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Rationale for esthetic tissue preservation of a fresh extraction socket by an implant treatment concept simulating a tooth replantation

CASE REPORT

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Abstract – In cases of an immediate insertion and loading of implants after a traumatic loss of the patient's own dentition or due to an inevitable extraction of an anterior tooth, it is essential to provide the patient with an adequate provisional crown. A soft-tissue recession must be avoided, whether it is due to a compression of the peri-implant soft-tissue caused by an over-dimensioned restoration in the cervical collar of the provisional crown or to a too small dimensioned sulcus former. A simulation of the exact dimension of the lost tooth – especially on the cervical part of the new provisional restoration – is expected to preserve all relevant information and allows the design of a naturally looking emergence profile. Based on theoretical considerations and a case report, the authors intend to demonstrate that a near-naturally dimensioned sealing of the dento-gingival soft-tissue collar may initiate a tissue-maintaining healing process, similar to a tooth replantation. The natural dental crown, connected to an implant instead of the root, is applied for a tight sealing of the wound. If due to traumatic impact the tooth is no longer available, a naturally dimensioned crown restoration will serve as an alternative wound sealant.

Introduction

Apart from indicated extractions, the loss of an anterior tooth is frequently caused by traumatic impact and always results in a hard- and soft-tissue wound of the respective socket. In case of a traumatic or iatrogenic loss of anterior teeth, certain circumstances may allow a preservation of the natural tooth by replantation. This procedure allows a complete maintenance of the clinical crown and the dento-gingival complex (1) after traumatic impact (1) or an extraoral therapy of the root (retrograde root filling, sealing of a root perforation, apectomy, etc.) (2). If the root fracture runs horizontally, slightly below the limbus alveolaris, an orthodontic extrusion of the root residues, followed by a post-retained crown, is described as a promising therapy (3).

However, numerous clinical situations exclude both, the replantation of the tooth and the extrusion of the root. Especially the destruction of the periodontal ligament due to a too long or inadequate storage of a totally luxated tooth (4, 5) would result in an ankylosis of the root, followed by resorption.

The healing processes of a socket always involve a loss of tissue in the vertical and horizontal dimension (6, 7) and has an adverse effect on the esthetic outcome (8, 9). Especially in implantology, numerous different therapies are described which aim at maintaining the socket as far as possible (7, 10). After an ossification of the socket, an augmentation of soft tissue, bone or bone grafting material may compensate the tissue loss, thus resulting in an esthetically appealing final result (8, 9, 11). However, the therapeutic effort is considerable (12) while the esthetic result can hardly be predicted exactly (8, 9).

The indication for an immediate placement of implants has been expanded decisively by a smooth healing process, even in inflamed sockets (13). However, this could not reduce the loss of tissue (14–16). This phenomenon can probably be attributed to similar healing processes, e.g. in sockets without an implant insertion (6).

The results of some case studies describing an immediate restoration with a provisional resin crown or a definite metal-ceramic crown after the implant placement seem more promising (17–22). However, in most studies, no unbiased measurements of the dento-alveolar tissue complex were performed. Only Cornelini et al. (23) describe a vertical loss of the marginal buccal gingiva with a mean of 0.75 mm.

Provisional restorations have been recognized as an essential tool in definitive implant treatment optimization in terms of esthetic potential, patient comfort,

treatment time, laboratory cost, occlusal clearance, durability, and ease of modification. Important factors for a fast and successful soft tissue healing and sealing (e.g. the surface topography of the materials applied) is neither mentioned nor clinically evaluated.

Moreover, according to the results of Abrahamsson et al. (24), it can be assumed that high-quality connective tissue does not cultivate on resin materials and veneering ceramics. Consequently, a homologous sealing between the soft tissue cuff and the restoration material cannot develop either. However, implant abutments made of titanium (25) or Al_2O_3 (24, 26) which support the peri-implant soft tissue show a histologically verified attachment (27–29).

Objective

If a root fracture or perforation does not allow a replantation, the traumatically or iatrogenically induced loss of an anterior tooth still is a therapeutic challenge. So far, a replantation is the only established therapy which allows a complete maintenance of the hard and soft tissue structures on the basis of a resitutio ad integrum. The present case report describes an efficient therapy which simulates a replantation in the dento-gingival complex in order to achieve or approach a resitutio ad integrum.

