

Case Report

Tooth auto-transplantation to close an oro-sinusal communication using a 3D printed model to adapt the alveolar socket: a case report

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Abstract - Introduction: Tooth auto-transplantation has a high success rate therapy when limiting the extra-oral time of the graft. In this way, printing a 3D model of the germ can be a useful tool in order to prepare the receiving site. **Observation:** We treated a case of post extractional oro-sinusal communication closure using a 3D pattern to adapt the alveolar socket receiving the wisdom tooth auto-transplantation. **Comment:** Extra-oral time spent by the graft was under 15 seconds improving the chance of success. After one year follow up, the graft is vital, functional and it continued its root formation. **Conclusion:** 3D printing seems to be an effective technique to minimize surgical time leading to a higher rate of success for auto-transplantation therapies.

Introduction

The intraoperative management of post-extraction sinusal communications should, when possible, be subject of a prior preoperative study to choose the adequate surgical technique [1]. In this perspective, the use of a dental graft by auto-transplantation when indicated allows for immediate management of the oro-antral communication as well as the replacement of the missing tooth [2]. Moreover, 3D printed models in auto transplantation procedures has proven over the years to be beneficial in reducing extraoral time and graft manipulation [3]. This clinical case illustrates the use of a printed model to optimize the auto transplantation procedure used to rehabilitate a 16-year-old patient who presented post-extractional oral-antral communication.

Observation

A 16-year-old boy was referred by his orthodontist for his upper right first molar (tooth 16) extraction presenting eruption default with ankylosis marks. No other orthodontic care was needed except for the rehabilitation of the right

molar's occlusion. The medical history was clear and the patient was needed functional and esthetic rehabilitation concerning the upper right quadrant.

Intra-oral observation revealed the tooth 16 hold up in upper position, stuck between the 15 and 17 whom mesialized itself for 2mm. No mobility was observable on the tooth 16 and a metallic sound was audible after percussion signing its ankylosis.

The orthopantomogram (OPT) showed the intra-sinusal position of the tooth's roots and a mesial resorption of the crown and amelocemental junction (Fig. 1). This was confirmed by the small field (5 X 5 X 5) high resolution Cone Beam CT (CBCT) showing massive resorption replaced with bone structure. The exam also allowed us to appreciate the homolateral wisdom tooth anatomy and its radicular edification being at 2/3 of their formation corresponding to stage 7/10 of Nolla's classification. The CBCT also confirmed the match between the dimension of the donor tooth and its future alveolar socket (Fig. 2).

Decision was taken, in correlation with the patient and his mother, to head for the extraction of the 16, and to auto-transplant his 18 in a single surgical time to close in the same time the oro-sinusal communication involved by the extraction. This surgery has been performed under local anesthesia and antibioprophylaxy. The tooth 16 has been extracted after corono-radicular separation; the vestibular alveolar wall has

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Fig. 1. Orthopantomogram and CBCT showing tooth 16 stuck in upper position with mesial bone replacement resorption.

