique. Recipient site made with bur; tooth stored in saline solution.	Splint not specified/ 2 weeks	Orthod: NA Endo: 22(34), 65% PD: 34(34), 100% ATB: 34(34), 100%	3(34) 8.82%	7(34):2.59%	NA	2(34) 5.88%	Success rate: 38% Survival rate: 83%	The procedure is technique sensitive and success rates are higher in teeth with open apices.
Schwartz et al. (1985)	Max/Max; Mad/Mad) NA	Recipient site made with bur; tooth stored in saline solution.	Flexible or acrylic or Sauer bar/ NA	Orthod: NA Endo: NA PD: NA ATB: NA	NA	NA	59(55.14%)	NA	NA	Progressive root resorption and ankylosis are strongly correlated with damage to the root surface during the surgery of transplantation.
Watanabe et al. (2010)	Max/Max; Mad/Mad; Mad/Max (NA)	According to the procedure described by Andreasen et al. [8]	Composites and wire splints/3 weeks	Orthod: NA Endo: 38(38)100% PD: NA ATB: NA	NA	NA	2(38)5.26%	9(38)23.69% A:NA	Success rate: 63.1% Survival rate: 86.8%	
Yang et al. (2019)	(Max/Max; Mad/Mad) 15 min	Computer-aided rapid prototyping (CARP, RP model) was manufactured for repeated fitting in the prepared bony socket in place of the real donor tooth. Recipient site made with	Wire and resin or 3-0 silk suture.	Orthod: NA Endo: NA PD: NA ATB: 69(69), 100%	NA	NA	25(36.23%)	NA/ A: 28(40.58%)	Success rate: NA Survival rate: 82.6%	Higher survival rates of transplanted teeth were significantly associated with the donor-erupted state, the existence of adjacent teeth, and prevention of further marginal

		bur; tooth stored in saline solution.		If necessary, the extracted teeth immediately received root end resection, root end preparation, and retrofilling with MTA					bone loss rather than ankylosis or IRR	
Yoshino_et al. (2012)	(Max/Max; Mad/Mad) NA	Recipient site made with bur; tooth stored in saline solution.	Suture + wire Only suture Others/ 1-3 weeks	Ortho: NA Endo: 559 (559), 100% ATB: NA Pros: single crown (75.5%), abutment of bridge (18.9%) and abutment of overdenture (7.7%) and other (1.0%).	NA	NA	27(14.85%)	NA/A (4.29)	5 (90.1%) 10 (70.5%) 15 (55.6%)	The main causes of loss of transplanted teeth in this study were attachment loss (54.9%) and resorption (26.5%)

NA= not applicable or not available; n= number of teeth with resorption; N= sample analysed; RCT: root canal treatment; AT: autotransplantation

Table 4. Summary of the prevalence of Root Resorption (RR) after autotransplantation of teeth with complete root formation

Sample details <i>Author, year</i>	Root Resorption (%)*					
	<i>Total Sample N</i>	<i>Internal RR</i>	<i>Surface RR</i>	<i>Inflammatory RR</i>	<i>Replacement RR /Ankylosis</i>	<i>Overall RR</i>
PROSPECTIVE STUDIES						
Ahlberg et al. (1983)	33	51.51	—	36.35	—	87.87
Akiyama et al. (1998)	25	—	—	—	—	0
Altonen et al. (1978)	28	7.14	—	50.0	21.43	75.00
Arikan et al. (2008)	32	—	3.12	3.12	0	6.25
Eliasson et al. (1988)	36	13.89	27.78	8.33	5.55	55.55
Hall & Reade (1983)	141	—	—	19.86	19.86	24.82
Kristerson et al. (1985)	16	—	—	25.0	37.5	62.5
Lundberg & Isaksson (1996)	74	—	—	4.05	16.21	20.27
Mejare et al. (2004)	47	—	—	10.63	—	10.63
Niimi et al. (2011)	117	—	—	4.27	18.80	23.07
Shinde; Deshmukh; Khairnar (2018)	45	0	—	17.77	2.22	20.0
Yan et al. (2010)	19	0	0	10.52	0	10.52
Yu et al. (2017)	65	—	—	10.77	9.23	20.0
Total from meta-analysis (95% CI)		0.14 [-0.03, 0.31] I ² = 95.91%, p< .001	0.42 [0.19,0.65] I ² = 16.04%, p= 0.382	0.15 [0.08, 0.22] I ² = 89%, p< 0.001	0.11 [0.06, 0.17] I ² = 84.07%, p< 0.001	0.30 [0.14, 0.46] I ² = 97.69%, p< 0.001
RETROSPECTIVE STUDIES						
Andreasen et al. (1990)	53	28.30	3.77	13.21	16.98	62.26
Azaz et al. (1988)	45	—	—	20.00	26.66	46.66
Chambers et al. (1988)	35	—	—	8.58	42.85	51.43
Jang et al. (2016)	105	—	—	14.28	28.57	42.85
Kallu et al. (2017)	39	10.26	—	10.26	20.50	41.02
Kokai et al. (2015)	100	—	—	13.00	19.00	27.00
Lucas-Taulé et al. (2021)	24	—	—	—	4.17	4.17
Patel et al. (2011)	34	8.82	—	20.59	5.88	35.29
Schwartz et al. (1985)	107	—	—	55.14	—	55.14
Watanabe et al. (2010)	38	—	—	5.26	23.69	28.95
Yang et al. (2019)	69	—	—	36.23	40.58	76.81
Yoshino et al. (2012) B	559	—	—	14.85	4.29	19.14
Total from meta-analysis (95% CI)		0.15 [0.04, 0.27] I ² = 74.1%, p< 0.029	—	0.19 [0.10, 0.18] I ² = 92.91%, p< 0.001	0.20 [0.12, 0.28] I ² = 90.83%, p< .001	0.41 [0.29, 0.52] I ² = 94.47%, p< 0.001

—, unclear or not reported; CI, confidence interval; * Internal replacement resorption; **one tooth had internal RR and replacement RR

* Data calculated by authors.