The basic idea was to change the healing mode of a fresh extraction socket. A comparison of different healing processes in extraction sockets led to the basic idea of a therapeutically induced healing process after the replantation of a tooth. The healing process of a socket after the loss of a tooth is expected to show a tissue maintaining process which is similar to that after a replantation.

The healing process of the hard and soft tissue trauma after the removal of a tooth has been described in-depth (6, 7). The primary aim of healing seems to be a fast sealing of the hard tissue trauma. Here, the remaining dento-alveolar soft tissue migrates into the extraction socket.

This process of wound sealing by soft tissue takes place within the first days and is accompanied by a modellation of crestal bone areas (6). The sharp coronal bone edges of the extraction wound are rounded off which leads to a loss of the original vertical height of the alveolar bone. Moreover, the alveolar bone is narrowed in the oro-vestibular direction (6). This is probably due to the scar contraction of the soft tissue healing over this region. The extraction socket itself ossifies, however it does not reach the vertical height of the original limbus alveolaris.

The healing process of a replanted tooth is mainly based on the optimum sealing of the often large hard and soft tissue extraction wound by replacing the tooth, thus providing a constant feed. Mainly Houston et al. (30) histologically determined a restitution ad integrum in animal studies after about 6 months. Preconditions for a treatment success were an intact periodontal ligament, a state-of-the-art performance of endodontic treatment, and the absence of a splint for the replanted tooth (1, 4, 5). After only 24 h, especially the gingiva no longer shows any sign of trauma (1, 30). After approximately 3 days, the tooth is clinically fixed (1). The tooth-gingiva complex remains intact, even if a root resorption occurs (1).

It is assumed that a near-naturally dimensioned sealing of the dento-gingival soft tissue cuff initiates a healing process similar to a tooth replantation. According to the authors' opinion, the use of the fractured tooth as a provisional restoration meets all prerequisites for an ideal shaping and a rapid sealing of the peri-implant soft-tissue, thus providing an ideal dimension and surface topography. If the tooth is lost after trauma, a near-naturally dimensioned crown restoration may serve as an alternative sealing.

Case report

The implant-prosthetic therapy concept for the simulation of a tooth replantation is presented in a case report with a trauma-induced loss of an anterior tooth (Fig. 1). Treatment follows the protocol described hereafter.

Initial situation

A 42 year old male patient presented in the emergency unit of the J.-W. Goethe University Frankfurt/Main (Germany) after trauma. The central incisor 21 had been avulsed about 11 h before; it was delivered in a tissue.

The clinical situation was similar to a tooth extraction without flap reflection and with remaining buccal bone (9, 21). The oral surgeon shortened the avulsed tooth and retained it temporary over a splinting. In order to preserve the original emergence profile, the tooth was completely 'sunk' into the wound (Fig. 1). The patient was informed about an implantation and the advantages of an immediate insertion for the maintenance of the hard and soft tissue stability.

Implant insertion

An implant (Ankylos® system, diameter 4.5 mm, length 11 mm) was inserted in the alveolar socket ca. 34 h after tooth avulsion (Fig. 2). According to the protocol

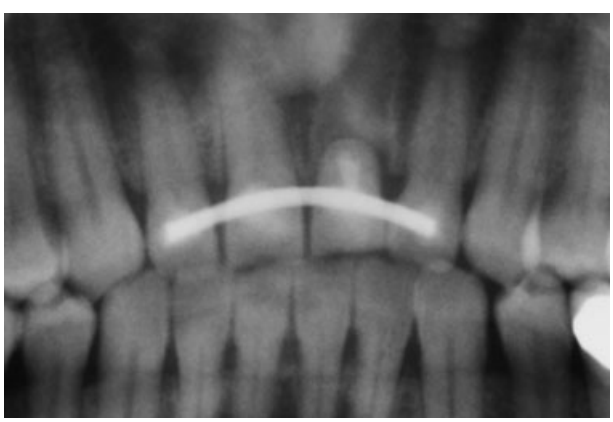


Fig. 1. Orthopantomogram after fixation of teeth 12-11-x-22 with a splint.

Fig. 2. Situation after trauma in the anterior region, avulsion of tooth 21.

described by Sammartino et al. (9), the implant was placed slightly palatal. The buccal plate was assessed by using a blunt instrument (9, 15). At the time of implant placement, no vertical resorption was detectable. Since primary implant stability was achieved, an immediate restoration could be realized (Fig. 3).