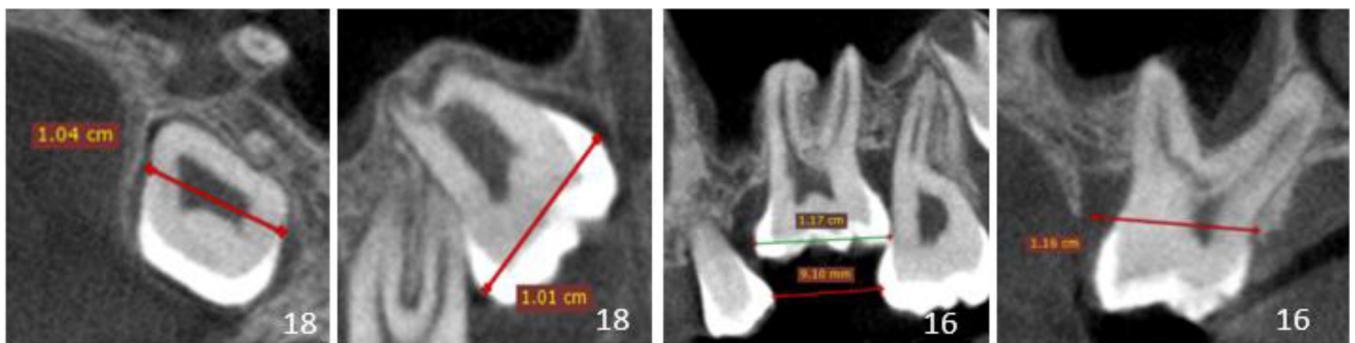


Fig. 2. Cone beam computed tomography sections and three dimensional analysis of teeth 16 and 18 showing the match between the dimension of the donor tooth and its future alveolar socket.

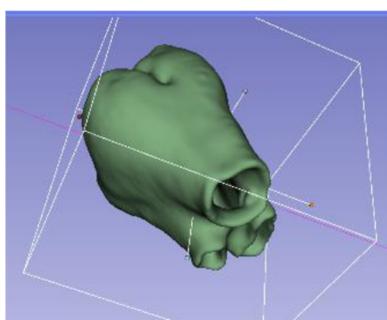


Fig. 3. Extracted digital model after numeric post treatment before 3D impression.

been fully conserved and a sinusosal communication over 5 mm diameter was confirmed after the 3 roots removal.

The 3D printed model has been extracted from the original CBCT with Slicer 3D (Fig. 3), a free software able to read DICOM files and to target specific tissues by manually selecting them or by switching with density gradient. Thanks to the open digital

workflow, the individualized included germ is now ready for digital post treatment using Slicer 3D surfacing option of exporting the file with Meshmixer. Once the surface is satisfying, it is printed in medical use resin by stereolithography before being disinfected in multiple antiseptic baths in compensation of not having the possibility to sterilize it by autoclave standard procedure.

The 3D printed model was fitted in the remaining alveolar site which had to be reworked to permit a slightly loose fitting. This model also helped us to apprehend the transplant morphology and its optimal insertion axis in the formed tooth socket limiting the fitting attempts.

Once the socket ready, the atraumatic extraction of the germ was performed and directly reimplanted in the site with extremely reduced extra-oral passed time (around 15 seconds) and closing the oro-sinusosal communication. After verification of any occlusal interference, the new transplant was stabilized by a Vicryl-hamac sewed and with orthodontic soft contention using 4/10 steel bar (Fig. 4).

