Autotransplantation of mature impacted tooth to a fresh molar socket using a 3D replica and guided bone regeneration: a one year retrospective study

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Abstract

Objective
The aim of this study was to evaluate the performance of autotransplantation of a mature third molar to a fresh molar extraction socket using a 3D replica. Materials and Methods Ten patients underwent autotransplantation of teeth. We observed the mobility, percussion, radiography examination, the probing depth and the masticatory function of the transplanted teeth during one year following up, which were transplanted into fresh molar sockets by using a 3D replica, and GBR when it is necessary. Results
The average extra-oral time of donor tooth had been shortened to 1.65 min. The clinical examination of the autotransplantation teeth during one year follow-up showed no sign of failure. Expect one patient feel slight sensitive when chewing with soft food at 4 weeks, and 3 points of probing depth deeper at different patients than 3mm and 1 points of probing depth deeper than 4mm at 4 weeks among them, and 1 points of probing depth deeper than 3mm at 5 weeks at the same patient. Conclusions
The autotransplantation of teeth using 3D replica is an effective method which can reduce the extra-oral time of the donor teeth and the demand for the experience of a surgeon, and had a high success rate. Clinical Relevance
The new 3D replica of donor tooth can make the surgery of tooth autotransplantation much easier, and improve it success rate.

Introduction

The autotransplantation of a tooth is a predictable method to reconstruct a missing tooth or replace a tooth that needs to be extracted due to caries, trauma, or tooth fracture. Since it was first introduced by Fauchard in his book, Le Chirurgien Dentiste, in 1728, the treatment strategy had been developed for hundreds of years[1-3]. Its brief process involves donor tooth (mostly an impact tooth or a supernumerary tooth) that is extracted for the insertion of a prepared recipient socket[4]. Compared to implants, the autotransplantation of teeth is a better way to restore a missing teeth for its proprioception, the vital periodontium, preservation of alveolar bone volume and the papilla[5], and also better than a fixed bridge.

Many previous studies have demonstrated that third molars, premolars, impacted teeth and supernumerary teeth can be donor tooth in the clinical practice[6-8]. The incidence of the compromised molars which need to be extracted due to caries is much higher than in other teeth, especially in young Chinese range from 25-30 years old. The transplantation of a third molar to replace compromised first or second molar has more practical value. The survival rates of autotransplantation teeth with incomplete root formation after 1, 5 and 10 years were 97.4%, 97.8% and 96.3% respectively[9]. However, some studies showed that the estimated 10-years success rate of a transplanted premolar with mature root was 81.6% which is much higher than that of a molar, with a 33.8% 10-years success rate[10]. Many factors affect the success of tooth transplantation, such as root development stage, surgical trauma, the recipient site (local inflammation, alveolar bone volume and quality), the surgery procedure (stabilization method, use of intraoperative drugs and storage) and so on[9]. The lower success and survival rates of the molar can be related to more complex root anatomy, more tissue trauma during extraction, and the requirement of high individual surgical skill[11]. The most important factor that affect a successful tooth
transplantation is the preservation of the healthy periodontal tissue[12]. The duration of the extra-oral time and the try-ins into the recipient socket will damage the periodontal tissues of the donor teeth.

Researchers still need to discover how to shorten the extraoral time of donor tooth, reduce the damage of the periodontal tissue, and improve the surgeon's skill. Many attempts tried to reduce the extraoral time of donor tooth[13]. With the development of radiological and 3D printing technology, a precisely replica of donor teeth can be fabricated by a 3D printer, according to the data of cone beam computed tomography. Many case reports have indicated that the use of a 3D replica of donor tooth can decrease the extraoral time and increase the ease of surgery[14]. Lee et al have used computer-aided rapid prototyping for tooth transplantation and shorten the extraoral time[15]. The bone defect between the prepared socket and the donor tooth is inevitable when transplantation was done in a fresh extraction socket. And the bone graft materials will need to fill the bone defect. Yu et al have autotransplanted canine combined with guided bone regeneration, which show an acceptable result during 7.1 years following up[16]. The technique of guided bone regeneration had been widely used in the implantation, where the bone graft materials create a space for bone regeneration. Yu et al also reported that the survival rate of the autotransplantation of third molars with completely formed roots in both surgically created and fresh extraction sockets were 93.1% and 95.2% during 10 years following up[17]. However, investigations of the clinical advantages and the success rate of this autotransplantation technique associationg with GBR are still lacking.

