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Tooth Bank (Cryopreserved Teeth) Concept in Conventional Orthodontic Treatment. An Electronic Search Study

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Abstract: Background: Autotransplantation has been carried out for many years, but with varying success rates. As a result, it is seldom regarded as an appropriate treatment option for patients. Autotransplantations of teeth are widely used in cases of severe impactions, early loss of permanent teeth, or congenital aplasia. However, sometimes patients may not have a donor tooth available because of previous extraction. To solve such problems, teeth cryopreservation systems have been developed. There are many clinical reports and animal experiments showing the efficacy of teeth cryopreservation. Hence, unnecessary wisdom teeth, supernumerary teeth and healthy premolars extracted by orthodontic treatment should be used as donor teeth for replacing a missing tooth in future. In this electronic search study, the biological properties of cryopreserved teeth and its clinical application are discussed. **Objective:** The present electronic search study was done to evaluate the importance of tooth bank (cryopreserved teeth) concept in conventional orthodontic treatment. **Materials and methods:** In this study an electronic literature search was performed for articles and books published from January 1972 to May 2016. **Results:** As a result 225 literature were found out of which only 37 publications (36 articles and 1 book) were relevant to the searched topic. **Conclusion:** To conclude, this study has shown that unnecessary wisdom teeth and healthy premolars which are extracted for orthodontic treatment can be the target to start a tooth bank which contribute in making autotransplantation the standard procedure for replacing a missing tooth in the future.

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Key words: autotransplantation, cryopreservation, ectopic eruption.

1. Introduction

Autotransplantation is defined as the surgical repositioning of a tooth within the same socket. Autotransplantation refers to the extraction of a tooth from one location of a patient and its replantation in a different location on the same individual. The new location may be a fresh extraction socket after extraction of a non-restorable tooth, or an artificially drilled socket on an edentulous alveolar ridge. Its definition also encompasses the surgical repositioning of a tooth within the same socket. [1,2]

The major disadvantage of using implants in anterior region is the marginal bone loss, time consumption and economy. But use of autotransplanted teeth can markedly reduce treatment time, financial burden of the patient, with maintenance of physiologic and the accurate anatomy of the arch. However the survival rate of replanted or autotransplanted teeth is the major issue due to lack of infrastructure. The

survival rate is affected by the reaction of the pulp, duration of time from donor site to recipient site. [3-5] The hidden truth behind the failure of these transplanted teeth is the storage media, rationale for dehydration, necrosis and rupture of periodontal fibers and its ground substance leads to failure of autotransplanted teeth. Usual outcome of autotransplantation is boney fusion, however, fused teeth cannot be used for orthodontic tooth movement. [6,7] The only possible alternative by extraoral storage of the tooth in optimal anatomic relations of the recipient region may create orthodontic tooth movements. One such technique is called cryopreservation. [8,9]

Cryopreservation is a process where cells or whole tissues are preserved by cooling to low sub-zero temperatures, such as (typically) 77 K or −196 °C (the boiling point of liquid nitrogen). At these low temperatures, any biological activity, including the biochemical reactions that would lead to cell death, is effectively stopped. When cryoprotectant solutions are not used, the cells being preserved are often damaged due to freezing during the approach to low temperatures or warming to room temperature. [10-13] Recent study reveals that only 79% of autotransplanted teeth have shown success, because cell damage induced by ice crystal formation inside cell as well as mechanical stress by extra cellular ice formation. This suggests that root canal treatment should be performed before transplant. This electronic search study gives a comprehensive idea of freezing methods, role of magnetic field during cryopreservation and clinical implication of the same. [12-14]

2. Materials and methods

Literature search design

An electronic literature search was performed for articles and books published from January 1972 to May 2016. The articles were selected on the basis that they are from a reputed Journals indexed in ISI Web of Knowledge, Scopus, PubMed or Medline and having a good impact factor and Eigen factor score.

3. Results

As a result only 225 literature were found out of which only 37 publications (36 articles and 1 book) were found relevant to the searched topic and meeting our criteria.

4. Discussion

Freezing methods for cryopreservation of teeth

The most serious problem during freezing is cell damage induced by ice crystal formation inside the cells as well as mechanical stresses by extracellular ice formation. When cell freezes a cluster of water molecule grows inside and injures membrane, known as ice injury.[14-1718-21]

To prevent ice injury, there are two approaches as given below.