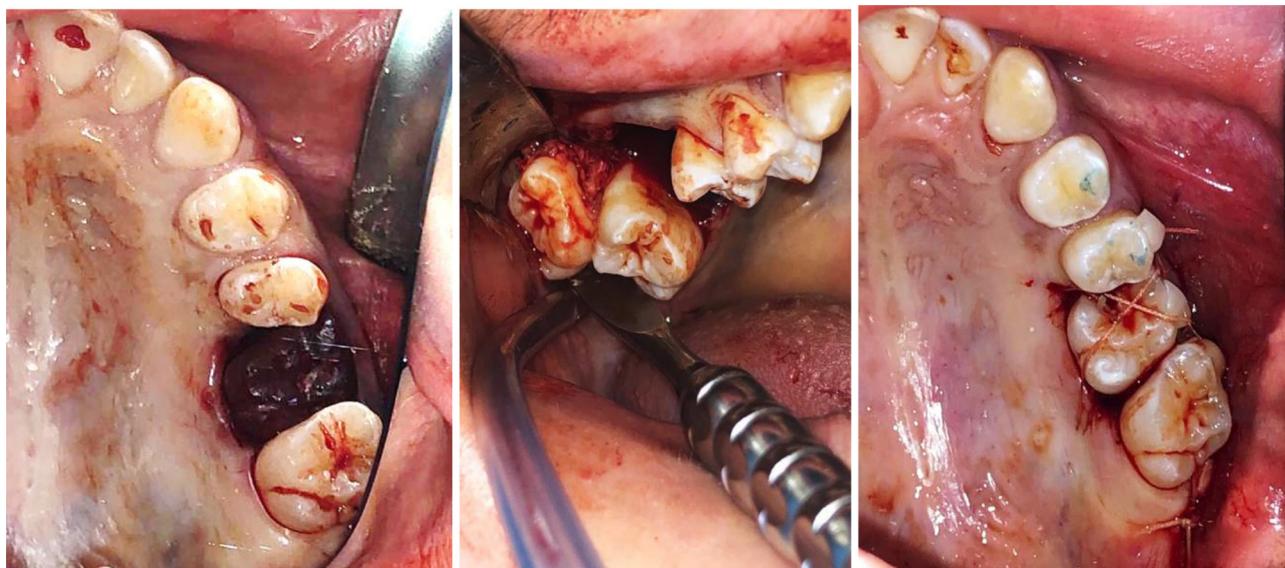


Fig. 4. Surgical view from left to right: 3D model placed in the socket after tooth extraction and socket conformation, atraumatic extraction of the germ of 18, 18 reimplantation stabilized by Vicryl-Hamac and 4/10 steel bar.

Table I. Therapeutic possibilities [6,7], pros and cons.

Implant therapy	Orthodontic therapy	Auto-transplantation therapy
<ul style="list-style-type: none"> Extraction 16 Oro-sinusal communication closing Space maintainer until growth ends Implantation 16 after growth 	<ul style="list-style-type: none"> Extraction 16 Oro-sinusal communication closing Orthodontic manoeuvres to close the gap by mesialing 17 18's spontaneous eruption in place of 17 	<u>One time surgery :</u> <ul style="list-style-type: none"> Extraction 16 Immediate auto-transplantation of 18 in place of 16, closing the sinusal communication in one time Transplant surveillance followed by orthodontic procedure
<p>Time consuming treatment, cost, no definitiv rehabilitation before adult age, orthodontic difficulties</p>		<u>Two time surgery :</u> <ul style="list-style-type: none"> Extraction 16 Sinusal communication closing Differed auto-transplantation of 18 in place of 16 Transplant surveillance followed by orthodontic procedure
<p>Risk of failure (ankylosis/resorption, transplant necrosis, incomplete result ...)</p>		

Week 1 follow up revealed a totally sealed marginal gingiva without any sinusal complications. At three weeks the transplant was responding positively to vitality tests. At 6 weeks, the contention was removed and a physiologic mobility

(less then 1 mm) was observable. The orthodontist began to manage mesio-distal space to allow the egression of this tooth before applying, after 2 months and a half egression forces on the transplant.

