

Autotransplantation of cryopreserved teeth: A review

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ABSTRACT

Autotransplantation of teeth, if carried out successfully, ensures that alveolar bone volume is maintained due to physiological stimulation of the periodontal ligament. 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 due to 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 the future. In this review, the biological properties of cryopreserved teeth, clinical application of missing teeth are discussed.

Key words: Autotransplantation, cryopreservation, ectopic eruption

Introduction

Autotransplantation refers to the extraction of a tooth from one location and its replantation in a different location in the same individual. The new location may be a fresh extraction socket after extraction of a nonrestorable 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]

The major disadvantage of using implants in the anterior region is the marginal bone loss,^[2] time consumption, and economy. But the use of autotransplanted teeth can markedly reduce treatment time, the financial burden of the patient, with maintenance of physiologic and the accurate anatomy for of arch.^[3] However, the survival rate of replanted or autotransplanted teeth is a major issue due to lack of infrastructure. The survival rate is affected by the

reaction of the pulp, duration of time from the donor site to recipient site.^[4]

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 bony fusion, however, fused teeth cannot use for orthodontic tooth movement.^[5]

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.^[3]

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.^[1-6]

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.^[7]

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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 extracellular ice formation. This suggests that root canal treatment should be performed before transplant.

This review of the article gives comprehensive idea of freezing methods, role of the magnetic field during cryopreservation, and clinical implication of the same.^[8]

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.^[9]

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.^[10]

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 nontoxic 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 the magnetic field can prevent ice formation without a high concentration of cryoprotectants.^[10]

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, the 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.^[11]

Periodontal Ligament 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.^[12]

At the 1st week, granulation tissue formation around the cryopreserved teeth was noted in associated with infiltration of inflammatory cells. The remaining PDL on the root surface was positively stained for alkaline phosphatase, suggesting the viability and potential differentiation function of PDL cells.^[12]

At the 2nd week, after transplantation, the regeneration of the periodontium was noted. Cementoblasts and fibroblasts were increased in number at root surface. The alveolar bone formation was noted around the root with the formation of PDL. Together, these data suggest the excellent periodontal healing of transplanted cryopreserved tooth.^[12]

Clinical Application of Cryopreserved Teeth

The transplantation of cryopreserved teeth would be a 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.^[1-7]

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.^[7-9]

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. With

respect to dental implants, the marginal bone loss around the adjacent teeth and buccal to the implants, as well as the infraoccluded implanted-supported crown, may be observed due to the continuous eruption of the adjacent teeth and growth of craniofacial structure, especially in adolescence patients.^[10-14]

A comprehensive study comparing the esthetics of autotransplanted premolars reshaped to incisor morphology with their natural, intact contralateral incisor was 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.^[14]

The authors 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.^[14]

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 caused by orthodontic treatment will be the target and it is an opportunity to start a tooth bank and contribute to make autotransplantation, the standard procedure for replacing a missing tooth in the future.

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