1. *Vitrification.*
2. *Slow rate /control cooling.*

In both methods cryoprotectants are used, these cryoprotectants possess the permeating property which is very important because it prevents intracellular ice formation. When a cell is placed into a hypertonic solution containing a cryoprotectant, it shrinks rapidly in response to the high extracellular osmolality, as diffusion of intracellular water out of the cell is faster than permeation of the cryoprotectant into the cell. After shrinking, the cell starts to regain its volume slowly as the cryoprotectant permeates the cell with water at a fixed osmolality. Thus, permeation of the cell with a cryoprotectant is critical for successful cell cryopreservation. [18]

Vitrification requires a very high concentration of cryoprotectants that is usually toxic to most cells. On the other hand, conventional *slow freezing* requires a low relatively non-toxic concentration of cryoprotectants, although it is always associated with cell injury due to ice formation and prolonged exposure to cryoprotectant. Therefore, a new technology of application of magnetic field can prevent ice formation without a high concentration of cryoprotectants. [18-20]

Role of magnetic field during freezing

The optimal intensity of the magnetic field was 0.01 mT, the optimal hold-time was 15 min, and the optimal plunging temperature was -30 C for periodontal ligament (PDL) cells cryopreservation. As cells contain a cluster of water molecules, when they freeze, this cluster grows and injures the cell membrane. However, a magnetic field can prevent the cluster from growing by causing it to vibrate, and produces uniform ice crystal. When the material defrosted, the original shape is retained. [21]

Periodontal ligament (PDL) healing of cryopreserved teeth

Periodontal healing is an important factor in determining the success after autotransplantation. It is generally known that if a tooth has a healthy and undamaged PDL, the success rate after transplantation is optimal. [16,22] At the first week, granulation tissue formation around the cryopreserved teeth will be noted in associated with infiltration of inflammatory cells. The remaining PDL on the root surface will be positively stained for alkaline phosphatase, suggesting the viability and potential differentiation function of PDL cells. [23]

At the second week after transplantation, the regeneration of periodontium will be noted. Cementoblasts and fibroblasts will increases in number at root surface. The alveolar bone formation will be

noted around the root with the formation of PDL. Together, these data suggest the excellent periodontal healing of transplanted cryopreserved tooth. [24,25]

Clinical application of cryopreserved teeth

The transplantation of cryopreserved teeth would be the suitable choice for treatment of missing teeth in children and adolescence, since it has been shown that the transplanted teeth retain the potential induction of alveolar bone growth during the eruption process. [25,26] The superior properties of transplanted teeth to those dental implants were reported. First, functional PDL of transplanted teeth is restored, unlike in dental implants, and this regeneration of PDL is crucial for various aspects, such as orthodontic movement and rotation for adjusting position of teeth, induction of alveolar bone remodeling and growth and preventing excessive chewing damage due to nociceptive nerve ending. [27-29] Second, transplanted teeth do not need the unnecessary preparation of the sound tooth structure, which was the major disadvantage of the conventional prosthetic treatment. Third, transplanted teeth have a potential to continue eruption. [30,31]

With respect to dental implants, the marginal bone loss around the adjacent teeth and buccal to the implants, as well as the infraoccluded implant-supported crown, may be observed due to the continuous eruption of the adjacent teeth and growth of craniofacial structure, especially in adolescence patients,[32-34] but these cannot be observed in auto transplanted teeth. A comprehensive study comparing the esthetics of autotransplanted premolars reshaped to incisor morphology with their natural, intact contralateral incisor are made. Most of the transplanted teeth matched the contralateral incisor, and most patients were satisfied with the appearance of the transplant, a potential for esthetic improvement was identified, because suboptimal positioning and morphologic transformation of the transplant were responsible for the discrepancies. [35-37]

The author did not discuss immunological reactions to transplanted cryopreserved tooth allografts. But as with other allografts, the risk of blood borne transmitted disease and immunological reaction are a concern.

