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Interfaces between orthodontics and prosthodontics: interdisciplinary possibilities and “innovations”

Introduction: This article presents possibilities regarding how orthodontists and prosthodontists can cooperate together to create conditions for an esthetically pleasing and functionally oriented treatment result. When planning the prosthetic treatment of anterior gaps, the gaps can be adjusted in advance by means of orthodontic treatment so that they can subsequently be treated in the best possible esthetic and functional manner.

Material and Methods: Adhesive bridges represent a suitable treatment option in adolescents for congenitally missing lateral incisors or after anterior tooth loss due to trauma. When designed with one wing, adhesive bridges can be used before the completion of jaw bone development and, if necessary, they can be orthodontically positioned together with the abutment tooth. Prior to complex prosthetic rehabilitation in the esthetic area, malpositioned abutment teeth can be orthodontically positioned or aligned to generate space for an ideal restoration design. Moreover, orthodontic extrusion provides the possibility of achieving sufficient abutment heights in the case of deeply destroyed or fractured teeth, thus permitting the adequate treatment of these critical teeth according to prosthetic guidelines. Oftentimes, in the case of tilted, protruded or retruded teeth, an orthodontic intervention previous to tooth preparation is useful for tooth substance conservation and maintaining the vitality of abutment teeth.

Conclusion: It can be concluded that a specific combination of orthodontic and prosthetic treatment measures can achieve a better restorative treatment result in terms of function, esthetics and long-term stability. Often, this is accompanied by a reduction in treatment duration and costs.

Keywords: interdisciplinary treatments; gap management; extrusion; esthetics; adhesive bridges

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Introduction

In order to achieve esthetically pleasing and functionally optimized treatment results in complex treatment cases, close cooperation between the orthodontist and prosthodontist is often advisable. In ideal circumstances, this teamwork extends from treatment planning to joint treatment implementation and is rewarded by satisfied patients and high-quality treatment results. The overlap, or interface, between the two disciplines is multifaceted. This article discusses 4 of these interfaces and presents clinical examples to illustrate them:

1. If individual teeth are missing, the question of which specialty domain should have pre-eminence, and accordingly the responsibility, often arises: Should an existing dental gap be orthodontically closed, or be restored by prosthetic means, such as a bridge, adhesive bridge or implant? Each of these approaches has advantages and disadvantages; they can best be discussed in a joint consultation between the dentist, orthodontist and patient.
2. In the case that a dental gap is to be treated by prosthetic means, it is necessary to first check the gap size and decide whether or not it is acceptable, as corrective orthodontic treatment may be required beforehand for an esthetically pleasing or functionally reasonable solution. The same applies for the restoration of multiple teeth in the esthetic zone. Often, this is only useful if the abutments are spaced at a distance that allows esthetically pleasing length-width ratios to be anticipated for each individual restoration and between adjacent anterior teeth.
3. For the crowning of teeth, it is necessary to have adequate abutment height and sufficient healthy tooth structure after tooth preparation. If this is not the case due to biological width considerations and a high degree of destruction, an orthodontic extrusion can be considered.
4. Following a crowning procedure, approximately 15 % of teeth show a negative response to sensitivity testing after 10 years [12]. A remaining dentin thickness of 0.5 mm should be aimed for in order to reduce the risk of pulp damage [15]. Therefore, it is important to remove as little healthy tooth structure as possible during preparation. Currently, preparation designs which preserve tooth substance have gained in importance. In this respect, the position and axial inclination of teeth play a decisive role. In clinical situations where the prospective abutment teeth require a common insertion path, but differ greatly in their axial inclinations, a conservative tooth preparation design is not attainable. In these cases, in order to avoid exceedingly invasive tooth preparations, orthodontically active components can be used in combination with interim dentures. By combining the temporary prosthetic phase with



Figure 1 Fixation of the lateral incisors – dimensioned and shaped according to the wax-up – for attaining a harmonious dental arch in the congenital absence of 12 and 22



Figure 2 Situation after removal of the brackets; width of the gaps optimally shaped



Figure 3 Placement of adhesive bridges to replace teeth 12 and 22



Figure 4 Two mesially interconnected adhesive bridges simultaneously adopt the function of a retainer.



Figures 5–7 Initial situation with multiple diastemas between the maxillary front teeth in the presence of a strongly abraded dentition; occlusal, frontal views and the patient's smile

