

## Immediate Autogenous Extracted Tooth as a Grafting Material For Fresh Socket Preservation: a Systematic Review.

Diente autógeno de extracción inmediata como material de injerto para la conservación de alvéolos frescos: Una revisión sistemática.

Zurab Khabadze.<sup>1</sup>  
Oleg Mordanov.<sup>1</sup>  
Marina Dashtieva.<sup>1</sup>  
Ia Todua.<sup>1</sup>  
Julia Generalova.<sup>1</sup>  
Artemy Nedashkovsky.<sup>1</sup>  
Meri Sheroziia.<sup>1</sup>  
Saida Adbulkerimova.<sup>1</sup>  
Yusup Bakaev.<sup>1</sup>

### Affiliations:

<sup>1</sup>RUDN University, Moscow, Russia.

**Corresponding author:** Oleg Mordanov.  
Miklukho-Maklaya Street, 6. Moscow, Russia. **Phone:** (+7) 91233 31533. **E-mail:** mordanov19@gmail.com

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**Abstract: Objectives:** To evaluate the use of extracted autogenous teeth for socket preservation after tooth extraction. **Material and Methods:** Cochrane, Scopus, and PubMed databases search was conducted to identify human clinical studies reporting the clinical, radiographic and/or histological outcomes of socket preservation techniques with autogenous extracted tooth. Only studies published in English language in the last 10 years were included in the study. **Results:** In total, 82 articles were identified. Five articles were included in the review. They included 58 teeth that were prepared as a graft for socket preservation. The grafts derived from autogenous teeth were presented in three forms: particles, blocks and powder. The mean bone loss ranged from 0.28 mm to 0.41mm in height and 0.15 mm in width. **Conclusion:** Immediate autogenous extracted tooth as a grafting material for fresh socket preservation is promising for future daily clinical practice. More clinical comparative studies are needed.

**Keywords:** bone transplantation; bone remodeling; systematic review; autografts; alveolar process; tooth extraction.

**Resumen: Objetivo:** Evaluar el uso de dientes extraídos autógenos para la preservación del alveolo tras la extracción dental. **Material y Métodos:** Se realizó una búsqueda en las bases de datos Cochrane, Scopus y PubMed para identificar estudios clínicos en humanos que informaban los resultados clínicos, radiográficos y / o histológicos de las técnicas de preservación de alveolos con dientes extraídos autógenos. Solo se incluyeron estudios publicados en inglés en los últimos 10 años. **Resultados:** En total se identificaron 82 artículos. Se incluyeron cinco artículos en la revisión. Incluyeron 58 dientes que se prepararon como injerto para la preservación del alveolo. Los injertos derivados de dientes autógenos se presentaron en tres formas: partículas, bloques y polvo. La pérdida ósea media osciló entre 0,28 mm y 0,41 mm de altura y 0,15 mm de ancho. **Conclusión:** El diente autógeno extraído de forma inmediata utilizado como material de injerto para la conservación del alveolo fresco es prometedor para la práctica clínica diaria futura. Se necesitan más estudios clínicos comparativos.

**Palabra Clave:** trasplante óseo; remodelación ósea; revisión sistemática; autoinjertos; proceso alveolar; extracción dental.gen.

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## INTRODUCTION.

The bone and soft tissue alterations secondary to tooth extraction have a significant impact on the outcome of implant-supported restorations.<sup>1</sup> Deficiency of the facial bone affects negatively on esthetics and is a critical causative factor for esthetic implant complications and failure.<sup>2</sup> Systematic reviews assessing the changes in alveolar bone dimension after tooth extraction have reported 2.6mm-4.6mm width reductions and 0.4mm - 3.9mm height reductions.<sup>3,4</sup> Bone regeneration requires the migration of specific cells to the healing socket to proliferate and provide the biological substrate for the new tissue development.