5. Conclusion

Transplantation represents a biologic approach in which the transplanted tooth germ retains the potential to induce alveolar bone growth; the single implant is an artificial method in which bone-regeneration techniques might be required when the alveolar bone support is insufficient. The transplant has a normal periodontal membrane and can be moved orthodontically like any other tooth. The osseointegrated implant is ankylosed to the bone, and its position cannot be changed. Hence, unnecessary wisdom teeth and healthy premolars which are extracted for orthodontic treatment can be the target to start a tooth bank which contribute in making autotransplantation the standard procedure for replacing a missing tooth in the future.

References

[1]. Schwartz O, Rank CP. Autotransplantation of cryopreserved tooth in connection with orthodontic treatment. Am J Orthod Dentofacial Orthop. Jul 1986;90(1):67-72.

[2]. Bauss O, Schwestka-Polly R, Hoy L, Kiliaridis S. Influence of orthodontic movement on root length of autotransplanted immature third molars. Eur J Oral Sci. Feb 2004;112(1):12-18.

[3]. Northway W. Autogenic dental transplants. Am J Orthod Dentofacial Orthop. Jun 2002;121(6):592-593.

[4]. Bjerklin K, Bennett J. The long-term survival of lower second primary molars in subjects with agenesis of the premolars. Eur J Orthod. Jun 2000;22(3):245-255.

[5]. Temmerman L, Vral A, Meire M, et al. Pulpal regeneration and root development after subcutaneous transplantation of cryopreserved immature teeth in rats. Cryobiology. Apr 2012;64(2):81-90.

[6]. Isa-Kara M, Sari F, Emre-Coskun M, et al. Stabilization of autotransplanted teeth using thermoplastic retainers. Med Oral Patol Oral Cir Bucal. May 2011;16(3):e369-375.

[7]. Plakwicz P, Wojtaszek J, Zadurska M. New bone formation at the site of autotransplanted developing mandibular canines: a case report. Int J Periodontics Restorative Dent. Jan-Feb 2013;33(1):13-20.

[8]. Lundberg T, Isaksson S. A clinical follow-up study of 278 autotransplanted teeth. Br J Oral Maxillofac Surg. Apr 1996;34(2):181-185.

[9]. Zachrisson BU, Stenvik A,Haanaes HR. Management of missing maxillary anterior teeth with emphasis on autotransplantation.Am J Orthod Dentofacial Orthop. Sep 2004;126(3):284-288.

[10]. Temmerman L, De Pauw GA, Beele H, Dermaut LR. Tooth transplantation and cryopreservation: state of the art. Am J Orthod Dentofacial Orthop. May 2006;129(5):691-695.

[11]. Andreasen J SO. Atlas of Replantation and Transplantation of Teeth. In: Fribourg S, ed: Mediglobe SA; 1992.

[12]. Schwartz O, Andreasen FM, Andreasen JO. Effects of temperature, storage time and media