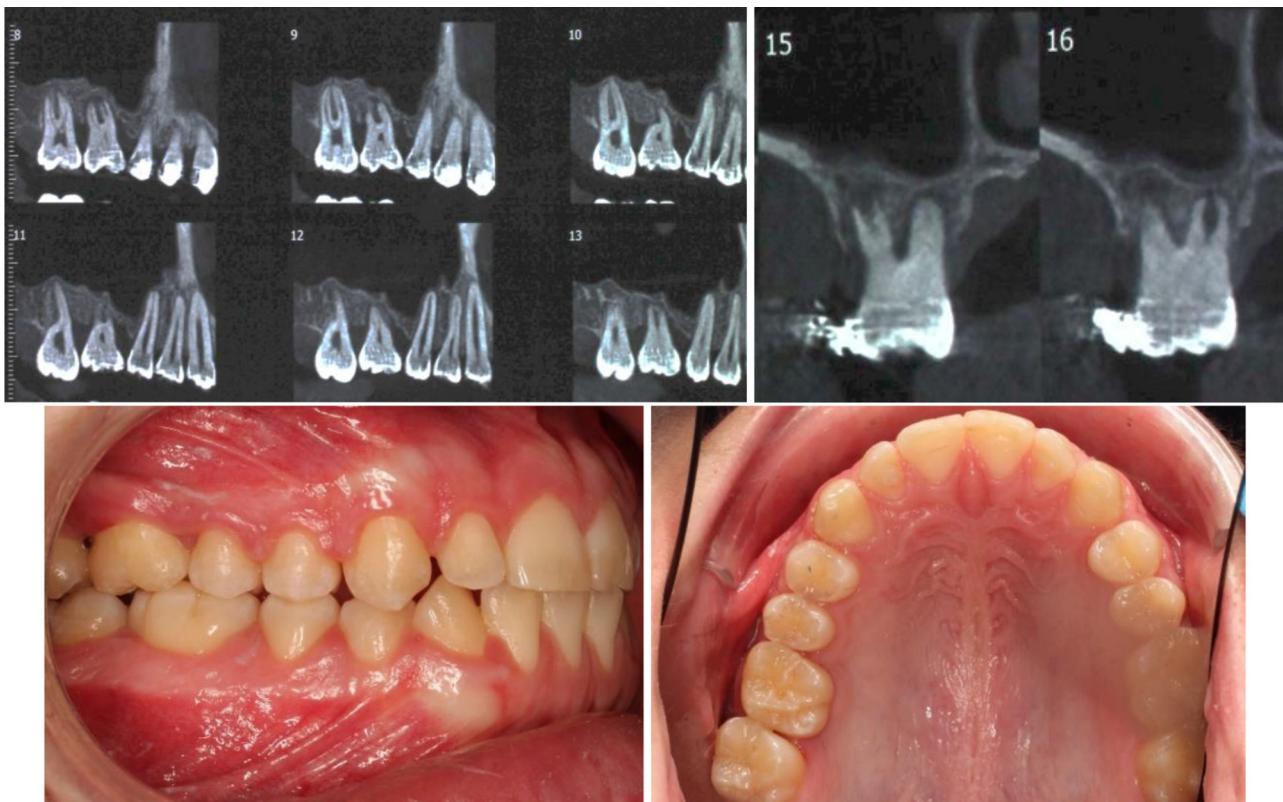


Fig. 5. 1 year follow up CBCT showing auto-transplant replaced, root formation at stage 9 of Nolla's classification (equivalent to the germ 28's development). No oro-sinusal communication but a slight mesio-distal bone loss.

After one year, the transplant has been leveled and replaced into a physiologic corridor, it is still vital and the root formation has continued its evolution (Fig. 5). The sinus is clear, without any buccal communication and any nasosinusal symptom described (although we observe vertical mesial alveolar bone loss). The new transplant is in place, showing physiological mobility (after orthodontic arc withdrawal) and responding to vitality tests.

Discussion

Auto-transplantation when possible for young patients is not often suggested but can be a reliable technique to manage missing teeth with a 92–98% survival rate at 5 years concerning immature tooth transplantation with 80% of revascularization [4,5]. When it involves mature teeth with closed apices, it seems that the survival rate decreases between 80% to 87% (pulp necrosis being mandatory). In our case, four possibilities were discussed (Tab. I). Therapeutic abstention wasn't possible due to the risk of infection and to the risk of tooth 17 mesialisation's accentuation leading to occlusal malfunction and local periodontal weakening.

Due to our patient's age, his motivation, the presence of a viable transplant in term of morphology and radicular edification, and because of the inevitable post extractional oro-sinusal communication, we chose to proceed to the extraction and auto-transplantation in a single surgical

procedure. This treatment avoids an early reoperation after 3 weeks and not having to pull a vestibulo-jugal flap for the closure of the antral communication and thus preserve the most quantity of soft tissue possible [2,8–10].

Also, the secondary orthodontic egression will allow the tooth and its surrounding tissues to migrate, bringing alveolar bone volume and keratinized gingiva to the crestal environment. The down effect of this technique was the risk of failure (ankylosis, or lack of desmodontal healing, root resorption, tooth devitalization, sinusal or local infectious complications). Since the patient was in dento-skeletal class 1 with a correct occlusal setting with a physiological overbite and overjet, the orthodontic solution mesializing 17 and allowing the spontaneous eruption of 18 was not retained [11–13].

