NARRATIVE REVIEW

Knowledge and awareness regarding uses of extracted natural tooth in clinical practice

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Abstract

Restoration of aesthetics is one the major patients' concern in dentistry which may be disrupted due to tooth-loss secondary to trauma, or as part of orthodontic treatment or periodontal problem. A number of treatment options are available for the replacement of teeth, but they may be expensive, and time-consuming, involving artificial teeth. For immediate tooth replacement, patient's own intentionally extracted or unintentionally avulsed tooth maybe used. The current narrative review was planned to discuss various techniques for the use of natural tooth pontic, which preserves the original contours, size and colour of the replaced tooth. Before using these teeth in a prosthesis, they need to be thoroughly disinfected and stored in appropriate medium according to the global guidelines. This reversible option would boost patient's confidence, preserve natural tooth anatomy and improve patient's acceptance.

Keywords: Extracted tooth, Natural tooth, Natural tooth pontic, Avulsed tooth, Auto transplantation, Intentional reimplantation.

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Introduction

Tooth-loss may occur due to trauma, periodontal disease, root resorption or intentional extraction secondary to failed endodontics, orthodontic treatment or any other reason. This may lead to aesthetic, functional and phonetic disability among the patients.[1]

Restoration of aesthetics is one of the primary goals of dentistry, especially in the anterior region where delayed replacement is unacceptable by the majority.[2] However, immediate replacement in the aesthetic zone is a challenge, especially when the adjacent teeth and periodontium are healthy. There are a number of options for replacement of teeth which include conventional fixed dental prosthesis (CFDP), removable dentures (RDs), implant-supported prosthesis (ISP), and resin-bonded partial dentures (RBPDs).[3] Nevertheless, all these treatment options are expensive and involve artificial tooth replacement which may or may not completely mimic the natural dentition. CFDP may not be a conservative option when the adjacent teeth are healthy, and also increases the risk of pulpal exposure. For ISP, patients may fear the surgical procedure associated with implant placement, ridge reconstruction or may have systemic conditions contraindicating surgery.[2]

In a number of clinical scenarios, immediate bonding of an intact natural tooth for replacement serves as a cost-effective, yet aesthetic treatment option to preserve the natural tooth contours, size, shape, colour match with excellent function at the same time. Thus with recent advancements, natural tooth pontic (NTP) maybe utilised using a combination of adhesive techniques and technologies.[3]

Use of patient's own tooth is not only a conservative restorative option, but also requires minimal laboratory involvement which is best suited for patients requiring immediate replacement, provided the tooth was preserved.[4] It helps maintain patient's confidence, has a positive psychological impact and increases tolerability towards tooth-loss.[4] This innovative technique has been implemented, followed and studied increasingly during recent years.[3]

There is a lack of awareness and knowledge about clinical implications of an extracted tooth, be it intentional or unintentional. The natural tooth can be planned and extracted intentionally when it is intact, but needs removal for orthodontic or periodontal reasons or the tooth is avulsed secondary to trauma, unintentionally, and is used subsequently depending upon its condition when brought to the dentist by patients.

Uses with intentionally extracted teeth

Intentional re-implantation

Orthograde root canal treatment is the foremost choice to treat pulpal or peri-apical infection.[5] However, if the symptoms fail to resolve despite optimum root canal treatment or retreatment, apical surgery is recommended as the second best choice. Regardless of high success rates of apical surgery, it may be challenging to execute due to anatomical constraints in the posterior molar region.[5] In

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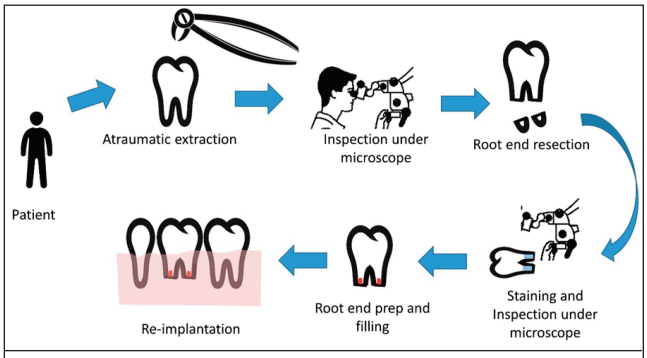

Figure-1: Stepwise demonstration of the steps of intentional reimplantation.

this perspective, intentional replantation may be an alternative option for some of these cases.

It is defined as intentionally extracting the tooth followed by sealing the resected root end with filling material and replacing it back in the socket.[6] This technique was first practiced by Ambrose Pare in the 16th century, and Pierre Fauchard, during the 18th century to salvage a tooth that was extracted accidentally.[7,8] Since then, intentionally carrying out this technique has been reported in various case studies.