on periodontal and pulpal healing after replantation of incisors in monkeys. Dent Traumatol. Aug 2002;18(4):190-195.
[13]. Kawasaki N, Hamamoto Y, Nakajima T, Irie K, Ozawa H. Periodontal regeneration of transplanted rat molars after cryopreservation. Arch Oral Biol. Jan 2004;49(1):59-69.
[14]. Kristerson L. Autotransplantation of human premolars. A clinical and radiographic study of 100 teeth. Int J Oral Surg. Apr 1985;14(2):200-213.
[15]. Czochrowska EM, Stenvik A, Zachrisson BU. The esthetic outcome of autotransplanted premolars replacing maxillary incisors. Dent Traumatol. Oct 2002;18(5):237-245.
[16]. Czochrowska EM, Stenvik A, Album B, Zachrisson BU. Autotransplantation of premolars to replace maxillary incisors: a comparison with natural incisors. Am J Orthod Dentofacial Orthop. Dec 2000;118(6):592-600.
[17]. Czochrowska EM, Stenvik A, Bjercke B, Zachrisson BU. Outcome of tooth transplantation: survival and success rates 17-41 years posttreatment. Am J Orthod Dentofacial Orthop. Feb 2002;121(2):110-119; quiz 193.
[18]. Bartlett PF, Reade PC. Cryopreservation of developing teeth. Cryobiology. Jun 1972;9(3):205-211.
[19]. Laureys W, Beele H, Cornelissen R, Dermaut L. Revascularization after cryopreservation and autotransplantation of immature and mature apicoectomized teeth. Am J Orthod Dentofacial Orthop. Apr 2001;119(4):346-352.
[20]. Schwartz O, Andreasen JO. Cryopreservation of mature teeth before replantation in monkeys (I). Effect of different cryoprotective agents and freezing devices. Int J Oral Surg. Dec 1983;12(6):425-436.
[21]. Schwartz O, Andreasen JO, Greve T. Cryopreservation before replantation of mature teeth in monkeys. (II). Effect of preincubation, different freezing and equilibration rates and endodontic treatment upon periodontal healing. Int J Oral Surg. Aug 1985;14(4):350-361.
[22]. Ziegler S, Neukam FW. Regional odontodysplasia: orthodontic treatment and transplantation of premolars. Am J Orthod Dentofacial Orthop. Nov 2012;142(5):710-719.
[23]. Price PJ, Cserepfalvi M. Pulp viability and the homotransplantation of frozen teeth. J Dent Res. Jan-Feb 1972;51(1):39-43.
[24]. Kristerson L, Andreasen JO. Influence of root development on periodontal and pulpal healing after replantation of incisors in monkeys. Int J Oral Surg. Aug 1984;13(4):313-323.
[25]. Paulsen HU, Andreasen JO, Schwartz O. Pulp and periodontal healing, root development and root resorption subsequent to transplantation and orthodontic rotation: a long-term study of autotransplanted premolars. Am J Orthod Dentofacial Orthop. Dec 1995;108(6):630-640.
[26]. Kaku M, Shimasue H, Ohtani J, et al. A case of tooth autotransplantation after long-term cryopreservation using a programmed freezer with a magnetic field. Angle Orthod. May 2015;85(3):518-524.
[27]. Jang Y, Choi YJ, Lee SJ, Roh BD, Park SH, Kim E. Prognostic Factors for Clinical Outcomes in Autotransplantation of Teeth with Complete Root Formation: Survival Analysis for up to 12 Years. J Endod. Feb 2016;42(2):198-205.
[28]. Kulkarni G, Lee L. Vital Autotransplantation and Orthodontic Treatment of a Transmigrant Mandibular Canine. Pediatr Dent. 2016;38(1):1-4.
[29]. Machado LA, do Nascimento RR, Ferreira DM, Mattos CT, Vilella OV. Long-term prognosis of tooth autotransplantation: a systematic review and meta-analysis. Int J Oral Maxillofac Surg. May 2016;45(5):610-617.
[30]. Ronchetti MF, Valdec S, Pandis N, Locher M, van Waes H. A retrospective analysis of factors influencing the success of autotransplanted posterior teeth. Prog Orthod. 2015;16:42.
[31]. Marques-Ferreira M, Rabaca-Botelho MF, Carvalho L, Oliveiros B, Palmeirao-Carrilho EV. Autogenous tooth transplantation: evaluation of pulp tissue regeneration. Med Oral Patol Oral Cir Bucal. Nov 2011;16(7):e984-989.
[32]. Verweij JP, Toxopeus EE, Fiocco M, Mensink G, van Merkesteyn JP. Success and survival of autotransplanted premolars and molars during short-term clinical follow-up. J Clin Periodontol. Feb 2016;43(2):167-172.
[33]. Yadav SS, Bodh R, Kaushik A, Talwar S. Autotransplantation of a Buccally Erupted Matured Mandibular Third Molar to Replace a Grossly Decayed Second Molar. J Clin Diagn Res. Feb 2016;10(2):ZD06-07.
[34]. Yoshizawa M, Koyama T, Izumi N, et al. Autotransplantation or replantation of cryopreserved teeth: a case series and literature review. Dent Traumatol. Feb 2014;30(1):71-75.
[35]. Choi SH, Hwang CJ. Orthognathic treatment with autotransplantation of a third molar. Am J

Orthod Dentofacial Orthop. Nov 2013;144(5):737-747.

[36]. Chung WC, Tu YK, Lin YH, Lu HK. Outcomes of autotransplanted teeth with complete root formation: a systematic review and meta-analysis. J Clin Periodontol. Apr 2014;41(4):412-423.

[37]. Kokai S, Kanno Z, Koike S, et al. Retrospective study of 100 autotransplanted teeth with complete root formation and subsequent orthodontic treatment. Am J Orthod Dentofacial Orthop. Dec 2015;148(6):982-989.

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