Therefore, the purpose of this study is to evaluate the efficacy of the transplantation of third molar to a fresh first or second molar extraction socket by using a 3D replica of donor teeth and grafting with autogenous bone to fill the gap between the tooth and the prepared socket.

**Materials And Methods**

**Study population and design**

This was a retrospective observational study of 10 autotransplantation of third molars into fresh first or second molar extraction socket positions simultaneously using a 3D replica and grafting with autogenous bone mixed with concentrated growth factor (CGF) in 10 patients (8 males and 2 females) (ages ranging from 19 to 42 years) between September 2016 and August 2017. All the patients were consecutively collected from Department of Oral and Maxillofacial Surgery, affiliated with the Stomatological Hospital of Fujian Medical University. All patients were informed about the surgical treatment procedure. The study design was performed in accordance with the Helsinki Declaration (revised in 2008).

The patients included in this study reach the following criteria:

1. First or second molar need to be extracted.
2. Third molar with mature root need to be extracted.
3. Recipient site without local acute inflammatory.
4. The rest bone height of the recipient site is enough for the donor tooth (the height from alveolar ridge crest to inferior alveolar nerve).

5. Systemic diseases such as diabetes mellitus and hypertension, which is not suit for oral surgery, were absent.

**Preoperative work-up**

All patients received a cone-beam computed tomography (CBCT) examination to analysis the compromised teeth and the donor teeth (the stage of the root development and the shape of the root), and the bone height / bone width in the recipient site were adequate for the donor teeth. All patients underwent an overall dental hygiene assessment, teeth washing or scaling, and root planning one week before surgery, if necessary. The 3D replica of the donor teeth, made of resin material, was fabricated by a 3D printer (Vida, Envision TEC) according to the data from the CBCT.

**Surgical procedure**

All the surgical procedures were performed by the same surgeon, who had more than 20 years of experience in oral surgery. Block anesthesia of the inferior alveolar nerve was used when the donor teeth and the recipient site were in the mandibular; local anesthesia was used when the donor teeth or the recipient site were in the maxillary. Local anesthesia was achieved with articaine chlorhydrate 4% and adrenaline 1:100 000. A crevicular incision was made from second premolar to third molar, and the vertical releasing incision in distal side was made if necessary. The compromised molar was extracted by minimally invasive maneuver, using high-speed fissure bur (SINOL) and a dental elevator or forceps (Stoma). The preparation of recipient site was done by piezosurgery according the root shape of the 3D replica of the donor teeth, which was sterilized by ethylene oxide before surgery. Meanwhile, the bone fragment was collected during the preparation of the recipient site if the recipient site had any bone defect. The impacted tooth was extracted by minimally invasive technique, using a dental elevator or forceps (Stoma) after the 3D replica of the donor teeth try-ins into the recipient socket. We put the donor teeth into the recipient socket immediately after the extraction of the donor teeth and then achieve an optimal fit. If there were bone defect around the neck of the donor tooth after inserted into the recipient site, we performed a bone graft by using the autogenous bone, which was collected during the socket preparation process, mixed with CGF (Medifuge, Silfradenstr, S. Sofia, Italy) which was done immediately before surgery. Blood from the patient was centrifuged using a tabletop centrifuge and the topmost layer consisting of CGF. Then the bone graft area was covered by CGF membrane which was also done before surgery. Finally, the flap was repositioned and sutured. We used fiber band to fixed the autotransplantation teeth with the adjacent teeth. The brief surgical procedure of the tooth autotransplantation was showed in Fig 1.