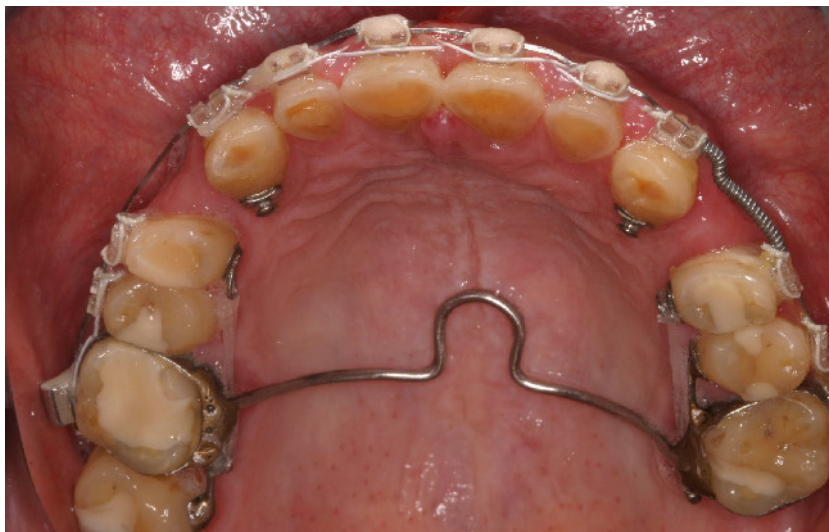


Figure 8 Gap closure mesially and gap opening in the area of the first premolars (orthodontic treatment performed by Prof. Dr. Fischer-Brandis, Kiel)

orthodontic dental alignment, a lower amount of tooth substance removal can be facilitated.

First interface: missing teeth

Anterior region gaps are most frequently caused by the congenital absence of teeth, especially maxillary lateral incisors, or traumatic loss. Around one quarter of young people experience front tooth trauma by the age of

14 and about 7 % of these front teeth are lost [23]. Circa 1.5–1.8 % of people in Germany are affected by upper lateral incisor agenesis [17]. Hence, it can be assumed that approximately 3–3.5 % of young people aged 14 years old are missing anterior teeth [7]. A number of treatment options can then be chosen. If the lateral incisors are congenitally missing, patients, or rather their parents, are often pres-

ented with the options of either an orthodontic gap closure or an implant-supported restoration. Orthodontists often favor gap closure by means of canine mesialization. Gap closure not only has functional implications, but also esthetic ones. This is because canines differ noticeably from lateral incisors, in both shape and color, as canines usually appear darker than incisors. Consequently, in the majority of cases, the treatment is not fully complete after orthodontic gap closure due to esthetic reasons; for a natural appearance, canines then require corrective treatment to imitate the appearance of lateral incisors. This implicates adapting the tooth's shape and color by means of applying a veneer, preparation of the enamel or whitening of the enamel by bleaching [18, 20, 26]. Particularly in the case of unilateral agenesis, asymmetrical tooth positions may lead to esthetic impairments. For this reason, the symmetrical alignment of the front teeth should always be an important objective.

Implant-supported restorations are contraindicated in adolescence. Nevertheless, even after transversal bone growth and canine eruption have been completed, vertical bone growth may continue into adulthood



Figure 9–11 Prosthetic restoration with metal-ceramic crowns and bridges in the upper jaw; occlusal, frontal views and the patient's smile



Figure 12 Fractured tooth 21 with adapted, fixed magnet



Figure 13 Miniplast splint with integrated magnet (B); magnet A fixed to the abutment

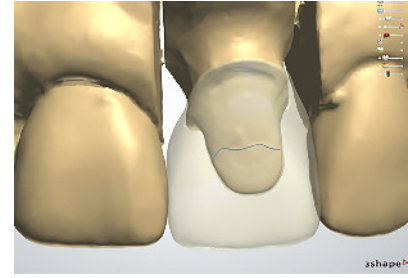


Figure 14 Abutment after successful extrusion; the incisal third of the abutment was built up with composite



Figure 15 Definitive zirconia crown half a year after cementation

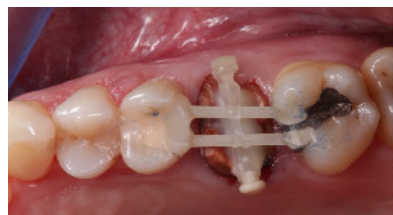


Figure 16 Forced extrusion of abutment 26



Figure 17 Forced extrusion of the root of tooth 11; a metal-reinforced cantilever bridge on implant 12 serves as an extrusion aid.

[21, 22]. Implants which are placed too early are often located in an infra position after a few years, which not only results in step formation at the incisal edges, but also in poor red-white esthetics in the area of the gingival line. Especially in the case of a high smile line, the timing for implant placement should be carefully considered. Adhesive bridges are often overlooked, or are solely considered a more or less temporary solution, until the age is reached when implants can be inserted. Lately, however, very good long-term results have been reported when using adhesive bridges. One-wing adhesive bridges have proven to be more reliable than two-wing bridges [2, 4, 10, 19, 24]. The clinical survival rate of one-wing adhesive bridges made of aluminum or zirconium oxide ceramics is between 95.4 and 98 % after 10 years [6, 9]. Thus, the survival rates of implant-supported crowns and one-wing adhesive bridges can therefore be regarded as being equivalent [11].