The procedure involves multiple surgical steps (Figure 1) that must be taken care of for predictable outcomes.

Protocol in the light of current literature

Handling and extra-oral time are two critical factors to ensure maximum viability of periodontal ligament (PDL) cells. Extraction of the tooth is considered to be the most technique-sensitive step.[9] The techniques for tooth extraction varied immensely according to researchers Multiple studies reported the use of dental elevators either to luxate the tooth before forceps application, whereas other stated that dental elevators should not be used at all.[9] However, there was a consensus that the grasp of dental forceps should be limited to the tooth crown only, and the beak must not rest on the root surface to prevent PDL damage.[10] Kratchman *et al*. suggested holding the extracted tooth in the dental forceps while preparing the root-end and periodically submersing the tooth in Hank's balanced solution to maintain viability of the PDL cells.[11]

There are different recommendations for extra-oral times. In 1966, Grossman[6] reported that owing to time dependent viability of PDL cells extra-orally, the time for manipulation outside the mouth must not exceed 15-20 minutes, whereas Kratchman[11,12] recommended a maximum extra-oral time of 10-15 minutes. In 1994, a study reported that the success rate was 90% when avulsed teeth were replanted within 30 minutes.[13]

Likewise, there is variation regarding whether to splint the tooth or not.[10] Many studies recommended splinting only when gross instability of the tooth was present.[14] Others incorporated a splint for each case.[6,15] Splinting time varies from 7 days to a month in reported literature.[10] Material for splint fabrication has ranged from wire to acrylic to sutures.[10]

Recently, modern micro-surgery has been favoured due to its utilisation of operating microscope, use of methylene blue dye to identify cracks, ultrasonic root-end preparation, use of micro-instruments and highly biocompatible root-end filling materials, like bio-silicate cements. Root resection of 3mm with cavity depth of 3mm and 0-degree bevel angle is also part of modern concept. The advent of micro surgery has increased the success rate to 90%.[12]

Due to deficient literature and the failure to generate a consensus on a protocol, intentional replantation is often considered a procedure of last resort. However, in order to retain the natural tooth, it should be considered a reliable option.

Auto-transplantation of tooth

It is defined as the re-implantation of one tooth in the same individual from one site to another. This includes the re-implantation of impacted or erupted teeth into fresh extraction sockets or into surgically-prepared sockets. It is a good treatment alternative for young patients who cannot be rehabilitated with implant prostheses due to continuous growth.[16] This gives advantage of being a cost-effective replacement with added benefits of alveolar ridge preservation, functional adaptation, improved aesthetics, dento-facial development, arch form integrity, mastication, and speech preservance.[17] The success rate of auto-transplantation varies from 74% to 100%.[16] The success also depends on patients' level of motivation, oral hygiene, general health status and the suitability of recipient-site and donor tooth.[17] Timings of reimplantation is also considered one of the main factors. There are indications and contraindications as well as recipient and donor site requirements that increase success rate (Table 1).[17]

Timing: Immediate replantation is reported to have good prognosis in comparison to teeth transplanted in recipient beds prepared at the same time. Ideally, either auto-transplantation should be carried out on the same day as extraction or within a month.[18] Late transplantation not just increases the chances of future resorption, but also may pose challenges due to less support provided by the post-extraction resorption.[18]

Pulp regeneration can be expected in immature teeth, but not in mature teeth. The right stage of root development

Table-1: Auto-transplantation of teeth.

Indications	Contraindications
• Traumatic tooth loss • Congenitally missing teeth • Teeth with bad prognosis • Developmental anomalies of teeth • Recipient site criteria[35] • No signs of infection • Adequacy of bone support • Additional bone graft or green-stick fracture may be required at the recipient site, in case of limited bone availability • Adequate attached keratinized tissue • Optimum mesio-distal and apico • coronal parameters • Additional preparation may be required to accommodate apico-coronal length of the donor tooth.	• Patients with cardiac anomalies • Poor oral hygiene • Lack of self-motivation • Insufficient alveolar bone support • Donor tooth criteria • Root development one-half to two-thirds • Transplantation of a bud with roots formed less than one-half may be too traumatic and could compromise further root development •Tooth with maximum length but stil • Has the potential for pulp regeneration (apex opening >1 mm radiographically[16] • Usually, the PDL fibers are absent. Salvaging maximum PDL prevents root resorption.

is most likely to be between the age of 9 and 12 years owing to the fact that root development continues for 2-3 years after tooth eruption. However, the indicated age group varies from person to person.[16]

Natural Inlay

The concept of natural inlay follows the concept of utilising natural tooth as a restorative material when intact tooth is extracted intentionally. Scientists so far were in the quest of having restorative material that can match the potential of a tooth. Unfortunately, despite large diversification of restorative materials now available commercially, none has proved to be equivalent to the natural tooth. Till date, natural enamel and dentine are still considered to be the gold standard.[19]