**Postoperative treatment**

After surgery, all the patients received mouth rinsing for 1 week. After 1 week, the sutures were removed and the wound was cleaned by normal saline. The preparation of the root canal was performed 2 weeks
after surgery and the filling of the root canal was done 5 weeks after surgery. The fiber band was removed 5 weeks after surgery.

Postoperative examination

Follow-up recalls were scheduled for 1, 2, 4 weeks and for 3, 6, 12 months. At each time of the follow-up the mobility and percussion were checked, while the probing depth of the mesial-buccal, buccal, distal-buccal, mesial lingual, lingual, and distal-lingual of the autotransplantation teeth and the masticatory function were checked 1, 3, 6, and 12 months after surgery. The radiography examination was taken before surgery and immediate, 1, 3, 12 months after surgery. We defined the masticatory function as the patient’ ability to chew normal food without pain or discomfort. The primary success criteria of the transplanted tooth were followed according to the book of Tsukiboshi[18]. In terms of the radiography (1) normal space of the parodontium; (2) no sign of progressivity absorb of the root; (3) the exist of the lamina dura. In terms of clinical examination (1) normal mobility; (2) normal percussion sound; (3) no periodontal pocket; (4) no sign of inflammation; (5) no discomfortable; (6) normal function of chewing.

Results

Retrospective, we evaluated 10 patients (8 male and 2 females, mean age 31.6+8.75, range from 19 to 42 years) who underwent transplantation of their third molar to their fresh first or second molar extraction socket, using a 3D replica. The basic information of the patients about the gender, age, site of the donor tooth, recipient site, reason for extraction, the extraoral time, as well as whether guided bone regeneration (GBR) was performed, are recorded in table 1. All the patients met the criteria of the success as we enumerated the points previously, and no periodontal pocket, mobility, inflammation and absorption of the root were found. The average extraoral time of the donor teeth spent was 1.35 min, and three donor teeth were transplanted in the recipient socket less than 1 min after extraction. But there were two cases cost 3.5 and 4 minutes respectively due to the error range of the 3D replica.

No mobility was found in any cases during the follow-up period and only one patient felt slight pain from percussion of the transplanted tooth at 4 weeks. In addition, only one patient feel slight sensitivity when chewing soft food at 4 weeks. In terms of probing depth, three patients’ probing depth was deeper than 3 mm, and one patient’s probing depth was deeper than 4 mm at 4 weeks, all the probing sites were distal-buccal/lingual. Meanwhile, the probing depth at the distal-buccal/lingual site was deeper than 3 mm in one patient at 3-months follow-up whose probing depth was deeper than 4 mm at 4 weeks. The probing depths in other transplanted teeth were normal at all follow-ups. The specific data about the related clinical symptoms appear in Table 2. In terms of the X-rays, no sign of bone loss of more than one third of the root length, ankyloses, or root resorption occurred during the 1-year follow-up, as shown in Figure 2.

Discussion
In our retrospective study, the autotransplantation teeth, using 3D replica, was an efficient method with a 100% success rate during one-year follow-up, according the success criteria previously mentional. Verweij et al[14] reported that high success rates were reported when using donor tooth replicas, success and survival rates of 80.0 - 91.1 % and 95.5 - 100 %, respectively. Healthy periodontal ligament and the good tissue adaptation are considered the most important factors in successful tooth transplantation[12]. Meanwhile, the extraoral time, number of fitting attempts of the donor teeth, skill of surgeon, and the trauma of the recipient socket may influence the periodontal ligament.

We used a 3D replica of donor tooth to preserve the periodontal ligament of the donor tooth. Firstly, the 3D replica of donor tooth can replace the real one to determine whether the recipient socket is ideally suited for the donor tooth; the process will damage the periodontal ligament seriously. Second, the use of the 3D replica of donor tooth shorten the extraoral time to 0-4 mins in our surgery. Meanwhile the use of minimally invasive technique reduced the damage of the periodontal ligament during the extraction of the donor tooth. Andreasen et al reported that the normal periodontal healing would proceed if the extraoral time of the donor tooth was less than 18 min[19]. The extraoral time in our cases were much less than 18 min and were consistent with other clinical studies. As Jang et al reported that there were immediate autotransplantation in four of five teeth and one with 2 min extraoral time[6].

