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Article

Prevention and Treatment of Teeth Displacement into the Area of an Extracted Tooth

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Abstract: Tooth displacement after extraction is a natural process in which the remaining teeth gradually shift from their original position, leading to malalignment and occlusal imbalance. This anomaly most commonly occurs after the removal of one or several adjacent teeth, resulting in the migration or tilting of neighboring teeth into the edentulous space. Early diagnosis and timely preventive or corrective measures are crucial to maintaining proper occlusion and preventing secondary deformities of the dental arch.

Keywords: Tooth Loss, Bounded Edentulous Space, Prevention

Introduction

Dentofacial Deformities as a Result of Tooth Loss and Their Prevention

Dentofacial deformities are among the leading clinical manifestations of partial tooth loss. Prosthetic rehabilitation of such patients is impossible without complex preliminary preparation. These deformities lead to traumatic occlusion, temporomandibular joint disorders, parafunction of the masticatory muscles, and impaired periodontal circulation, which either complicate or completely prevent rational prosthetic treatment [1].

The relevance of the problem is evident, considering the high frequency of deformities following partial tooth loss and the widespread use of surgical correction methods such as extraction or significant grinding of hard dental tissues after endodontic treatment [2].

The most effective preventive method against tooth displacement toward the area of extraction is the timely replacement of the edentulous space with a temporary or permanent orthopedic structure [4]. One known solution is the adhesive bridge prosthesis, consisting of a connector with vertical supports and an artificial tooth mounted on the bridge. The supports may be L-shaped with oppositely directed ends [5].

Another known method involves the prosthetic replacement of small bounded defects in the posterior dental region. It includes the preparation of abutment teeth, impression taking, model fabrication, and prosthesis production. The fixation is achieved by filling the undercut areas between the lateral surfaces of the prosthesis and abutment teeth with an adhesive material using a wax matrix to maintain a cleaning gap [6].

A removable short-span denture has also been proposed, featuring a saddle section with artificial teeth and retentive elements. It is made monolithically from polyurethane, with clasp and occlusal rest designs. The clasps have two T-shaped arms and are connected to the occlusal rest, ensuring fixation on the abutment teeth through elastic tension [7].

However, the disadvantage of these temporary structures is their passive action — they do not exert pressure on the teeth bordering the defect, making them unsuitable for the correction of deformed dental arches, such as those observed in Popov–Godon's phenomenon.

The elimination of already developed deformities is significantly more complex, as evidenced by numerous proposed methods for repositioning teeth to their original alignment [3].

For example, one method for treating vertical dentoalveolar elongation involves tooth disocclusion using a cap: on its inner surface, in the area corresponding to the elongated teeth, small "pearls" (protrusions) are created, and a bioinert material is layered onto the cap's inner surface in the area of the elongated tooth cusps every 1–2 weeks.

Another method for correcting abnormal anterior tooth positioning uses an appliance with a base plate and wire elements placed within elastic plastic plates, fitting both lingual and labial surfaces of the anterior teeth and covering two-thirds of their surface. To create space in the dental arch, omega-shaped wire loops are included.

For extrusion of anterior maxillary teeth in deep distal occlusion, the Katz plate is used. This is a partial removable acrylic denture fixed on the posterior mandibular teeth, with an anterior bite plane for contact with the upper front teeth. Treatment involves adding acrylic to the occlusal plane, with an initial separation of 0.5–1 mm, repeated every 2–4 weeks until completion.

A partial removable acrylic denture can also be used to replace a defect in the area of dentoalveolar elongation — acrylic is layered onto the occlusal surface in the affected zone every 2–3 weeks, maintaining a 0.5–1 mm disocclusion to achieve tooth intrusion. This principle can also be implemented using a removable cast (skeletal) partial denture.

An orthodontic appliance consisting of a base plate and artificial teeth, mounted on a movable section of the plate in the area of missing teeth, has been developed to eliminate vertical tooth displacement. The movable section allows vertical movement toward the deformed area of the opposing jaw by means of a spring made of superelastic material.

To address horizontal dental arch deformities, a device has been proposed featuring supporting elements attached to tilted teeth and connected by a zigzag-shaped wire spring that exerts corrective force to reposition the teeth.

The aim of the study is the prevention and treatment of dentoalveolar displacements occurring in small bounded edentulous spaces.

Materials and Methods

To prevent and treat dentoalveolar displacements in small bounded edentulous spaces, a device called "Temporary Short-Span Dental Prosthesis" [8] was developed and used in combination with the "Method for Horizontal Tooth Movement in Bounded Edentulous Spaces" [9]. Both underwent clinical testing.

For the purpose of this study, a series of individually programmed fixed dental prostheses were fabricated. These prostheses ensured temporary restoration of masticatory efficiency and created space necessary for permanent prosthetic rehabilitation in patients with deformed dental arches.

Each patient underwent jaw computed tomography (CT) and intraoral scanning of the dental arches. The obtained digital contours were then aligned and uploaded into a specialized orthodontic software module that simulates the movement of tilted teeth adjacent to the edentulous space by applying controlled pressure until they are repositioned along their vertical axis.