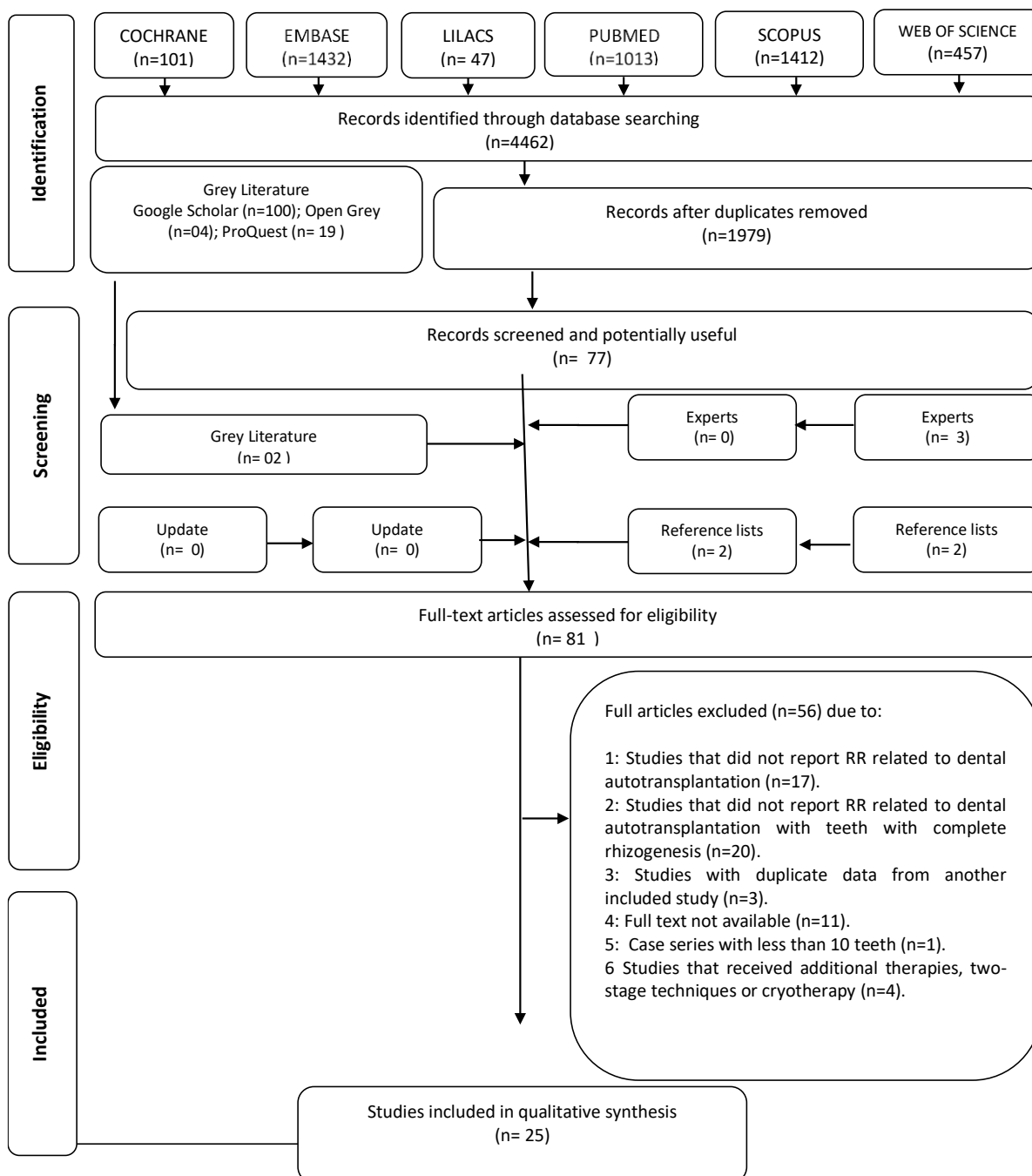
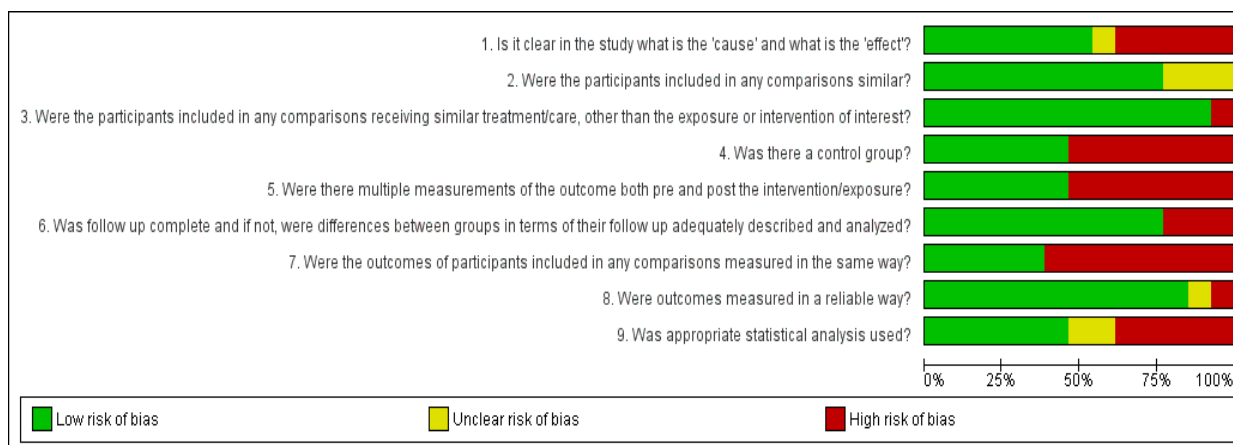
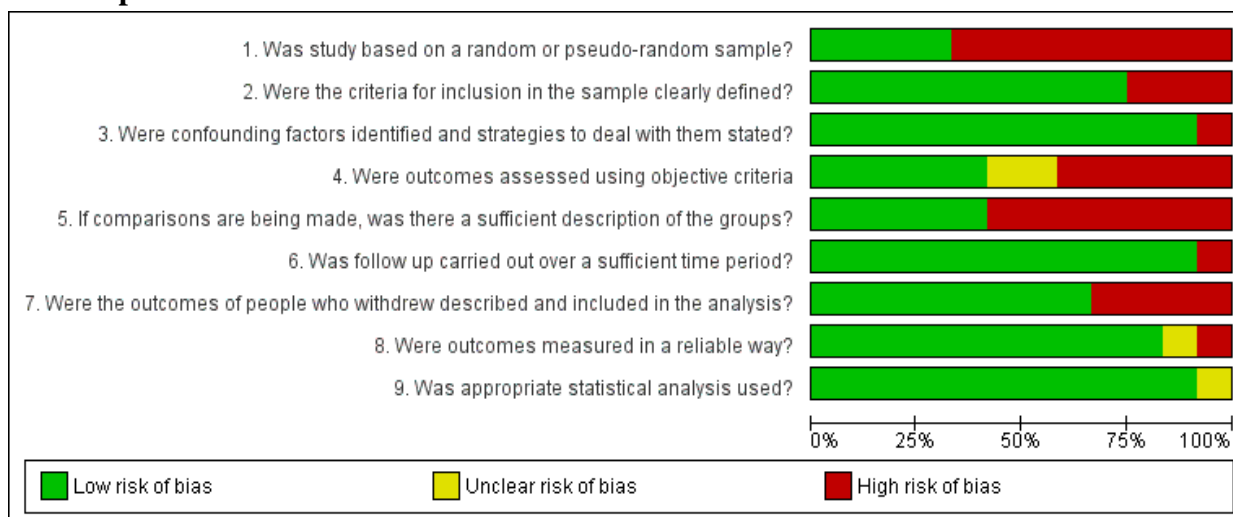
Figure 1. Flow Diagram of Literature Search and Selection Criteria¹.¹ Adapted from PRISMA.