In our cases, there are two cases cost 3.5 and 4 minutes due to the error range of the 3D replica, that is the inaccuracy of the model. So the accuracy of the 3D replica model is important to the produce of the surgery. The accuracy of the 3D replica model also effected the fitness of the donor teeth to the recipient socket. Many factors may affect the accuracy of the replica model, such as the data from the CBCT, the material shrinkage during the building or postcuring and the minimal thickness of the layers[20]. So far there is no standard definition of the clinically acceptable differences between the replica model and the donor teeth, although several studies reported that the differences of less than 0.25 mm are clinically acceptable[21]. And Lee et al reported that the mean deviations of the replica model manufactured by 3D printer were 0.038-0.047 mm[22], which is much less than the clinically acceptable value. Also Lee and Kim reported that the 3D replica models were, on an average, 0.149 mm smaller in size than the real teeth[23]. And Khalil et al proved that the dimensional differences between the 3D replica models made by 3D printing technologies and the real teeth were below 0.25 mm, which is accepted by the clinical demand[24]. Therefore, the 3D printing technologies, used for 3D replica models of the donor teeth, is accuracy enough for the autotransplantation of the teeth. The fitness of the donor teeth to the recipient socket was well in our clinical operation, expect the two cases due to the date of the CBCT was incomplete during the date transmission.

The use of a 3D replica model of a donor tooth can not only reduce the damage to the periodontal ligament but also increase the ease of the autotransplantation and lower the requirement for the experience of the surgeon. Verweij et al demonstrated that the surgery time of the autotransplantation when using replica model can be shorten to less than 30 minutes even if the surgery was done by a less experienced surgeon[25]. Shahbazian et al compared the traditional technique to 3D autotransplantation and found that the time of the surgery procedure were 40-90 min and 30-45 min, respectively[26].
Many other factors affect the success of the autotransplantation tooth. Yoshino et al analyzed the influence of age on the tooth autotransplantation and found that the younger the patient is, the higher success rate of the tooth autotransplantation, the success rate was lower in the 55-69 years old group[27]. Sugai et al and Yoshino et al also reported that patients under 40 years old showed a higher success rate than the older one group[28, 29] Yoshino et al also analyzed the influence of gender on the tooth autotransplantation and found that compared with female the survival rate of the tooth autotransplantation of males was low at 5-years, 10-years and 15-years follow-ups and need more attention during the autotransplantation process[30]. Therefore, the use of donor tooth replicas are more needed in male patients so that the surgery process can be handle well.

The third molars slated for autotransplantation in all cases in the present study is mature teeth with developed roots, so the revascularization of the pulp is not likely to happen after transplantation and needed root canal therapy[28, 31]. Some cases in the present study use the GBR to regeneration the bone defect. Yu. HJ et al reported that using GBR during autotransplantation in recipient site where buccolingual alveolar bone atrophy had occurred could also result in a good long-term outcome[17]. Other studies also proved that the usefulness of GBR in the autotransplantation at recipient sites with bone defects[16]. The autogenous bone that was collected from extraction socket was used for the GBR in the present study. Compared with xenogenic bone, autogenous bone has the capable of osteogenesis, osteoinduction, and osteoconduction, and may reduce the foriegn-body reaction. The success rate of using GBR in autotransplantation is consistent with the non GBR one.

The success rate of the autotransplantation, using 3D replica, is high, but the long-term survival rate still need to be observed, and the precise of the autotransplantation need not only a 3D replica as a guide but also a preparation guide of the recipient site and a guide for occlusion, all of which still need more research.

Declarations

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Compliance with Ethical Standards

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

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Ethical approval: The study protocol was evaluated and approved by the Institutional Ethics Committee of the School of Stomatology, Fujian Medical University (Ref. [2016] NO.10). 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."