The tooth movement increment was set to 1 mm per step. At each step, a polymer model of the patient's dental arches was 3D-printed, followed by scanning to create the required number of virtual models.

On each model, a 1 mm reduction of the contour of the tooth adjacent to the edentulous space (with the greatest inclination toward the defect) was performed. A virtual model of the missing tooth was then designed, with occlusal morphology matching that of the opposing teeth. The length of the prosthesis exceeded the distance between the adjacent teeth by 1 mm to provide controlled movement.

A monolithic system of retention elements, 2 mm thick, extended from the modeled artificial tooth along the lingual and buccal surfaces of the abutment teeth, positioned 2 mm above and below the equatorial line.

Subsequently, the designed prosthetic structures were 3D-printed from dental-grade polymer for sequential use. Each prosthesis was fitted and fixed intraorally, with replacement every 10 days.

This approach to computer-aided tooth movement modeling enables the dentist to predict treatment duration and determine the required number of temporary prostheses at the planning stage.

The orthodontist plans the tooth movement timeline and number of prosthetic stages according to the principle:

One prosthesis = 1 mm movement over 10 days.

Results

The effectiveness of the orthopedic design for the prevention and treatment of horizontal tooth displacement in cases of bounded edentulous spaces is illustrated by the following clinical case.

A 26-year-old patient (L.) presented with complaints of difficulty chewing due to a defect in the upper left dental arch. Tooth 2.5 had been extracted one year prior because of a periapical abscess with fistula formation. Tooth 2.6 had a composite restoration of satisfactory quality, and teeth 1.5 and 1.6 were restored with metal-ceramic crowns on cast post-and-core foundations. The patient had an orthognathic occlusion.

Clinical examination revealed horizontal displacement of the teeth adjacent to the edentulous space toward the missing tooth 2.5, with disrupted cusp-fossa relationships between the opposing teeth.

Diagnosis: Partial tooth loss due to extraction, complicated by displacement of adjacent teeth.

Treatment plan:

Placement of a dental implant in the 2.5 region, preceded by creation of sufficient space for the implant crown using the method of horizontal tooth movement in bounded edentulous spaces.

The patient underwent cone-beam computed tomography (CBCT) of the jaws, followed by intraoral scanning to register occlusion and obtain a digital model of the dental arches. Using computer software, the DICOM file (from CBCT) and the STL file (from intraoral scanning) were merged into a single 3D digital model, which was then imported into an orthodontic module of the CAD software.

Within the orthodontic module, the tilted teeth adjacent to the edentulous space were virtually moved 3 mm to align them along their vertical axes.

At each 1 mm step of movement, polymer models of the dental arches were fabricated using 3D printing, scanned, and used to generate the necessary number of virtual and physical models.

To fabricate the orthopedic construction, a 1 mm reduction of the contour of tooth 2.4 (most inclined toward the defect) was performed. The missing tooth 2.5 was digitally modeled with an occlusal surface matching that of the antagonist teeth, and a system of retention elements was created, extending from the modeled tooth along the lingual and buccal surfaces of the adjacent teeth, overlapping them by 2 mm above the clinical equator.

Following computer modeling, three prosthetic designs were 3D-printed from dental polymer. Each construction was fitted and fixed intraorally at 10-day intervals until the desired tooth alignment was achieved.

As a result, sufficient space was created for the placement of a dental implant in the region of the missing tooth 2.5, restoring occlusal balance and allowing for subsequent definitive prosthetic treatment.

Discussion

The presented method for replacing small bounded edentulous spaces effectively solves two major clinical tasks:

1. Restoration of the integrity of the dental arch, aesthetics, and masticatory efficiency during the period preceding fabrication of the permanent prosthesis;

2. Correction of displaced teeth toward the extraction site through sequential use of temporary prosthetic constructions, each time increasing the prosthesis body length by 1 mm.

The polymer material used in the temporary prosthesis contributes to the gradual correction of deformation. High precision in planning and fabrication is ensured through the integration of digital technologies, including jaw computed tomography (CT), virtual reconstruction of dental arches with occlusion registration using intraoral scanning, and virtual repositioning of tilted teeth in the orthodontic module of CAD software to achieve their optimal position. The process also includes 3D printing of polymer models, their subsequent scanning, computer-aided modeling, and additive manufacturing of prosthetic structures [10], [11].

The proposed method is accessible, non-invasive, and technically simple. Unlike orthodontic approaches such as bracket systems, this method immediately restores the continuity of the dental arch and maintains chewing function throughout treatment. Such an approach is particularly suitable for patients with incompletely developed dentoalveolar systems, for whom bridge or implant-supported prostheses are not yet indicated [12], [13], [14], [15].

Conclusion

A new method for the prevention and treatment of horizontal tooth displacement in cases of small bounded edentulous defects has been proposed and clinically tested.

Its essence lies in the computer-based planning and digital fabrication of sequentially applied removable polymer prosthetic constructions, which not only restore masticatory function but also gradually correct tooth displacement, providing a functional and esthetic interim solution before definitive prosthetic treatment.

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