Figure 2. Risk of bias (RoB) graph: review authors' judgments about each risk of bias item presented as percentages across all included studies.

JBI Critical Appraisal Checklist for Quasi-Experimental Studies (non-randomized experimental studies) – Prospective Studies.



JBI-MAStARI Critical Appraisal Checklist for Descriptive/Case Series studies – Retrospective studies.



3.B) JBI-MAStARI Critical Appraisal Checklist for Descriptive/Case Series studies. Retrospective Studies.

	1. Was study based on a random or pseudo-random sample?	2. Were the criteria for inclusion in the sample clearly defined?	3. Were confounding factors identified and strategies to deal with them stated?	4. Were outcomes assessed using objective criteria	5. If comparisons are being made, was there a sufficient description of the groups?	6. Was follow up carried out over a sufficient time period?	7. Were the outcomes of people who withdrew described and included in the analysis?	8. Were outcomes measured in a reliable way?	9. Was appropriate statistical analysis used?
Andreasen et al. (1990)	-	+	+	+	+	+	-	+	+
Azaz et al. (1988)	-	+	-	+	+	+	-	+	+
Chaambers et al. (1988)	-	+	+	?	+	+	-	+	+
Jang et al. (2016)	+	+	+	-	-	+	+	+	+
Kallu et al. (2017)	+	-	+	+	+	-	+	?	+
Kokai et al. (2015)	+	+	+	+	-	+	+	+	+
Lucas-Taulé et al. (2021)	-	-	+	-	-	+	+	+	+
Patel et al. (2011)	+	+	+	-	-	+	+	+	+
Schwartz et al. (1985)	-	+	+	?	+	+	+	+	?
Watanabe et al. (2010)	-	+	+	+	-	+	-	-	+
Yang et al. (2019)	-	-	+	-	-	+	+	+	+
Yoshino et al. (2012)	-	+	+	-	-	+	+	+	+

4 CONSIDERAÇÕES FINAIS

O objetivo do presente trabalho foi responder à pergunta de pesquisa sobre qual seria a prevalência da RR após o autotransplante de dentes com rizogênese completa. Para isso, buscamos na literatura, de forma sistemática, estudos observacionais, prospectivos e retrospectivos, que nos trouxessem informações a respeito da ocorrência dos processos de RR, em dentes com formação completa da raiz e submetidos ao autotransplante.

Um total de vinte e cinco estudos foram selecionados para esse fim, de acordo com o uso de critérios de inclusão e de exclusão bem definidos. A avaliação do RoB dos estudos mostrou que nenhum deles atendeu completamente aos critérios de qualidade avaliados, sendo quase todos de médio risco de viés e, em menor número, de baixo e alto risco de viés. De forma interessante, nenhum dos estudos retrospectivos apresentaram alto risco de viés. Porém, vale lembrar que estes estudos foram feitos com amostras selecionadas e de forma retrospectiva, o que os faz perder pontos na avaliação da qualidade da evidência.

A prevalência da RR foi avaliada como sendo 30% com base nos resultados dos estudos prospectivos e 41%, quando dados dos estudos retrospectivos foram considerados. Quando os subtipos de RR foram avaliados isoladamente, observou-se que os tipos mais comumente relatados foram a RR inflamatória e a RR de substituição. Interessantemente, a RR superficial não foi relatada com muita frequência. Isto porque, segundo os estudos, a avaliação da RR superficial é difícil de ser realizada por radiografias periapicais, panorâmicas e mesmo por tomografias, visto a pequena dimensão desse tipo de reabsorção, muitas vezes mascarada por estruturas dentárias e ósseas adjacentes.

A maioria dos estudos relacionou a ocorrência da RR aos danos causados ao LPD durante os processos cirúrgicos de remoção do dente doador e reimplante do mesmo no novo sítio ósseo. Além disso, muitos estudos também reforçaram a importância de o tratamento endodôntico ser realizado previamente, ou num prazo máximo de início entre 2 a 3 semanas após o procedimento cirúrgico.

Importante ressaltar que não foram encontrados estudos clínicos randomizados, os quais seriam o padrão ouro para a observação da certeza da evidência. Diante disso, como resultado desta RS, indicamos que novos estudos clínicos sejam feitos de acordo com protocolos adequados, a fim de propiciar maior certeza da evidência quanto as prevalências de RR aqui relatadas.

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APÊNDICES

Apêndice A – Registro do protocolo no site Internacional prospective register of systematic reviews (PROSPERO, CRD42020141516).

NIHR | National Institute
for Health Research

PROSPERO
International prospective register of systematic reviews

Prevalence of root resorption in autotransplanted tooth with complete root formation: a systematic review

Cleonice da Silveira Teixeira, Ramiro Luiz Calza, Daniela Peressoni Vieira Shuldt, Beatriz Dulcineia Mendes Souza, Charles Marin, Jessica Conti Reus, Lucas da Fonseca Roberti Garcia, Graziela de Luca Canto

Citation

Cleonice da Silveira Teixeira, Ramiro Luiz Calza, Daniela Peressoni Vieira Shuldt, Beatriz Dulcineia Mendes Souza, Charles Marin, Jessica Conti Reus, Lucas da Fonseca Roberti Garcia, Graziela de Luca Canto. Prevalence of root resorption in autotransplanted tooth with complete root formation: a systematic review. PROSPERO 2020 CRD42020141516 Available from: https://www.crd.york.ac.uk/prospERO/display_record.php?ID=CRD42020141516

Review question

What is the prevalence of root resorption in autotransplanted tooth with complete root formation?

Searches

Appropriate truncation and word combinations will be elaborated and adapted for each of the following electronic databases: PubMed/MEDLINE, EMBASE, LILACS, Web of Science, Scopus and Cochrane Library. In addition, a partial grey literature search will be conducted on Google Scholar, OpenGrey, Proquest, hand searches of reference lists from included studies, and with experts. No time and language restriction will be applied.

Types of study to be included

Observational (Before and after); Case series; Retrospective studies.

Condition or domain being studied

The presence of resorption after autotransplantation of permanent teeth with complete root formation.