Cell migration, proliferation and differentiation is regulated by a number of factors in coordination with extracellular signals, three-dimensional support and scaffolds and with the correct blood supply.<sup>5</sup>

Allografts, xenografts, and alloplastic bone grafts, mesenchymal stem cells and bioactive molecules, bioglass, and/or hydroxyapatite and autogenous extracted tooth are utilized either with resorbable or non-resorbable membrane for extraction socket preservation.<sup>3,6-12</sup> A bone graft material must be bi-modal, which, in the early stages of differentiation, allows osteoblasts to build bridges between grains of different sizes and integrate with other osteoblasts, supporting both proliferation and differentiation.<sup>14,17,18</sup>

Autogenous tooth biomaterial derived from human extracted teeth is a potential material for bone regeneration due to its chemical composition and the high quantity of material obtained from each tooth.<sup>14</sup>

It is well known that the structure and composition of dentin is similar to that of bone, consisting of collagen 20%, hydroxyapatite 70%, and body fluid 10% by weight.<sup>13</sup> After scanning electron microscopy-energy dis-persive X-ray evaluation, it appeared that calcium and phosphates were still present within the collagen components even after the particle cleaning procedures.<sup>14</sup> Thus, the aim of the systematic review is to evaluate the use of extracted autogenous teeth for socket preservation chairside after tooth extraction.

## MATERIALS AND METHODS.

### Protocol and registration

This systematic literature review adheres to the PRISMA Statement. The review protocol was registe-

red in an international prospective register of systematic reviews (PROSPERO ID CRD42020189487) in which the methodology and inclusion and exclusion criteria were specified and documented.

### Eligibility criteria

Publications that met the following selection criteria were included:

1. Full-text articles in English, not older than 10 years.
2. *In vivo* human studies and clinical trials, comparative studies, cohort studies and case series studies;
3. Fresh socket augmentation with the immediately extracted and prepared tooth;
4. At least 6 months of follow-up after the extraction and following procedure.

Publications that were not related to the topic of the study, literature reviews, as well as articles that did not have sufficient and specific data for the analysis were excluded.

### Information sources

The electronic databases used for the search were *Cochrane*, *Scopus*, and *PubMed* and supplemented by a manual search and a gray literature search. It was not necessary to contact the authors to access the articles. The search started on January, 21, 2020 and ended on April 15, 2020.

### Search and Selection of Studies

A search in English with no time limit was performed by three independent people. The following search query was used: [autogeneous OR autogenic AND tooth socket OR tooth AND socket AND preservation OR conser-vation]. The studies were filtered and selected in several stages. Firstly, they were evaluated by titles. Secondly, individual documents at the first stage were additionally assessed by reading the abstracts and full-text articles. The difference in the choice was resolved through discussion among the readers.

### Data collection process

The data from different studies were extracted from studies according to the interests of the current review.

### Data items

Data from the included articles were extracted and filled in the table with the following information:

author and year, sample size, socket location, tooth extraction reason, results and conclusions.

### Risk of bias

The assessment of the risk of bias was undertaken during the data extraction process. For the included studies, it was conducted using the Cochrane Collaboration's ROBINS-I tool for assessing the risk of bias.<sup>15, 16, 29</sup>

Overall risk of bias was then assigned to each trial, according to Higgins *et al.*<sup>16</sup> The levels of bias were classified as follows: low risk, if all the criteria were met; moderate risk, when only one criterion was missing; high risk, if two or more criteria were missing; and unclear risk, if there were very few details to make a judgement about a certain risk assessment.

### Synthesis of results

Tables were constructed with columns as data items.

### Statistical analysis

No meta-analysis could be performed due to the high heterogeneity among the studies and the low number of studies.