Temporization of an immediately loaded implant

To preserve the original soft-tissue dimension and the original emergence profile, the patient was provided with a fixed restoration on an immediately loaded implant.

The fractured tooth was modified by removing the root and by enlarging the pulp cavity. It served as a provisional crown (Fig. 4a) which allows an immediate sealing of the extraction socket and thus the development of a naturally dimensioned emergence profile around the original sized tooth. The roughness and topography of a natural tooth are favored over the surface topography of any long-term provisional crown.

The relining of the tooth on the implant abutment was performed in two stages:

1 Firstly, the optimum position of the tooth in relation to the adjacent and opposite teeth was 'fixed' intraorally with a small amount of flowable light-curing resin. A contamination of the wound by excess resin material was avoided.

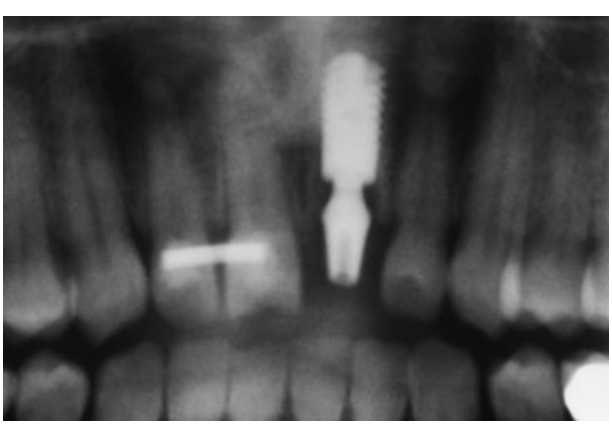
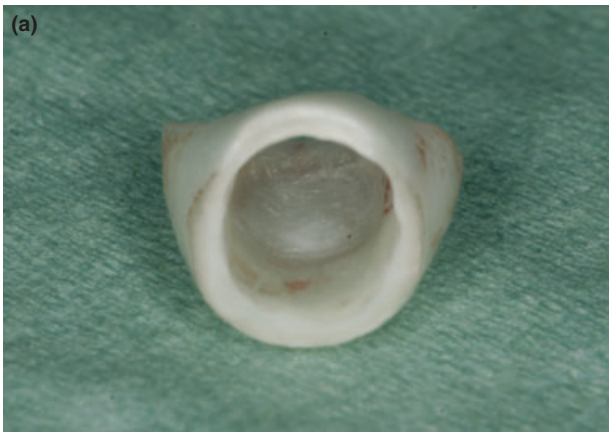


Fig. 3. Postoperative orthopantomogram.



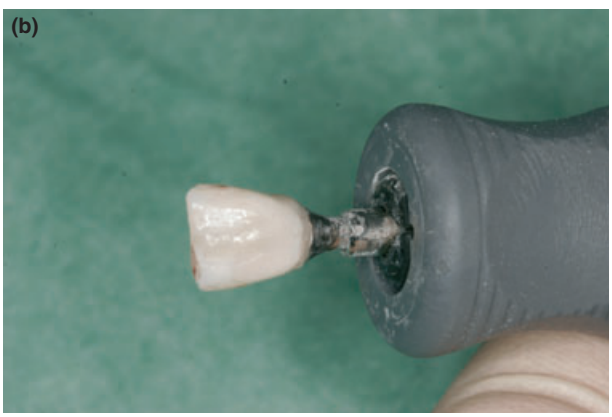


Fig. 4. (a) The patient's own tooth was modified to serve as a provisional restoration. (b) Final extraoral relining with a flowable resin for a gap free condition.

2 Secondly, the crown was finally relined extra-orally with a flowable acrylic material in order to optimize the fitting accuracy on the titanium abutment. This procedure also allows an irritation-free maturation of the soft-tissue (Fig. 4b).

The incisal edge of the modified tooth was reduced to avoid occlusal trauma during protrusion. The restoration was cemented with temporary cement (Temp Bond, KerrHawe, Bioggio, Switzerland). Even in this phase the adaptation of the soft tissue around the patient's own tooth is remarkable (Fig. 5a,b).

Three days after the implant insertion the soft-tissue shows a perfect sealing around the tooth at both, the labial and the palatal side (Fig. 6a,b).