Participants/population

Studies in which sample includes patients who received tooth autotransplantation with complete root formation for any reason including traumatic/ pathological/ developmental tooth absence, tooth ectopia.

Exclusion criteria: Studies that reported patients with severe periodontal disease, swelling or sinus tract.

Studies that reported patients in which teeth have mobility greater than grade 1 or severely damaged

Apêndice B – Estratégias de busca das bases de dados

Do artigo em inglês:

Appendix 1. Database search strategy.

Search query
2021, April 19 th
("transplantation" OR "transplantations" OR "autologous" OR "autotransplantation" OR "autotransplantations" OR "autotransplant" OR "autotransplants" OR "auto transplantation" OR "auto transplantations" OR "auto transplant" OR "auto transplants" OR "autotransplanted" OR "auto transplanted" OR "autografts" OR "Autograft" OR "Autografting" OR "Autograftings" OR "autogenous") AND ("dentition permanent" OR "permanent dentition" OR "permanent teeth" OR "permanent tooth" OR "tooth" OR "teeth" OR "canine" OR "canines" OR "molars" OR "molar" OR "premolar" OR "premolars" OR "pre-molars" OR "incisors" OR "incisor") AND ("resorption" OR "resorptions")
(tw:(autolog* OR autotransplant* OR "auto transplantation" OR "auto transplantations" OR "auto transplant" OR "auto transplants" OR "auto transplanted" OR autograf* OR autogen* OR "auto transplante" OR "auto transplantes" OR "auto transplantado" OR "auto transplantados")) AND (tw:("dentition permanent" OR "permanent dentition" OR "permanent teeth" OR "permanent tooth" OR "tooth" OR "teeth" OR "canine" OR "canines" OR molar* OR premolar* OR "pre-molars" OR incisor* OR dente* OR dentic* OR dient* OR "pre-molar" OR "pre-molares" OR incisiv*)) AND (tw:(resorption OR resorptions OR reabsorcao OR reabsorcoes OR reabsorcion)) AND (instance:"regional") AND (db:("LILACS") AND type:("article")).
((("transplantation, autologous"[MeSH Terms] OR "transplantation" OR "transplantations" OR "autologous" OR "autotransplantation" OR "autotransplantations" OR "autotransplant" OR "autotransplants" OR "auto transplantation" OR "auto transplantations" OR "auto transplant" OR "auto transplants" OR "autotransplanted" OR "auto transplanted" OR "autografts"[MeSH Terms] OR "autografts" OR "Autograft" OR

"Autografting" OR "Autograftings" OR "autogenous")) AND (("dentition, permanent"[MeSH Terms] OR "dentition permanent" OR "permanent dentition" OR "permanent teeth" OR "permanent tooth" OR "tooth"[MeSH Terms] OR "tooth" OR "teeth" OR "canine" OR "canines" OR "molars" OR "molar" OR "premolar" OR "premolars" OR "pre-molars" OR "incisors" OR "incisor")) AND (("root resorption"[MeSH Terms] OR "resorption" OR "resorptions"))

TITLE-ABS-KEY(("transplantation" OR "transplantations" OR "autologous" OR "autotransplantation" OR "autotransplantations" OR "autotransplant" OR "autotransplants" OR "auto transplantation" OR "auto transplantations" OR "auto transplant" OR "auto transplants" OR "autotransplanted" OR "auto transplanted" OR "autografts" OR "Autograft" OR "Autografting" OR "Autograftings" OR "autogenous") AND ("dentition permanent" OR "permanent dentition" OR "permanent teeth" OR "permanent tooth" OR "tooth" OR "teeth" OR "canine" OR "canines" OR "molars" OR "molar" OR "premolar" OR "premolars" OR "pre-molars" OR "incisors" OR "incisor") AND ("resorption" OR "resorptions")) AND (LIMIT-TO (DOCTYPE,"ar")

("transplantation" OR "transplantations" OR "autologous" OR "autotransplantation" OR "autotransplantations" OR "autotransplant" OR "autotransplants" OR "auto transplantation" OR "auto transplantations" OR "auto transplant" OR "auto transplants" OR "autotransplanted" OR "auto transplanted" OR "autografts" OR "Autograft" OR "Autografting" OR "Autograftings" OR "autogenous") AND ("dentition permanent" OR "permanent dentition" OR "permanent teeth" OR "permanent tooth" OR "tooth" OR "teeth" OR "canine" OR "canines" OR "molars" OR "molar" OR "premolar" OR "premolars" OR "pre-molars" OR "incisors" OR "incisor") AND ("resorption" OR "resorptions")

noft(("transplantation" OR "transplantations" OR "autologous" OR "autotransplantation" OR "autotransplantations" OR "autotransplant" OR "autotransplants" OR "auto transplantation" OR "auto transplantations" OR "auto transplant" OR "auto transplants" OR "autotransplanted" OR "auto

transplanted" OR "autografts" OR "Autograft" OR "Autografting" OR "Autograftings" OR "autogenous") AND ("dentition permanent" OR "permanent dentition" OR "permanent teeth" OR "permanent tooth" OR "tooth" OR "teeth" OR "canine" OR "canines" OR "molars" OR "molar" OR "premolar" OR "premolars" OR "pre-molars" OR "incisors" OR "incisor") AND ("resorption" OR "resorptions"))

<https://scholar.google.com.br/>

("autologous" OR "transplantation" OR "autotransplant" OR "auto transplantation" OR "autotransplanted" OR "Autograft" OR "autogenous") AND ("tooth" OR "teeth" OR "canine" OR "molar" OR "incisor") AND ("resorption")

("transplantation" OR "transplantations" OR "autologous" OR "autotransplantation" OR "autotransplantations" OR "autotransplant" OR "autotransplants" OR "auto transplantation" OR "auto transplantations" OR "auto transplant" OR "auto transplants" OR "autotransplanted" OR "auto transplanted" OR "autografts" OR "Autograft" OR "Autografting" OR "Autograftings" OR "autogenous") AND ("dentition permanent" OR "permanent dentition" OR "permanent teeth" OR "permanent tooth" OR "tooth" OR "teeth" OR "canine" OR "canines" OR "molars" OR "molar" OR "premolar" OR "premolars" OR "pre-molars" OR "incisors" OR "incisor") AND ("resorption" OR "resorptions"))

("transplantation" OR "transplantations" OR "autologous" OR "autotransplantation" OR "autotransplantations" OR "autotransplant" OR "autotransplants" OR "auto transplantation" OR "auto transplantations" OR "auto transplant" OR "auto transplants" OR "autotransplanted" OR "auto transplanted" OR "autografts" OR "Autograft" OR "Autografting" OR "Autograftings" OR "autogenous") AND ("dentition permanent" OR "permanent dentition" OR "permanent teeth" OR "permanent tooth" OR "tooth" OR "teeth" OR "canine" OR "canines" OR "molars" OR "molar" OR "premolar" OR "premolars" OR "pre-molars" OR "incisors" OR "incisor") AND ("resorption" OR "resorptions"))

†Search strategies were performed for each database by using specific words combinations and truncations with support of an experienced librarian.