## RESULTS.

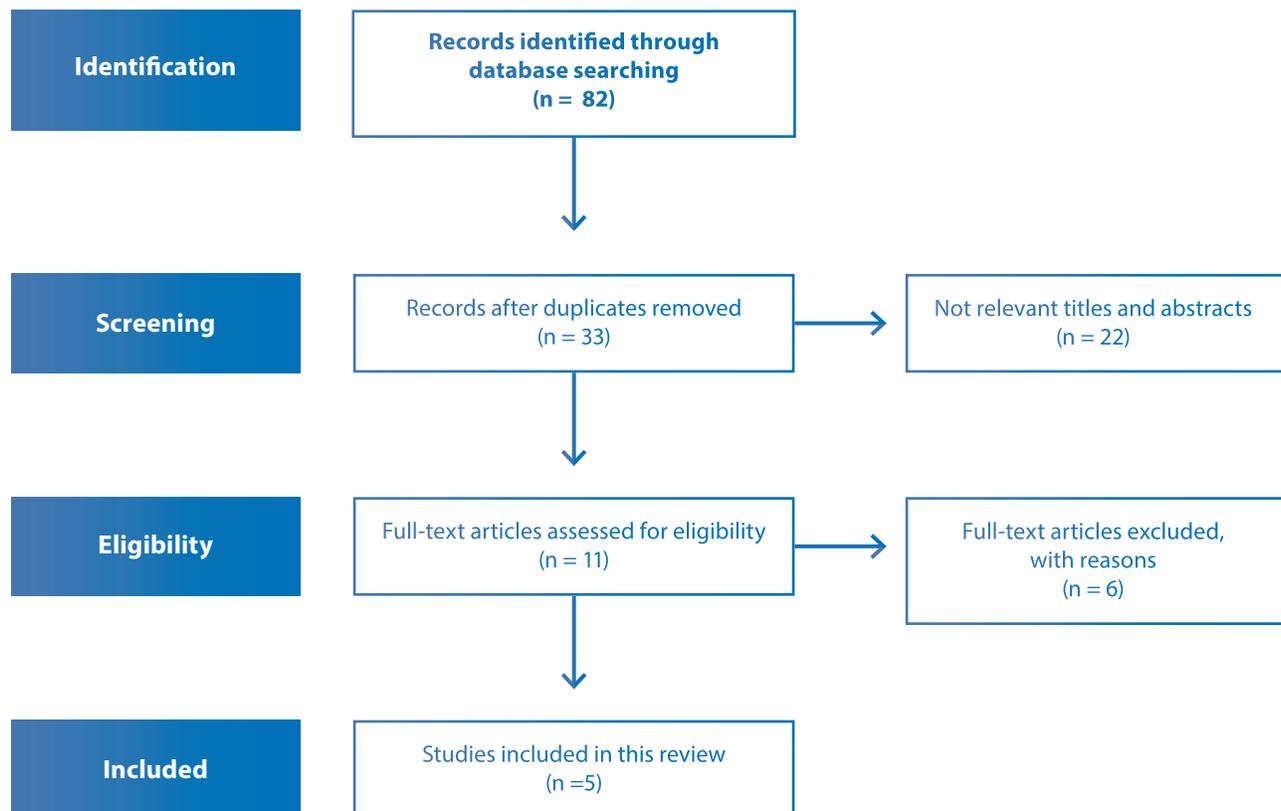
### Study selection

Article review, selection and data extraction were conducted as shown in the preferred reporting items for systematic reviews and meta-analyses (PRISMA) flow diagram (Figure 1).

A manual search and a gray literature search did not result in any applicable results. In total, 82 articles were identified. Of those, 11 were identified as potentially relevant articles by the screening of the article titles and abstracts.

Finally, these 11 publications were evaluated by full-text reading.