Final restoration

Twelve weeks after implant insertion a Periotest measurement (Medizintechnik Gulden e.K, Modautal, Germany) was taken [PTW = –04]. Prior to the 3D-transfer of the implant position by applying the closed tray-technique, the adjacent tooth 11 was reconstructed with composite material.

Due to its high biocompatibility, low plaque accumulation, and optimum coloration, an all-ceramic anatomically designed implant abutment (Balance Cercon® anterior, Ankylos® implant system; Dentsply Friadent,

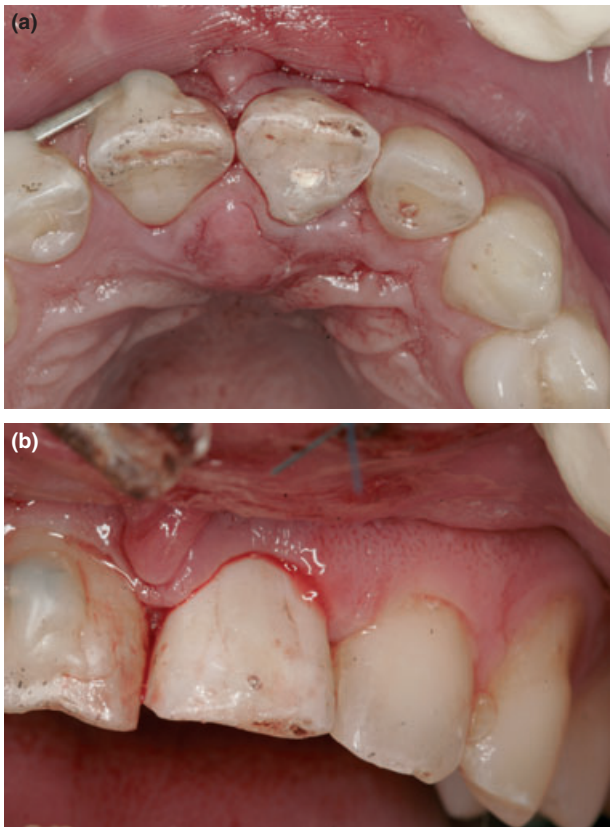


Fig. 5. (a, b) Clinical situation immediately after insertion of the patient's own tooth as a provisional restoration at the day of implantation.

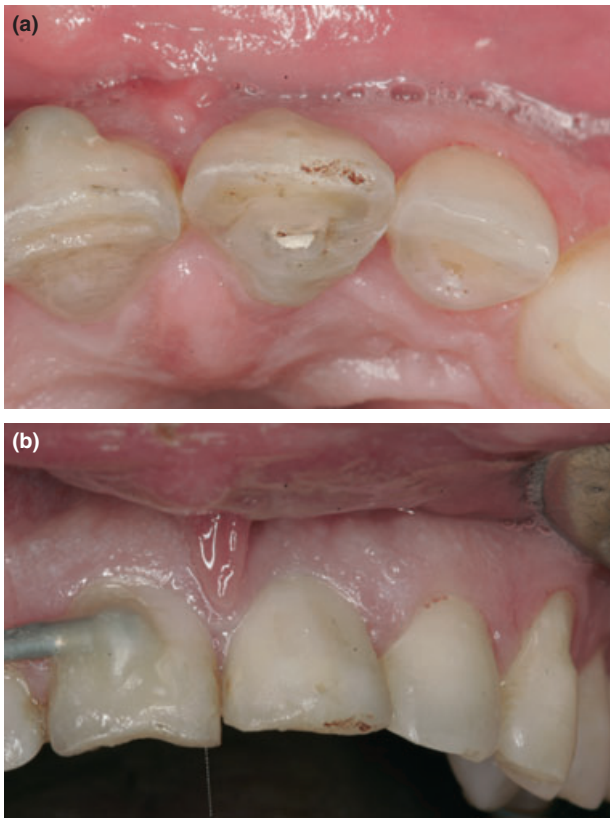


Fig. 6. (a, b) Clinical situation and soft tissue adaptation one week after implant insertion and restoration with the patient's own tooth.

Mannheim, Germany) was chosen for the final restoration. An all-ceramic core of the crown was manufactured of zirconium (Lava system; 3M-Espe, Seefeld, Germany).

The final restoration (Fig. 7) was cemented with temporary cement (Temp-Bond; Kerr Hawe, Bioggio, Switzerland). An orthopantomogram was taken after completion of the case (Fig. 8). It showed bone stability around the implant.