**Informed consent:** All patients provided written informed consent.

**References**

1. Cross D, El-Angbawi A, McLaughlin P, et al. (2013) Developments in autotransplantation of teeth. The surgeon : journal of the Royal Colleges of Surgeons of Edinburgh and Ireland 11:49-55. 
   [https://doi.org/10.1016/j.surge.2012.10.003](https://doi.org/10.1016/j.surge.2012.10.003)

2. Almpani K, Papageorgiou SN, Papadopoulos MA (2015) Autotransplantation of teeth in humans: a systematic review and meta-analysis. Clinical oral investigations 19:1157-1179. 
   [https://doi.org/10.1007/s00784-015-1473-9](https://doi.org/10.1007/s00784-015-1473-9)

3. Verweij JP, Anssari Moin D, Mensink G, et al. (2016) [Autotransplantation 2.0. Considerations, results and the latest techniques]. Nederlands tijdschrift voor tandheelkunde 123:348-353. 
   [https://doi.org/10.5177/ntvt.2016.07/08.16119](https://doi.org/10.5177/ntvt.2016.07/08.16119)

4. Ong D, Itskovich Y, Dance G (2016) Autotransplantation: a viable treatment option for adolescent patients with significantly compromised teeth. Australian dental journal 61:396-407. 
   [https://doi.org/10.1111/adj.12420](https://doi.org/10.1111/adj.12420)

5. Czochrowska EM, Stenvik A, Album B, et al. (2000) Autotransplantation of premolars to replace maxillary incisors: a comparison with natural incisors. American journal of orthodontics and dentofacial orthopedics : official publication of the American Association of Orthodontists, its constituent societies, and the American Board of Orthodontics 118:592-600. 
   [https://doi.org/10.1067/mod.2000.110521](https://doi.org/10.1067/mod.2000.110521)

6. Jang JH, Lee SJ, Kim E (2013) Autotransplantation of immature third molars using a computer-aided rapid prototyping model: a report of 4 cases. Journal of endodontics 39:1461-1466. 
   [https://doi.org/10.1016/j.joen.2013.06.026](https://doi.org/10.1016/j.joen.2013.06.026)

7. Cardona JL, Caldera MM, Vera J (2012) Autotransplantation of a premolar: a long-term follow-up report of a clinical case. Journal of endodontics 38:1149-1152. 
   [https://doi.org/10.1016/j.joen.2012.04.001](https://doi.org/10.1016/j.joen.2012.04.001)

8. Cousley RRJ, Gibbons A, Nayler J (2017) A 3D printed surgical analogue to reduce donor tooth trauma during autotransplantation. Journal of orthodontics 44:287-293. 
   [https://doi.org/10.1080/14653125.2017.1371960](https://doi.org/10.1080/14653125.2017.1371960)

9. Rohof ECM, Kerdiijk W, Jansma J, et al. (2018) Autotransplantation of teeth with incomplete root formation: a systematic review and meta-analysis. Clinical oral investigations 22:1613-1624. 
   [https://doi.org/10.1007/s00784-018-2408-z](https://doi.org/10.1007/s00784-018-2408-z)

10. Ronchetti MF, Valdec S, Pandis N, et al. (2015) A retrospective analysis of factors influencing the success of autotransplanted posterior teeth. Progress in orthodontics 16:42. 
    [https://doi.org/10.1186/s40510-015-0112-y](https://doi.org/10.1186/s40510-015-0112-y)
11. Denys D, Shahbazian M, Jacobs R, et al. (2013) Importance of root development in autotransplantations: a retrospective study of 137 teeth with a follow-up period varying from 1 week to 14 years. European journal of orthodontics 35:680-688. https://doi.org/10.1093/ejo/cjs112

12. Kim E, Jung JY, Cha IH, et al. (2005) Evaluation of the prognosis and causes of failure in 182 cases of autogenous tooth transplantation. Oral surgery, oral medicine, oral pathology, oral radiology, and endodontics 100:112-119. https://doi.org/10.1016/j.tripleo.2004.09.007

13. Lee SJ, Jung IY, Lee CY, et al. (2001) Clinical application of computer-aided rapid prototyping for tooth transplantation. Dental traumatology: official publication of International Association for Dental Traumatology 17:114-119.