**Figure 1.** Flow diagram of the article selection process, according to PRIMA guidelines.



**Table 1.** Characteristics of studies. N/R – not reported.

Authors	Year	Number of teeth extracted	Socket location reason	Tooth extraction	Results	Conclusions
Shejali <i>et al.</i> <sup>19</sup>	2020	13	Maxillary and Mandibular single rooted teeth	Hopeless apical periodontitis	Clinical ridge width between baseline and 6 months postoperatively was 5.9mm ( $p=0.001$ ) The mean difference in pre-operative and post-operative alveolar ridge width was 5.8mm, showing a gain in the width which was statistically significant ( $p=0.001$ ).	Immediate ridge augmentation using autogenous tooth root block graft can be an effective option in managing the periodontally hopeless extraction site indicated for implant placement
Kim <i>et al.</i> <sup>20</sup>	2015	16	11(2) -12(1) -21(2); 22(1) - 31(2) - 32(3); 3(1) - 41(2) - 42(2)	Apical periodontitis with the bone loss	N/R – visual and histological analysis	Autogenous fresh tooth presents good results for socket preservation using Auto-FDT with respect to implant installation and alveolar ridge maintenance.
Canto-Díaz <i>et al.</i> <sup>21</sup>	2019	6	Single-rooted teeth	Periodontal reason	0.41 mm of bone loss, or 4.2% of the initial socket height and 0.15mm $\pm$ 0.08mm width changes were observed	The dimensional contraction of the post-extraction socket in the autologous dental material. The group was lower than the control group at 16 weeks after surgery, both vertically and horizontally. The densitometric values (HU) in the autologous dental material. group remained stable and homogeneous between the three areas, being equal to the control group after 16 weeks, with the exception of the coronal area, which continued to show higher $p$ -values
Minamizato <i>et al.</i> <sup>22</sup>	2018	8	Impacted mesiodens (1); 11(1)-21(1); 35(1) -36(1) -45(1); 46(2)	Apical periodontitis (3), root fracture (2), caries (2), and impacted mesiodens (1).	All implants had initial stability, with insertion torque $p$ -values of 25 to 40N*cm. At second surgery 3 months after implant placement, the ISQ values ranged from 65 to 80, with a mean $p$ -value of 72.6.	Extracted teeth prepared immediately after tooth extraction for bone augmentation, taking advantage of the relatively short preparation time with partial demineralization, have the potential to become one of the options as a bone substitute in implant dentistry
Joshi <i>et al.</i> <sup>23</sup>	2016	15	N/R	N/R	Sites grafted with extracted teeth consistently showed least reduction in ridge height, <i>i.e.</i> , 0.28mm $\pm$ 0.13 mm which was significantly lower as compared to ungrafted sites ( $p<0.05$ ).	The mean width change was 0.15mm $\pm$ 0.08mm. A mean width change for autogenous tooth-grafted sites was significantly lesser when compared to $\beta$ -TCP-grafted sites and ungrafted sites ( $p<0.05$ ). Extracted teeth showed more promising results as compared to $\beta$ -TCP in achieving minimum volumetric alveolar bone loss when it is grafted immediately in a post-extraction socket. This resorbable material allows most predictable, consistent, and reproducible bone regeneration. Derived from an extracted human tooth, it is the most easily available and cost effective material.

After applying the inclusion and exclusion criteria, five articles fulfilled the predefined criteria and were, therefore, incorporated in the systematic review. They included three pilot studies,<sup>19,21,22</sup> one case series<sup>19</sup> and one randomized, controlled, prospective, clinical pilot study.<sup>23</sup> (Table 1).

### Study characteristics and results of individual studies

Selected studies examine the efficacy and safety of an autogenous extracted tooth prepared onsite for fresh socket preservation. In total 58 teeth (30 of them were single rooted) were extracted and treated chairside for the fresh socket preservation and augmentation. Extraction reasons are indicated in Table 1.

The tooth indicated for extraction should have been free of soft tissue recession and the adjacent teeth should be periodontally healthy. Patients who were smokers, pregnant/lactating females, those on drugs affecting bone metabolism or radiation therapy and those not willing to participate were excluded from all studies. The grafts derived from autogenous teeth were presented in three forms: particles,<sup>20-22</sup> blocks<sup>19,20</sup> and powder.<sup>20,23</sup> Generally removal of crowns or fillings of any kind (composites resins or amalgams), decay, or discoloured dentine, pulp (if presented), periodontal ligament and/or dental plaque were provided.

Shejali *et al.*,<sup>19</sup> trimmed the extracted tooth according to the measured defect site to adapt very closely over the recipient bone. After adequate trimming, the tooth root block was immersed in dentin cleansing solution (KometaBio, New Jersey, USA) for 10 minutes followed by the buffer saline solution (Dulbecco's Phosphate) for 2-3 minutes to obtain a graft free of all the organic debris, resulting in a bacteria-free sterile graft.

The auto tooth grafts were stabilized with 1 or 2 titanium mini screws of 1.2mm diameter and enclosed with resorbable collagen membrane. There is no specific information about Kim's *et al.*,<sup>20</sup> graft preparation.

Canto-Díaz *et al.*,<sup>21</sup> crushed dentine fragments in a crushing chamber capable of grinding the roots into particles of 300 and 1200 microns. The particles

were ground for 3 separated using vibration for 20 seconds. Any particles smaller than 300 microns were discarded. Grafted sockets were sealed with a 15mm x 20mm collagen membrane. Minamizato *et al.*,<sup>22</sup> crushed teeth with ice cubes in a ceramic cup using a specific machine with a high-speed rotation ceramic blade. Sockets were augmented with platelet-rich plasma (PRP).