This has led to the re-use of human tooth as an inlay material bonded by means of adhesive cement. This technique was first reported by Simonsen *et al*.[20] and Kanca *et al*.[21] to become the basis of production of restoration using Computer-aided design (CAD) and Computer-aided manufacturing (CAM) with extracted human tooth to be used instead of a porcelain block. The Natural Inlay (NI) technique makes it possible to construct a restoration which may be expected to restore a damaged tooth. Studies do report use of ground dentine material in restorative material, but that resulted in a poor-fit restoration.[22]

Natural tooth pontic (NTP) in complete denture

Until the middle of the 19th century, human natural teeth were used for denture construction. Along with being cost-effective, the use of extracted teeth in complete denture seems beneficial to patient's self-esteem. Specially, in cases

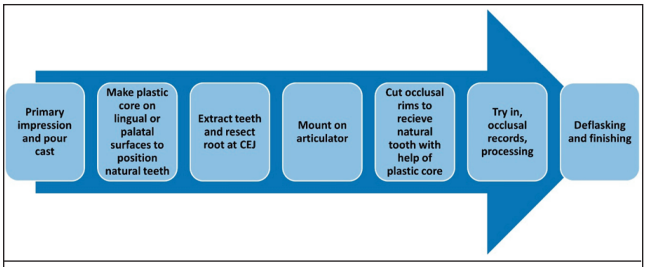

Figure-2: Technique to fabricate complete denture with natural tooth pontic (NTP).

Table-2: Handling and disinfection of extracted teeth.

Handling and disinfection of extracted teeth
• Appropriate PPE should be worn before handling of the extracted or avulsed natural tooth.
• Store in a lid-covered jar preferably of glass to prevent leakage during transport.
• A biohazard symbol should be placed on the jar.
• Store in appropriate medium such as sodium hypochlorite (household bleach diluted in a ratio of 1:10) or specimen fixation solution such as formalin.
• They should be cleaned of visible blood or debris and washed in ultrasonic cleaner.
• The use of teeth without amalgam restorations are preferred because they can be safely autoclaved.
• Amalgam containing extracted teeth should not be autoclaved. They require immersion in 10% formalin solution for 2 weeks for appropriate disinfection of both the internal and external structures of the teeth.

when there are planned extractions of intact teeth, they are suitable to be used in dentures after disinfection (Figure 2).[23]

The patient is instructed to keep the denture in water while not in use to avoid any loss of hue and natural appearance due to dehydration.

Uses of naturally extracted/avulsed tooth

Few considerations are made while using natural tooth as pontic i.e. it must not participate in heavy occlusion, presence of adequate inter-occlusal space and periodontally sound abutments.[24] Before using such teeth, adequate cleaning and disinfection is required.

Handling and disinfection of extracted/avulsed teeth

Extracted human teeth harbour a variety of pathogens. In order to use the natural tooth as a pontic, it should be handled and stored in appropriate medium and disinfected according to the Centers for Disease Control and Prevention (CDC) guidelines to prevent transmission of infection.[25] There is a recommended handling procedure and disinfection protocol (Table 2).

According to a study,[26] treatment under 10% formalin for 7 days and autoclaving at 121°C for 30 minutes will completely sterilise the extracted teeth.

Practice of undergrad students

Extracted human teeth are most commonly used by dental students for practising numerous dental procedures, such as cavity preparations, endodontic procedures, crown preparations, indirect restorations and to learn pre-clinical skills as they best simulate the in-vivo situations.[27] These teeth need to be processed and prepared by undergoing disinfection procedures before using it for dental educational exercises.[25]

Research work

Multiple in-vitro experimental studies, such as evaluation of micro-leakage, marginal gap, measurement of bond strength, evaluation of fracture strength and for studying histology of teeth by preparing ground sections of tooth necessitates the use of extracted human teeth, so typodonts, or other artificial teeth, cannot replace them.[27] The extracted teeth must be sterilised to prevent cross-contamination.

Natural tooth pontic in fixed bridge

Immediate natural tooth bridges are least invasive and fully reversible with the added advantage of patient comfort by preservation of his own natural tooth, aesthetic maintenance of gingival architecture associated with lost tooth and simple laboratory procedures. Skilled clinician is an important requirement to carry out such procedures. The design of the immediate bridge contributes to its success and prognosis. The pontic should be designed to maintain optimal aesthetics and allow maintenance of adequate oral hygiene. A modified ridge lap pontic design will fulfill this criterion. The main difference between conventional laboratory-made bridge and natural tooth immediate bridge is the presence of a biological structure which means that it is vulnerable to caries and requires professional maintenance and regular follow-ups.[28] These NTPs can be utilised in bridge form when cemented to abutment teeth using composite or as a cantilevered adhesive bridge using metal wing or by using steel wires.[28]