Fig. 7. Final result with the cemented crown in situ.

Discussion

The rationale for long-term esthetic tissue preservation immediately after a tooth loss is based on the idea to chance the healing-mode of the residual fresh extraction socket. If all prerequisites (1) are met, a replantation after the traumatic loss of a tooth or an intended replantation after extra-oral therapy of the root are well-known to allow a healing with the result of a restitutio ad integrum. However, the daily routine rather seldom offers all necessary conditions for a replantation (4, 5), especially after a traumatic loss of anterior teeth. Therefore, a replantation of the tooth often results in an ankylosis of the root, followed by a substitute resorption (5, 30). This leads to a melting of the thin buccal wall and sometimes to a complicated removal of the ankylosed and partially resorbed root. Due to the excellent option of a healing with restitutio ad integrum, a replantation was often considered even under unfavourable conditions – with the negative effects described above. Therefore, the immediate implant placement instead of a replantation became more and more accepted as an alternative treatment therapy. However, up to now the treatment concepts did not result in a complete maintenance of the bony structures and the soft tissue in the former dento-alveolar complex (12, 14–16). Here, in case of a successful complete healing, the replantation is an advantage compared with the

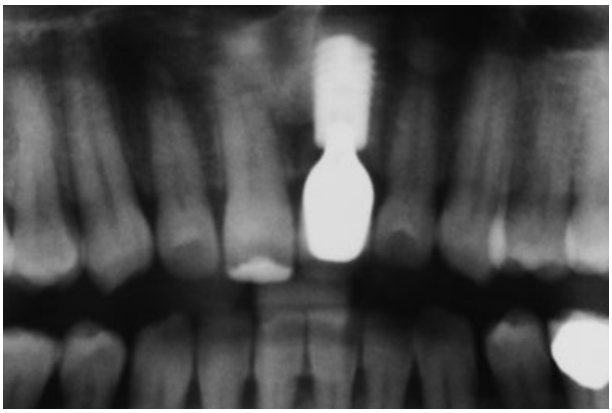


Fig. 8. Orthopantomogram taken after final insertion of the implant-retained crown regio 21.

immediate implant insertion. Especially in the esthetically challenging areas it is essential to simulate the optimum healing process of a replantation in the dento-alveolar region in order to avoid a therapy- or healing-induced loss of tissue. A fast and tight sealing of the soft-tissue collar seems to be the key to the targeted conversion of the healing process of an extraction wound to the healing process of a replantation wound. An immediate implant insertion offers an excellent possibility to anchor this 'sealing plug'.

The therapy-regime for the manufacturing and retaining of the wound closure described in this case report is very efficient, since it can be applied in every dental practice without any dental-technical effort and expenditure. The use of the autogenous, non-replantable tooth as an exactly dimensioned wound closure offers several advantages: The peri-implant soft-tissue not only meets the identical dimension and shape of the lost tooth but also offers an identical surface structure. Optimum biocompatibility and thus an optimum potential for the development of a tight soft-tissue attachment can be assumed (26, 28, 29). However, this restoration without any dental-technical assistance holds a disadvantage: In many cases it is not possible to place an individualized anatomically shaped all-ceramic or titanium abutment on the implant immediately after insertion. A repeated impression taking and the assembly of a final abutment for the final restoration imply frequent re-openings of the 'extraction wound' which causes a repetitive histological healing cascade (28). As the new formation of a soft-tissue attachment initially comes with a high density of inflamed cells (17), an additional and unnecessary loss of soft tissue occurs (31). The influence of the repeated changing of the implant components can perhaps have had an influence also in the above described case, since we can recognize a slightly recession of the soft tissue after finalization of the crown. The consequence of our own case-analysis is that similar cases should only run with one single, final assembling of the abutments at the day of implant insertion. Prefabricated abutments offer relief. They achieve a rotation stop by a morse taper connection only and thus do not require an indexing of the implant-abutment connection. These abutments can simulate the asymmetric shape of a tooth prepared for crowning because the elliptic cross-section of the abutment can be optimally adjusted to the course of the dental arch and thus is perfect for a tight, tension-free sealing of the asymmetric opening of the extraction wound.

Anatomically shaped healing abutments offer another alternative. They can either be manufactured individually by the application of a composite material or purchased as prefabricated elements without indexing (Fig. 9a,b).