Joshi *et al.*,<sup>23</sup> powdered teeth using a conventional grinder having motor rating 1500 W and speed of 700 rpm. The crushed granules were passed through two autoclaved stainless steel sieves in a sequential manner to obtain graft with particle size measuring between 300µm and 500µm. All their grafted sites were covered with a membrane.

### Clinical, radiographic and histological assessment

All included articles except of Kim *et al.*,<sup>20</sup> and Minamizato *et al.*,<sup>22</sup> provided clinical and radiographic measurements right after surgery and in 7 days<sup>23</sup> (only clinical assessment), 8 weeks,<sup>21</sup> 16 weeks<sup>21,23</sup> and 6 mon-ths follow-up periods.<sup>19</sup> Radiographic measurements were provided with cone beam computed tomography (CBCT). (Table 1)

Minamizato *et al.*,<sup>22</sup> additionally measured initial stability and indicated insertion torque *p*-values of 25 to 40 N cm and ISQ values ranged from 65 to 80 with a mean value of 72.6 in 3 months after implant placement. A bone biopsy sample was collected using a 2.0mm-3.0mm trephine bur at 3 to 6 months postoperative from the transplanted sites of the patients who under-went socket preservation. In all articles histological analysis obtained from the bone core, demonstrated new bone formation along with complete organization. None of the sections demonstrated any remaining tooth graft particles.

### Risk of Bias within Studies and Across Studies

Summarizing the risk of bias for each study, most of the studies were classified as an unclear risk. A number of studies were considered as having a low risk of bias.

There were several limitations present in the current review, including studies written in English only, which could introduce a publication bias.

There were various degrees of heterogeneity in each study design, materials and methods and treatment provided among the studies.

## DISCUSSION.

The current systematic review has included a number of articles analyzing the use of extracted teeth as a simultaneous preservation material for fresh sockets. The advantages of using a tooth as a graft are multiple. As it is an autograft, there is no possibility of graft rejection or cross infection. The graft is the extracted tooth itself and hence there is no second surgical site.<sup>19</sup> Powder and chip or block extracted tooth grafts with a barrier membrane are able to preserve extraction sockets with respect to height and width that was proved clinically and radiographically. Histologically, it has been proved to provide new bone formation.

The possible explanations for such results with an autogenous extracted tooth as a grafting material has been validated by various *in vitro* and animal studies which have demonstrated its biocompatibility, osteoinductivity, and osteoconductivity.<sup>18,27,28</sup> A wide range of bone graft materials are available, and it is a challenging decision that will be dictated by the bone substitute material's physicochemical properties in relation to the type of defect and the main purpose of the procedure.<sup>24-26</sup> Joshi *et al.*,<sup>23</sup> has shown more promising results with extracted teeth as compared to  $\beta$ -TCP in achieving minimum volumetric alveolar bone loss when it is grafted immediately in fresh sockets.

Minamizato *et al.*,<sup>22</sup> have shown acceptable outcomes of maxillary sinus augmentation with the extracted tooth grafts as well as outcomes of socket preservation for dental implant placement.

Several articles included<sup>19,22</sup> in the systematic review mention limitations of immediate autogenous extracted tooth as a grafting material for fresh socket preservation. They include the presence of a healthy tooth root free of caries and restorations which may not be frequently present. Also, root canal treated teeth are not ideal for such a technique. It requires either buccal plate or palatal plate to present to support the graft and ensure good vascularity.

The preparation of extracted tooth graft is time-consuming. On the other hand it is the most easily available and cost effective material. The limitations of the studies are mostly related to the study design. This systematic review included four pilot studies and one case series. Additional prospective studies are

needed to validate these findings using larger sample sizes. Longer duration of evaluation will give more predictable results and would confirm its stability.

As well, such a socket preservation technique needs more comparative studies with other techniques, which employ, for example, stem cells and growth factors.

## CONCLUSION.

Immediate autogenous extracted tooth as a grafting material for fresh socket preservation is promising for future daily clinical practice. Future studies are needed not only to reveal its long-term effectiveness, but to develop clinical protocols as well, that will reduce chairside graft preparation time.

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

**Ethics approval:** This systematic literature review adheres to the PRISMA Statement. The review protocol was registered in an international prospective register of systematic reviews (PROSPERO ID CRD42020189487) in which the methodology and inclusion and exclusion criteria were specified and documented.

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