Apêndice C – Artigos excluídos e justificativas

Do artigo em inglês:

Appendix 2. Articles excluded and the reasons for exclusion (n=56).

References	Author	Reasons for Exclusion†
41	(ABELLA <i>et al.</i> , 2018)	4
18	(AOYAMA <i>et al.</i> , 2012)	1
26	(BAUSS <i>et al.</i> , 2003)	2
17	(BERGLUNDH; THILANDER; SAGNE, 1997)	1
10	(BOKELUND <i>et al.</i> , 2013)	1
19	(BOLTON, 1974)	2
25	(CZOCHROWSKA <i>et al.</i> , 2000)	2
43	(DE ABREU, 1989)	4
54	(DE FREITAS COUTINHO <i>et al.</i> , 2021)	2
40	(DE MENEZES <i>et al.</i> , 1986)	4
34	(DÍAZ; JANS; ZAROR, 2014)	2
22	(EDMUNDS; BECK, 1989)	2
53	(ERDEM; GÜMÜŞER, 2021)	6
21	(FAGADE; GILLBE; WASTELL, 1988)	2
51	(FAY, 1969)	5
52	(GAULT; WAROCQUIER-CLEROUT, 2002)	6
44	(HOVINGA, 1969)	4
11	(HUTH <i>et al.</i> , 2013)	1
9	(ISA-KARA <i>et al.</i> , 2011)	1
27	(JONSSON; SIGURDSSON, 2004)	2
12	(KAFOUROU <i>et al.</i> , 2017)	1
2	(KAHNBERG, 1987)	1
45	(KHOURY, 1984)	4
16	(KIM <i>et al.</i> , 2005)	1
46	(KRISTERSON; KVINT, 1981)	4
5	(KRISTERSON; LAGERSTRÖM, 1991)	1
30	(KVINT <i>et al.</i> , 2010)	2
47	(LECHIEN; ZACHEE, 1976)	4
37	(LEE; KIM, 2012)	2
55	(LUCAS-TAULÉ <i>et al.</i> , 2020)	6

23	(MARCUSSON; LILJA-KARLANDER, 1996)	2
15	(MARTIN, 1983)	1
48	(MARTIN, 1990)	4
31	(MENSINK; VAN MERKESTEYN, 2010)	2
33	(MICHL <i>et al.</i> , 2017)	2
20	(MOSS ET AL 1975, 1975)	2
32	(MURTADHA; KWOK, 2017)	2
36	(NAGORI <i>et al.</i> , 2014)	2
7	(NETHANDER, 1994)	6
24	(NETHANDER, 1998)	2
42	(NIE <i>et al.</i> , 2018)	4
1	(NORDENRAM, 1969)	1
49	(PERSSON; HELLEM; NORD, 1983)	4
4	(POGREL, 1987)	1
29	(POHL; GEIST; FILIPPI, 2008)	2
8	(REICH, 2008)	1
6	(SCHATZ; JOHO, 1992)	1
3	(SCHWARTZ; BERGMANN, 1985)	1
50	(SHULMAN, 1979)	4
39	(SUGAI <i>et al.</i> , 2010)	3
28	(TANAKA <i>et al.</i> , 2008)	2
13	(TANG <i>et al.</i> , 2017)	1
35	(TRONSTAD, 1981)	2
14	(URBAŃSKA; MUMFORD, 1980)	1
38	(WISE; NEVINS, 1988)	3
56	(YOSHINO <i>et al.</i> , 2012)	3

† Legend:

- 1) Estudos que não relataram RR relacionado ao autotransplante dentário;
- 2) Estudos que não relataram RR relacionados ao autotransplante dentário com dentes com rizogênese completa;
- 3) Estudos com dados duplicados de outro estudo incluído;
- 4) Texto completo não disponível;
- 5) Avaliações, relatos de casos, resumos de conferências, cartas, artigos de opinião, livros, séries de casos com menos de 10 dentes;
- 6) Estudos que receberam terapias adicionais, como a crioterapia e
- 7) Estudos publicados em língua romana não latina.

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Apêndice D – Risco de Viés

Do artigo em inglês:

Appendix 3. Risk of bias assessed by Joanna Briggs Institute critical appraisal tools.

Risk of bias was categorized as High when the study reaches up to 49% score “yes”, Moderate when the study reached 50% to 69% score “yes”, and Low when the study reached more than 70% score “yes”.

JBI Critical Appraisal Checklist for Quasi-Experimental Studies (non-randomized experimental studies).

Question	1. Is it clear in the study what is the 'cause' and what is the 'effect' (i.e. there is no confusion about which variable comes first)?	2. Were the participants included in any comparisons similar?	3. Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest?	4. Was there a control group?	5. Were there multiple measurements of the outcome both pre and post the intervention/exposure?	6. Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analyzed?	7. Were the outcomes of participants included in any comparisons measured in the same way?	8. Were outcomes measured in a reliable way?	9. Was appropriate statistical analysis used?	%yes/risk
Ahlberg et al. (1983)	N	Y	Y	Y	Y	Y	N	Y	N	66.67%
Akiyama et al. (1998)	N	Y	Y	Y	Y	N	N	Y	Y	66.67%
Altonen et al. (1978)	Y	Y	Y	N	N	Y	N	Y	N	55.56%
Arikan et al. (2008)	U	Y	Y	N	N	Y	N	Y	Y	55.56%
Eliasson et al. (1988)	N	Y	Y	Y	Y	Y	N	Y	N	66.67%
Hall & Reade, 1983	N	Y	Y	Y	Y	N	N	U	N	44.45%
Kristerson et al. (1985)	Y	U	Y	N	N	Y	Y	Y	Y	66.67%
Lundberg & Isaksson (1996)	Y	U	Y	Y	Y	Y	N	Y	U	66.67%
Mejare et al. (2004)	N	Y	N	Y	Y	N	Y	N	U	44.45%

Shinde; Deshmukh1; Khairmar (2018)	Y	Y	Y	N	N	Y	Y	Y	Y	77.78%
Niimi et al. (2011)	Y	Y	Y	N	N	Y	Y	Y	Y	77.78%
Yan et al.(2010)	Y	U	Y	N	N	Y	N	Y	Y	55.56%
Yu et al. (2017)	Y	Y	Y	N	N	Y	Y	Y	Y	77.78%

Legend - Y=Yes, N=No, U=Unclear, NA=Not applicable.