Thus, the healing abutments simulate a supragingivally decapitated tooth. The procedure aims at a tight wound closure with the healing abutments while avoiding an immediate loading of the implant – if a respective indication for a delayed loading of the implant is given.

Completely individualized ceramic abutments can only be applied after CAD/CAM-based production processes which require either an optical registration of the implant platform with an intraoral scanner (System CARES, Sirona Dental, Bensheim, Germany) or a conventional registration with an intraorally fabricated transfer key. Both procedures lead either to a virtual or a

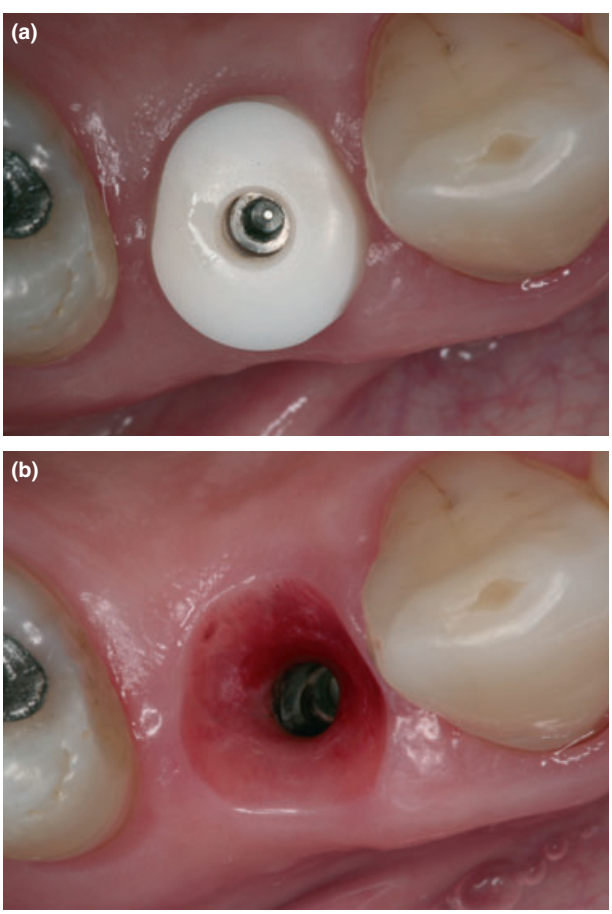


Fig. 9. (a) Prefabricated anatomically shaped zirconium dioxide sulcusformer (Ankylos® implant system; Dentsply Friadent, Mannheim, Germany), situation one week after exposure. (b) The bleeding of the peri-implant mucosa-collar indirectly refers to an attachment of the soft-tissue to the surface of the prefabricated anatomically shaped zirconium sulcusformer.

real master model which allows a patient-specific anatomically shaping of the implant abutment. The high expenditures regarding equipment, dental-technical work, and logistics limit the immediate treatment with fully anatomical abutments to scheduled extractions. However, in cases with traumata in the anterior region, this procedure cannot always be realized immediately. Here, as in the present case report, the implant insertion and a tight sealing of the wound have to be postponed until the next day. Additionally the time frame of implant insertion after trauma has to consider the ethical aspects of having the patient commit to an implant treatment in an emergency situation.

The present treatment concept for the maintenance of tissue after the loss of a tooth by a replantation, simulated with implants, bear risks which are not yet completely evaluated. Due to a lack of evidence-based clinical studies, the role of an incomplete buccal wall cannot yet be defined. Therefore the authors recommend the application of the described therapy concept only in cases with an intact and complete buccal bone wall. The uncertain clinical evaluation of the condition of the buccal wall is an aggravating factor because an objective radiographic evaluation with a modern cone-beam CT is extensive; it requires the appropriate equipment and it exposes the patient to radiation.

The presented treatment concept does not cover clinical long-term evaluations which could verify a lasting dento-alveolar tissue maintenance. However, beside the existing therapeutic risks, an immediate tight wound closure of the extraction socket with an implant-retained component simulating the lost tooth seems to be a rational procedure. In order to realize the aim of a simulated tooth replantation in an easy and efficient manner, the application of the natural tooth crown should be the first choice whenever patient are treated in a scope of implantation and restoration. In a prospective clinical trial we evaluate the efficiency and long term results of the above described technique in the esthetic zone of the maxilla. Although the first results are promising we should await for the final outcome after 1 year function time.

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Conflict of Interest

None.

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