NTP with fibre-reinforced composite (FRC) for single tooth replacement

The FRC bridges are adhesive, minimally invasive and economic single-unit restorations. Three types of pontics can be used for the fabrication of this bridge i.e. composite resin teeth, acrylic resin teeth and natural extracted teeth. The last one is a more preferable and conservative option if the tooth or its crown is intact to be bonded easily to the adjacent teeth using light cure composite material.[29] The step-wise technique for replacement of edentulous space with NTP using FRC is well known (Figure 3).[29] The glass fibre composite splint serves as an additional advantage of simultaneously splinting the adjacent teeth if they are

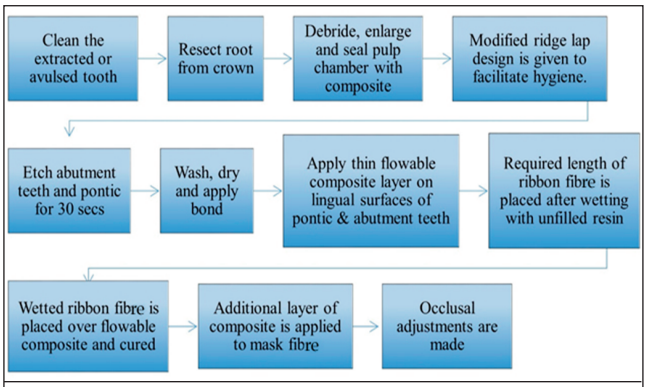

Figure-3: Technique for the use of natural extracted or avulsed tooth with fibre-reinforced composite bridge.

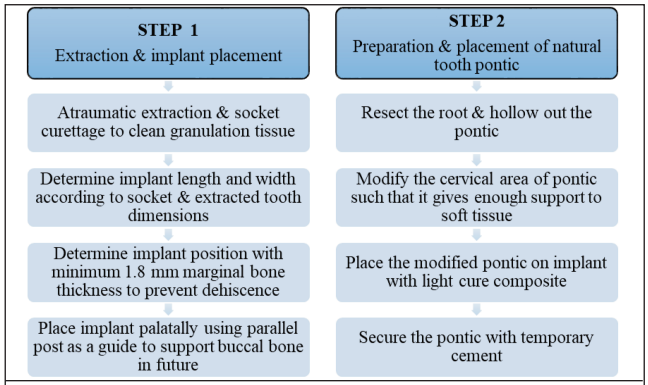

Figure-4: Technique for soft tissue moulding and emergence profile of implant-supported restoration.

periodontally compromised. However, limited data is available regarding the survival of NTP-based prosthesis. Quirynen et al.[30] reported survival rate of 80% after 5 years of function of composite-bonded NTP for replacement of lower incisors.

For soft tissue moulding and maintenance of peri-implant gingival aesthetics

Implant placement in aesthetic region is challenging for a clinician.[31] The patient's natural tooth can be utilised after extraction for immediate implant placement cases in order to simulate the soft tissue yielding adequate gingival profile in critical areas i.e. interproximal contact papilla.[31] The steps for soft tissue moulding in immediate implant cases utilising NTP has been described (Figure 4).[31]

This technique fulfills four out of five diagnostic keys to predict the peri-implant aesthetic outcomes given by Kois *et al*.[32] With proper patient selection, using natural tooth as a provisional restoration creates an excellent emergence profile by preserving pre-extraction papilla contours.[31]

NTP as removable space maintainers in primary dentition

Usually, space maintenance is not required following loss of primary anterior teeth due to stability of this region and no net loss of space. But in some cases, early loss of primary tooth raise concerns regarding space maintenance (in canine and molar region), aesthetics, masticatory function, tongue habits and difficulty in speech development in children <3 years of age who have not yet developed speech skills.[33] Tannure *et al*. reported a 3-year-old child whose avulsed tooth was utilised as pontic for construction of aesthetic space. Along with providing better aesthetics in terms of size, shape and colour, it also facilitates good oral hygiene and reduced plaque retention due to surface smoothness.[34] On 12-month follow-up, the patient and parents were satisfied with no speech difficulty faced, proving it to be a successful approach.

Conclusion

The importance of NTP in different clinical scenarios is established. It can be extracted intentionally and used accordingly for the patient's benefit to restore aesthetics, function and to preserve natural tooth or it can be avulsed due to trauma, stored and still be used with a different perspective. Being a reversible option, if the patient desires to get a conventional or implant-supported bridge to be placed, the NTP-based restoration can always be replaced as it is less expensive and requires less laboratory effort. However, appropriate case selection, disinfection, pontic modifications and occlusal adjustments are imperative for its success.

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