JBI-MAStARI Critical Appraisal Checklist for Descriptive/Case Series studies

Question	1. Was study based on a random or pseudo-random sample?	2. Were the criteria for inclusion in the sample clearly defined?	3. Were confounding factors identified and strategies to deal with them stated?	4. Were outcomes assessed using objective criteria	5. If comparisons are being made, was there a sufficient description of the groups?	6. Was follow up carried out over a sufficient time period?	7. Were the outcomes of people who withdrew described and included in the analysis?	8. Were outcomes measured in a reliable way?	9. Was appropriate statistical analysis used?	%yes/risk
Andreasen et al. (1990)	N	Y	Y	Y	Y	Y	N	Y	Y	77.78%
Azaz et al. (1988)	N	Y	N	Y	Y	Y	N	Y	Y	66.67%
Chambers et al. (1988)	N	Y	Y	U	Y	Y	N	Y	Y	66.67%
Jang et al.(2016)	Y	Y	Y	N	N	Y	Y	Y	Y	77.78%
Kallu et al. (2017)	Y	N	Y	Y	Y	N	Y	U	Y	66.67%
Kokai et al. (2015)	Y	Y	Y	Y	N	Y	Y	Y	Y	88.87%
Lucas-Taulé et al. 2021	N	N	Y	N	N	Y	Y	Y	Y	55.56%
Patel et al. (2011)	Y	Y	Y	N	N	Y	Y	Y	Y	77.78%
Schwartz et al. (1985)	N	Y	Y	U	Y	Y	Y	Y	U	66.67%
Watanabe et al. (2010)	N	Y	Y	Y	N	Y	N	N	Y	55.56%

Yang et al. (2019)	N	N	Y	N	N	Y	Y	Y	Y	55.56%
YOSHINO_et al. (2012)	N	Y	Y	N	N	Y	Y	Y	Y	66.67%

Legend - Y=Yes, N=No, U=Unclear, NA=Not applicable

Apêndice E – Prisma checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	23
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	24, 26
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	25
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	26
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	26
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	27
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	28
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Appendix 1 79
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	28
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	28
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	27
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	28
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	29
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	29

ANEXO 1



UNIVERSIDADE FEDERAL DE SANTA CATARINA
CENTRO DE CIÊNCIAS DA SAÚDE
CURSO DE ODONTOLOGIA
DISCIPLINA DE TRABALHO DE CONCLUSÃO DE CURSO DE ODONTOLOGIA

ATA DE APRESENTAÇÃO DO TRABALHO DE CONCLUSÃO DE CURSO

Aos **26** dias do mês de **Agosto** de **2021**, às **09** horas, em sessão pública no (a) <https://conferenciaweb.rnp.br/webconf/tcc-do-curso-de-graduacao-em-odontologia-ufsc> desta Universidade, na presença da Banca Examinadora presidida pelo Professor Prof^a. Dr^a Cleonice da Silveira Teixeira e pelos examinadores:

1 - Prof. Dr. Lucas da Fonseca Roberti Garcia.

2 – Prof^a. Dr^a Daniela Peressoni Veira Schuldt,
o aluno Ramiro Luiz Calza

apresentou o Trabalho de Conclusão de Curso de Graduação intitulado:

“Prevalência de reabsorção radicular após autotransplante de dentes com rizogênese completa: uma revisão sistemática” como requisito curricular indispensável à aprovação na Disciplina de Defesa do TCC e a integralização do Curso de Graduação em Odontologia. A Banca Examinadora, após reunião em sessão reservada, deliberou e decidiu pela **Aprovação** do referido Trabalho de Conclusão do Curso, divulgando o resultado formalmente ao aluno e aos demais presentes, e eu, na qualidade de presidente da Banca, lavrei a presente ata que será assinada por mim, pelos demais componentes da Banca Examinadora e pelo aluno



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orientando.

Prof^a. Dr^a Cleonice da Silveira Teixeira

Presidente da Banca Examinadora



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Prof^a. Dr^a Lucas da Fonseca Roberti Garcia.

Examinador 1



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Examinador 2



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Ramiro Luiz Calza (Aluno)

ANEXO 2

Instructions for Authors

Types of papers

Papers may be submitted for the following sections:

Original articles

Invited reviews

Short communications – with up to 2000 words and up to two figures and/or tables

Discussion paper

Letters to the editor

It is the general policy of this journal not to accept case reports and pilot studies.

Editorial Procedure

If you have any questions please contact:

Professor Dr. M. Hannig

University Hospital of Saarland

Department of Parodontology and Conservative Dentistry

Building 73

66421 Homburg/Saar

Germany

Email: eic.hannig@uks.eu

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Manuscript Submission

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Objectives (stating the main purposes and research question)

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Results

Conclusions

Clinical Relevance

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Do not use field functions.

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Always use footnotes instead of endnotes.

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Acknowledgments of people, grants, funds, etc. should be placed in a separate section on the title page. The names of funding organizations should be written in full.

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Reference citations in the text should be identified by numbers in square brackets. Some examples:

1. Negotiation research spans many disciplines [3].
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3. This effect has been widely studied [1-3, 7].

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Smith J, Jones M Jr, Houghton L et al (1999) Future of health insurance. *N Engl J Med* 341:325–329

- Article by DOI

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- Book

South J, Blass B (2001) *The future of modern genomics*. Blackwell, London

- Book chapter

Brown B, Aaron M (2001) The politics of nature. In: Smith J (ed) *The rise of modern genomics*, 3rd edn. Wiley, New York, pp 230-257

- Online document

Cartwright J (2007) Big stars have weather too. IOP Publishing PhysicsWeb. <http://physicsweb.org/articles/news/11/6/16/1>. Accessed 26 June 2007

- Dissertation

Trent JW (1975) *Experimental acute renal failure*. Dissertation, University of California
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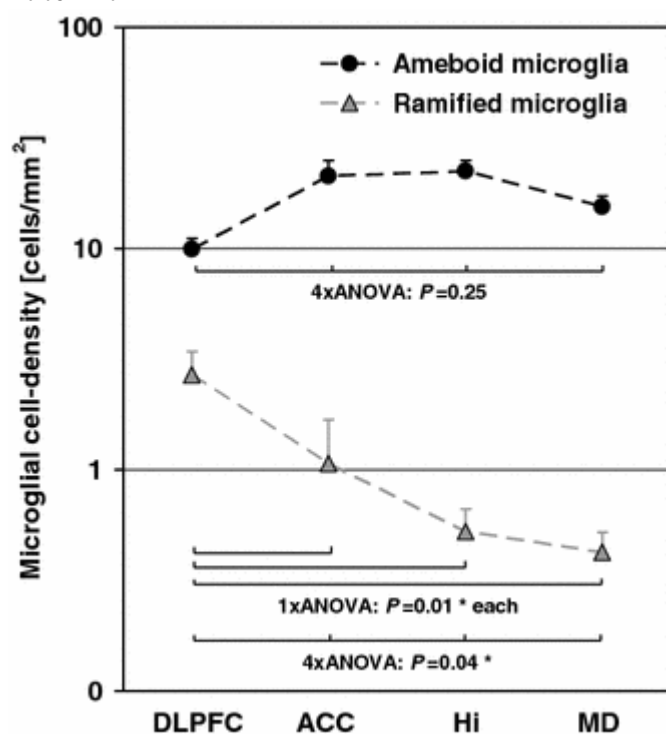
Indicate what graphics program was used to create the artwork.