It is well defined and documented [14–16] that one of the main success criterion in the auto-transplantation techniques is the management of extra-oral time after transplant extraction. Graft adaptation and matching of vestibulo-palatal and mesio-distal dimensions are necessary conditions for the feasibility of an auto-transplantation [14–16].

Overestimation or underestimation of the available space must be taken into account and can be predicted by a detailed analysis of the preoperative CBCT. The transplant should have a slightly loose fitting in the neo alveolar socket, being gently inserted in the blood clot. Any occlusal or apical interference are success criteria.

In this case, the dimensional analysis found a slightly under-dimensioned graft in all three planes of space. However, it was not possible to directly level the graft on the arch because of the lack of space due to the mesialisation of 17. Not a problem in this case because the objective was to close the post-extractional, oro-sinusal communication by inserting the graft in place of 16.

It is beneficial to have a 3D model to handle the conformation of the new alveolar socket. In our case, the mesialisation of tooth 17 reduced the mesiodistal space allowing us to apprehend the right insertion axis. This benefit resulted in less than one minute of extra-oral phase and minimal transplant manipulation which is mandatory to preserve desmodontal cells. These results are correlated with Verweij's studies showing a real benefit of 3D printed model as a trial guide for the future transplant with a decrease of the extra-alveolar time and a decrease amount of graft manipulation [3,17,18].

When printed with medical resins, 3D printed scale models, can be sterilized using standard autoclave procedure. Shaheen & al. shows low volumetric changes with 0.6–0.9% dimension variation [19]. This shouldn't impact our clinical manipulation of the model compared to the tooth transplant.

It is usually accepted that only one retention (either with Vicryl or with a flexible orthodontic wire) is necessary and this for a period of 4–6 weeks to limit the risk of ankylosis. However, according to different studies, no option seems to show superiority one over the other [16,20,21]. In our case, we opted for both techniques to maximize the stabilization of the graft in the vestibulo-palatal and in the vertical direction (to avoid the fall of the graft or its impaction in the sinus due to the lack of apical bone wall).

Concerning the orthodontic phase, the decision was taken to apply low forces with segmental forces over one year (including a non-working phase due to COVID 19 pandemic which complicated the orthodontical appointments). This phase is mandatory to level the donor tooth on the occlusal curve. In this case, tooth 16 being retained in a high position, the graft was implanted in the extraction socket, higher than its physiological position. This compromise also allowed the periodontal environment to migrate at the same time as the tooth itself, thus increasing the amount of keratinized gingiva, the height of the alveolar rampart and the formation of a sinusal bone floor.

In this case, the presence of a functional vital tooth, with good osteo-gingival integration after one year is a success confirmed by the patient's comfort.

Conclusion

This case report demonstrate the usefulness of modern techniques such as 3D printed scaled models to improve the auto-transplantation procedures. This therapeutic option showing high success rates, it is a good alternative for closing bucco-sinusal communications or for preserving the bone capital of our young patients, too young to benefit from implant rehabilitation.

This minimally invasive surgical technique respects the therapeutic gradient. In case of failure, if removal of the transplant is necessary, orthodontic and implant solutions can always be considered after closure of the oro-sinus communication. In addition, it may be interesting to propose auto-transplantation in cases of severe MIH in adolescents with terminal damage to their first molars compared to their early extraction [13,22]. In any case, a multidisciplinary approach is mandatory to apprehend auto transplantation procedures.

Authors contributions

LUCIDARME: redaction and case management, BAAROUN – LESCAILLE – MONDOLONI: revision, DESHORS: case management.

Conflicts of interests

The authors declare that they have no conflicts of interest in relation to this article.

Informed consent

Patient and his mother approved and gave a written consent for this article.

Ethical committee approval

The authors declare that Ethical approval not required.

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