14. Verweij JP, Jongkees FA, Anssari Moin D, et al. (2017) Autotransplantation of teeth using computer-aided rapid prototyping of a three-dimensional replica of the donor tooth: a systematic literature review. International journal of oral and maxillofacial surgery 46:1466-1474. https://doi.org/10.1016/j.ijom.2017.04.008

15. Lee SJ (2004) Clinical application of computer-aided rapid prototyping for tooth transplantation. Australian endodontic journal: the journal of the Australian Society of Endodontology Inc 30:29-31.

16. Yu HJ, Qiu LX, Wang XZ (2014) Long-term follow-up of autogenous canine transplants with application of guided bone regeneration. International journal of oral and maxillofacial surgery 43:355-361. https://doi.org/10.1016/j.ijom.2013.08.019

17. Yu HJ, Jia P, Lv Z, et al. (2017) Autotransplantation of third molars with completely formed roots into surgically created sockets and fresh extraction sockets: a 10-year comparative study. International journal of oral and maxillofacial surgery 46:531-538. https://doi.org/10.1016/j.ijom.2016.12.007

18. Tsukiboshi M AJ, Asai Y. Autotransplantation of teeth 2001.

19. Andreasen JO, Paulsen HU, Yu Z, et al. (1990) A long-term study of 370 autotransplanted premolars. Part II. Tooth survival and pulp healing subsequent to transplantation. European journal of orthodontics 12:14-24.

20. Barker TM, Earwaker WJ, Lisle DA (1994) Accuracy of stereolithographic models of human anatomy. Australasian radiology 38:106-111.

21. Hazekveld A, Huddleston Slater JJ, Ren Y (2014) Accuracy and reproducibility of dental replica models reconstructed by different rapid prototyping techniques. American journal of orthodontics and dentofacial orthopedics: official publication of the American Association of Orthodontists, its constituent societies, and the American Board of Orthodontics 145:108-115. https://doi.org/10.1016/j.ajodo.2013.05.011

22. Lee KY, Cho JW, Chang NY, et al. (2015) Accuracy of three-dimensional printing for manufacturing replica teeth. Korean journal of orthodontics 45:217-225. https://doi.org/10.4041/kjod.2015.45.5.217

23. Lee SJ, Kim E (2012) Minimizing the extra-oral time in autogeneous tooth transplantation: use of computer-aided rapid prototyping (CARP) as a duplicate model tooth. Restorative dentistry & endodontics 37:136-141. https://doi.org/10.5395/rde.2012.37.3.136
24. Khalil W, EzEldeen M, Van De Casteele E, et al. (2016) Validation of cone beam computed tomography-based tooth printing using different three-dimensional printing technologies. Oral surgery, oral medicine, oral pathology and oral radiology 121:307-315. https://doi.org/10.1016/j.oooo.2015.10.028

25. Verweij JP, Moin DA, Mensink G, et al. (2016) Autotransplantation of Premolars With a 3-Dimensional Printed Titanium Replica of the Donor Tooth Functioning as a Surgical Guide: Proof of Concept. Journal of oral and maxillofacial surgery : official journal of the American Association of Oral and Maxillofacial Surgeons 74:1114-1119. https://doi.org/10.1016/j.joms.2016.01.030

26. Shahbazian M, Jacobs R, Wyatt J, et al. (2013) Validation of the cone beam computed tomography-based stereolithographic surgical guide aiding autotransplantation of teeth: clinical case-control study. Oral surgery, oral medicine, oral pathology and oral radiology 115:667-675. https://doi.org/10.1016/j.oooo.2013.01.025

27. Yoshino K, Kariya N, Namura D, et al. (2013) Influence of age on tooth autotransplantation with complete root formation. Journal of oral rehabilitation 40:112-118. https://doi.org/10.1111/joor.12012