For vector graphics, the preferred format is EPS; for halftones, please use TIFF format. MSOffice files are also acceptable.

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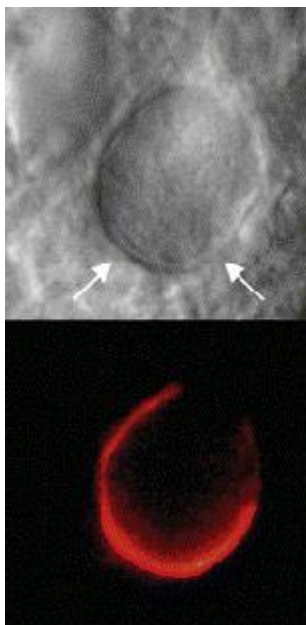
Do not use faint lines and/or lettering and check that all lines and lettering within the figures are legible at final size.

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Vector graphics containing fonts must have the fonts embedded in the files.

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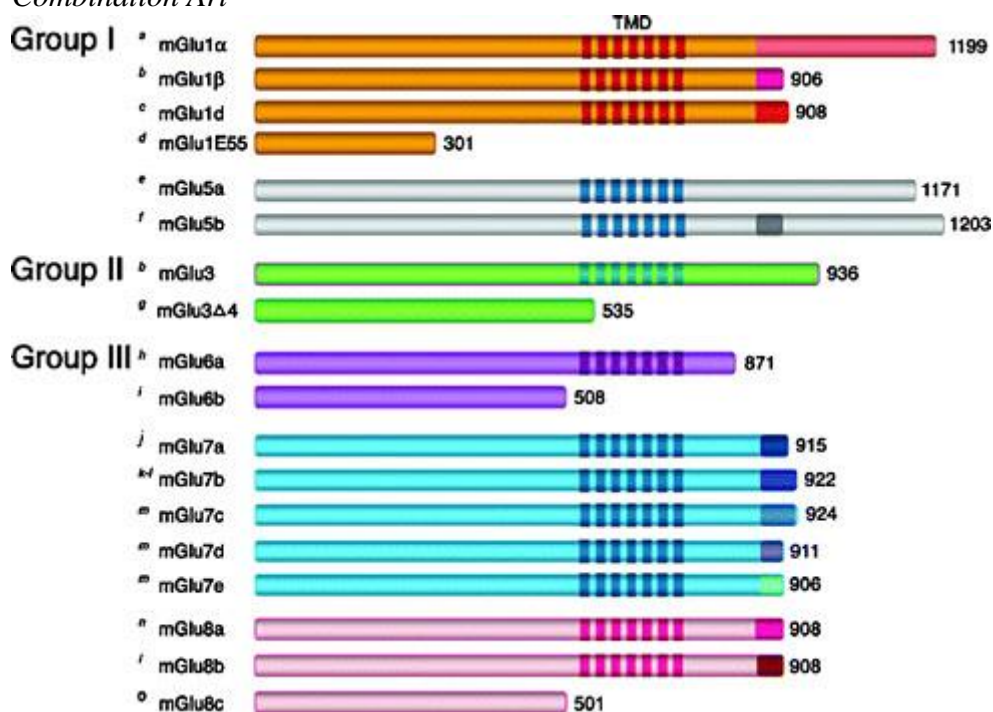


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If any magnification is used in the photographs, indicate this by using scale bars within the figures themselves.

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Authors must disclose all relationships or interests that could have direct or potential influence or impart bias on the work. Although an author may not feel there is any conflict, disclosure of relationships and interests provides a more complete and transparent process, leading to an accurate and objective assessment of the work. Awareness of a real or perceived conflicts of interest is a perspective to which the readers are entitled. This is not meant to imply that a financial relationship with an organization that sponsored the research or compensation received for consultancy work is inappropriate. Examples of potential conflicts of interests **that are directly or indirectly related to the research** may include but are not limited to the following:

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See below examples of disclosures:

Funding: This study was funded by X (grant number X)

.

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If no conflict exists, the authors should state:

Conflict of Interest: The authors declare that they have no conflict of interest.

Research involving human participants, their data or biological material

Ethics approval

When reporting a study that involved human participants, their data or biological material, authors should include a statement that confirms that the study was approved (or granted exemption) by the appropriate institutional and/or national research ethics committee (including the name of the ethics committee) and certify that the study was performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. If doubt exists whether the research was conducted in accordance with the 1964 Helsinki Declaration or comparable standards, the authors must explain the reasons for their approach, and demonstrate that an independent ethics committee or institutional review board explicitly approved the doubtful aspects of the study. If a study was granted exemption from requiring ethics approval, this should also be detailed in the manuscript (including the reasons for the exemption).

Retrospective ethics approval

If a study has not been granted ethics committee approval prior to commencing, retrospective ethics approval usually cannot be obtained and it may not be possible to consider the manuscript for peer review. The decision on whether to proceed to peer review in such cases is at the Editor's discretion.

Ethics approval for retrospective studies

Although retrospective studies are conducted on already available data or biological material (for which formal consent may not be needed or is difficult to obtain) ethics approval may be required dependent on the law and the national ethical guidelines of a country. Authors should check with their institution to make sure they are complying with the specific requirements of their country.

Ethics approval for case studies

Case reports require ethics approval. Most institutions will have specific policies on this subject. Authors should check with their institution to make sure they are complying with the specific requirements of their institution and seek ethics approval where needed. Authors should be aware to secure informed consent from the individual (or parent or guardian if the participant is a minor or incapable) See also section on **Informed Consent**.

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If human cells are used, authors must declare in the manuscript: what cell lines were used by describing the source of the cell line, including when and from where it was obtained, whether the cell line has recently been authenticated and by what method. If cells were bought from a life science company the following need to be given in the manuscript: name of company (that provided the cells), cell type, number of cell line, and batch of cells.

It is recommended that authors check the [NCBI database](#) for misidentification and contamination of human cell lines. This step will alert authors to possible problems with the cell line and may save considerable time and effort.

Further information is available from the [International Cell Line Authentication Committee](#) (ICLAC).

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Examples:

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Antibody: Luciferase antibody DSHB Cat# LUC-3, **RRID:AB_2722109**

Plasmid: mRuby3 plasmid **RRID:Addgene_104005**

Software: ImageJ Version 1.2.4 **RRID:SCR_003070**

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The World Health Organization (WHO) definition of a clinical trial is "any research study that prospectively assigns human participants or groups of humans to one or more health-related interventions to evaluate the effects on health outcomes". The WHO defines health interventions as "A health intervention is an act performed for, with or on behalf of a person or population whose purpose is to assess, improve, maintain, promote or modify health, functioning or health conditions" and a health-related outcome is generally defined as a change in the health of a person or population as a result of an intervention. To ensure the integrity of the reporting of patient-centered trials, authors must register prospective clinical trials (phase II to IV trials) in suitable publicly available repositories. For example www.clinicaltrials.gov or any of the primary registries that participate in the [WHO International Clinical Trials Registry Platform](#).

The trial registration number (TRN) and date of registration should be included as the last line of the manuscript abstract.

For clinical trials that have not been registered prospectively, authors are encouraged to register retrospectively to ensure the complete publication of all results. The trial registration number (TRN), date of registration and the words 'retrospectively registered' should be included as the last line of the manuscript abstract.

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Quality improvement studies ([SQUIRE](#))

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Summary of requirements

The above should be summarized in a statement and placed in a ‘Declarations’ section before the reference list under a heading of ‘Ethics approval’.

Examples of statements to be used when ethics approval has been obtained:

- All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The study was approved by the Bioethics Committee of the Medical University of A (No. ...).
- This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee of University B (Date.../No. ...).
- Approval was obtained from the ethics committee of University C. The procedures used in this study adhere to the tenets of the Declaration of Helsinki.
- The questionnaire and methodology for this study was approved by the Human Research Ethics committee of the University of D (Ethics approval number: ...).

Examples of statements to be used for a retrospective study:

- Ethical approval was waived by the local Ethics Committee of University A in view of the retrospective nature of the study and all the procedures being performed were part of the routine care.
- This research study was conducted retrospectively from data obtained for clinical purposes. We consulted extensively with the IRB of XYZ who determined that our study did not need ethical approval. An IRB official waiver of ethical approval was granted from the IRB of XYZ.
- This retrospective chart review study involving human participants was in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The Human Investigation Committee (IRB) of University B approved this study.

Examples of statements to be used when no ethical approval is required/exemption granted:

- This is an observational study. The XYZ Research Ethics Committee has confirmed that no ethical approval is required.
- The data reproduced from Article X utilized human tissue that was procured via our Biobank AB, which provides de-identified samples. This study was reviewed and deemed exempt by our XYZ Institutional Review Board. The BioBank protocols are in accordance with the ethical standards of our institution and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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Informed consent

All individuals have individual rights that are not to be infringed. Individual participants in studies have, for example, the right to decide what happens to the (identifiable) personal data gathered, to what they have said during a study or an interview, as well as to any photograph that was taken. This is especially true concerning images of vulnerable people (e.g. minors, patients, refugees, etc) or the use of images in sensitive contexts. In many instances authors will need to secure written consent before including images.

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Informed consent for publication should be obtained if there is any doubt. For example, masking the eye region in photographs of participants is inadequate protection of anonymity. If identifying characteristics are altered to protect anonymity, such as in genetic profiles, authors should provide assurance that alterations do not distort meaning. Exceptions where it is not necessary to obtain consent:

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- Reuse of images: If images are being reused from prior publications, the Publisher will assume that the prior publication obtained the relevant information regarding consent. Authors should provide the appropriate attribution for republished images.

Consent and already available data and/or biologic material

Regardless of whether material is collected from living or dead patients, they (family or guardian if the deceased has not made a pre-mortem decision) must have given prior written consent. The aspect of confidentiality as well as any wishes from the deceased should be respected.

Data protection, confidentiality and privacy

When biological material is donated for or data is generated as part of a research project authors should ensure, as part of the informed consent procedure, that the participants are made aware what kind of (personal) data will be processed, how it will be used and for what purpose. In case of data acquired via a biobank/biorepository, it is possible they apply a broad consent which allows research participants to consent to a broad range of uses of their data and samples which is regarded by research ethics committees as specific enough to be considered “informed”. However, authors should always check the specific biobank/biorepository policies or any other type of data provider policies (in case of non-bio research) to be sure that this is the case.

Consent to Participate

For all research involving human subjects, freely-given, informed consent to participate in the study must be obtained from participants (or their parent or legal guardian in the case of children under 16) and a statement to this effect should appear in the manuscript. In the case of articles describing human transplantation studies, authors must include a statement declaring that no organs/tissues were obtained from prisoners and must also name the institution(s)/clinic(s)/department(s) via which organs/tissues were obtained. For manuscripts reporting studies involving vulnerable groups where there is the potential for coercion or where consent may not have been fully informed, extra care will be taken by the editor and may be referred to the Springer Nature Research Integrity Group.

Consent to Publish

Individuals may consent to participate in a study, but object to having their data published in a journal article. Authors should make sure to also seek consent from individuals to publish their data prior to submitting their paper to a journal. This is in particular applicable to case studies. A consent to publish form can be found

[here. \(Download docx, 36 kB\)](#)

Summary of requirements

The above should be summarized in a statement and placed in a ‘Declarations’ section before the reference list under a heading of ‘Consent to participate’ and/or ‘Consent to publish’. Other declarations include Funding, Conflicts of interest/competing interests, Ethics approval, Consent, Data and/or Code availability and Authors’ contribution statements.

Please see the various examples of wording below and revise/customize the sample statements according to your own needs.

Sample statements for "Consent to participate":

Informed consent was obtained from all individual participants included in the study.

Informed consent was obtained from legal guardians.

Written informed consent was obtained from the parents.

Verbal informed consent was obtained prior to the interview.

Sample statements for "Consent to publish":

The authors affirm that human research participants provided informed consent for publication of the images in Figure(s) 1a, 1b and 1c.

The participant has consented to the submission of the case report to the journal.

Patients signed informed consent regarding publishing their data and photographs.

Sample statements if identifying information about participants is available in the article:
Additional informed consent was obtained from all individual participants for whom identifying information is included in this article.

Authors are responsible for correctness of the statements provided in the manuscript. See also Authorship Principles. The Editor-in-Chief reserves the right to reject submissions that do not meet the guidelines described in this section.

Images will be removed from publication if authors have not obtained informed consent or the paper may be removed and replaced with a notice explaining the reason for removal.

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