28. Sugai T, Yoshizawa M, Kobayashi T, et al. (2010) Clinical study on prognostic factors for autotransplantation of teeth with complete root formation. International journal of oral and maxillofacial surgery 39:1193-1203. https://doi.org/10.1016/j.ijom.2010.06.018

29. Yoshino K, Kariya N, Namura D, et al. (2012) Risk factors affecting third molar autotransplantation in males: a retrospective survey in dental clinics. Journal of oral rehabilitation 39:821-829. https://doi.org/10.1111/j.1365-2842.2012.02325.x

30. Yoshino K, Ishizuka Y, Sugihara N, et al. (2013) Gender difference in tooth autotransplantation with complete root formation: a retrospective survey. Journal of oral rehabilitation 40:368-374. https://doi.org/10.1111/joor.12038

31. Mejare B, Wannfors K, Jansson L (2004) A prospective study on transplantation of third molars with complete root formation. Oral surgery, oral medicine, oral pathology, oral radiology, and endodontics 97:231-238. https://doi.org/10.1016/s107921040300461x

Tables

Table 1: Basic information of the patients
| NO. | Gender | Age | Donor tooth | Recipient site | Reason for extraction | Extra-oral time (min) | GBR (autogenous bone) |
|-----|--------|-----|-------------|-----------------|----------------------|----------------------|---------------------|
| 1   | Female | 33  | 48          | 46              | Root fracture        | 4.0                  | Y                   |
| 2   | Male   | 23  | 48          | 46              | Root fracture        | Less than 1 min      | N                   |
| 3   | Female | 24  | 38          | 36              | severe caries        | Less than 1 min      | N                   |
| 4   | Male   | 22  | 38          | 16              | Furcation involvement| Less than 1 min      | Y                   |
| 5   | Male   | 42  | 28          | 47              | severe caries        | 3.5                  | Y                   |
| 6   | Male   | 38  | 28          | 37              | severe caries        | 1.0                  | Y                   |
| 7   | Male   | 39  | 48          | 47              | Root fracture        | 1.0                  | Y                   |
| 8   | Male   | 35  | 48          | 47              | severe caries        | 1.5                  | Y                   |
| 9   | Male   | 41  | 28          | 37              | severe caries        | 1.5                  | Y                   |
| 10  | Male   | 19  | 38          | 37              | severe caries        | 1.0                  | Y                   |

Table 2: the number of patient who had the clinical symptom

| Follow-up | mobility | Pain when percussion | No masticatory function | probing depth 3mm | probing depth 4mm |
|-----------|----------|-----------------------|-------------------------|-------------------|-------------------|
| 1 week    | 0        | 0                     | /                       | /                 | /                 |
| 2 weeks   | 0        | 0                     | /                       | /                 | /                 |
| 4 weeks   | 0        | 1 (slight sensitive)  | 3 (distal-buccal/lingual)| 1 (distal-buccal/lingual)| /                 |
| 3 months  | 0        | 0                     | 0                       | 1 (distal-buccal/lingual)| 0                 |
| 6 months  | 0        | 0                     | 0                       | 0                 | 0                 |
| 12 months | 0        | 0                     | 0                       | 0                 | 0                 |

Figures
Figure 1

The surgical procedure of autotransplantation of a mature third molar tooth in a fresh socket of second molar tooth: (a) compromised second molar tooth. (b) fresh socket of the second molar tooth after extraction. (c) try-in of the 3D replica of the donor tooth. (d) the 3D replica was almost the same of the donor maxillary third tooth. (e) try-in of the donor tooth. (f) grafting of the autogenous bone in the buccal and distal side of the donor tooth. (g) covering with CGF membrane. (h) suturing the flap and fixed the autotransplantation tooth.

Figure 2

The X-ray photograph before surgery (a) and immediate (b), 1 (c), 3 (d), 12 (e) months after surgery.

Supplementary Files

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- supplement1.pdf