With reference to legally consistent patient education, the law governing the improvement of patients' rights, anchored in the Federal Law

Gazette 2013, specifies that the patient should be completely informed regarding all possible treatment options [1]. Accordingly, adhesive bridges must definitely be discussed as a treatment option. This necessity is also underlined by the fact that adhesive bridges are listed as a standard care procedure in the service catalogue of statutory health insurance companies since 2016. The key advantages of one-wing adhesive bridges are the minimally invasive preparation design which is only confined to the enamel and the fact that the restoration can be applied regardless of the stage of jaw bone development. The requirement is the presence of a completely erupted, caries-free neighboring tooth which borders the gap, having an adhesive surface in the enamel of at least 30 mm², as well as, sufficient space relative to the antagonist jaw for the purpose of being able to design a connector with a height of at least 3 mm [8]. Additionally, sufficient space should be generated for wing insertion in the case of maxillary adhesive bridges. For this purpose, the corresponding abutment tooth is protruded by approximately 0.7 mm

using an aligner or multiband therapy. This creates sufficient space to attach the wing of the bridge without the need to perform any occlusal adjustments by grinding of antagonist teeth in the antagonist jaw. These necessary space conditions should be taken into consideration early on when planning an orthodontic treatment.

If only one incisor is missing, the contralateral tooth in the same jaw determines the size and shape of the intended restoration. A timely consultation with the prosthodontist is helpful here. Thus, a wax-up/set-up can be prepared at an early stage in order to model a suitable tooth. A try-in of the tooth wax-up can be made, which is thereafter converted into composite. The model tooth is fixed in the dental arch in order to give the orthodontist the chance to adjust the dental gap exactly to the desired size and position for the subsequent esthetic restoration. A similar procedure is useful if both lateral incisors are missing (Fig. 1). In this case, too, an ideal situation can be created through precise prosthetic planning



Figure 18 Extrusion of approximately 4 mm after 4 weeks



Figure 19 Initial situation, distally inclined canines

before, or at the latest, during orthodontic treatment (Fig. 2). Above all, the ideal width of the lateral incisors must be carefully considered. When the width of the lateral incisors is between 50 and 74 % of that of the central incisors, they are perceived as being esthetic [25] (Fig. 3). However, if the gaps are set-up as being too small or too large, the dental restoration can either

- then be too narrowly or too widely designed,
- arranged in an overlapping position,
- be fitted in, but with a remaining gap
- or orthodontic measures must be carried out once again after the prosthetic treatment.

Directly after the removal of the multiband appliance, a retention splint must be worn; it is essential to ensure that the patient wears it continuously until the adhesive bridge is introduced. Otherwise, there is a risk that the teeth could move in the short time it takes for the adhesive bridge to be finished. Directly after the adhesive

bridge is cemented, a retainer must be applied, as is common for all orthodontic treatments. The splinting together of the two adhesive wings can take over this function (Fig. 4).

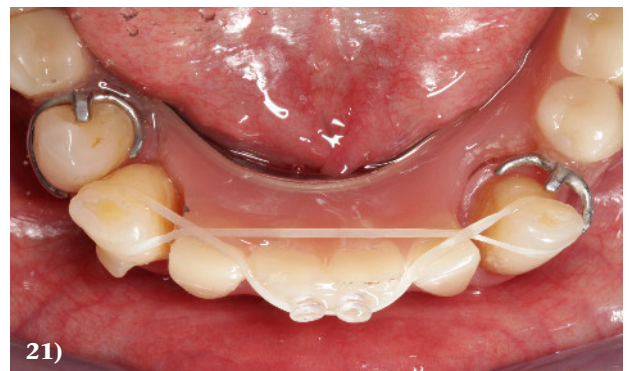
Second interface: setting ideal tooth spaces before beginning with the restoration

Provided that several teeth in the esthetic zone must be restored with crowns, or veneers, it is always useful to prepare a wax-up in advance to check if the ideal length-width ratios and proportions of the teeth with respect to each other can be achieved. In the abrasive dentition shown here, conspicuous diastemas existed between all anterior teeth. Given the tooth positions, it was not possible to close the spaces and make sufficient vertical bite correction, and yet, still be able to create esthetically pleasing anterior esthetics (Fig. 5–7). For this purpose, anterior tooth lengths averaging 11.7 mm for the central incisors, 9.5 mm for the lateral incisors and 10.8 mm for the canines are de-

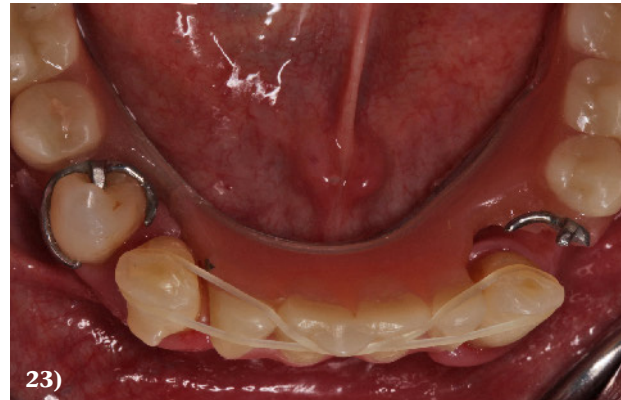
sirable [13]. Additionally, a harmonious anterior overjet, a length-to-width ratio of the central incisors corresponding to 75–85 %, and a central to lateral incisor width ratio between 50 and 74 % should be present [25]. In order to achieve this, a gap closure by means of mesialization and a gap expansion in the premolar region took place. Based on this orthodontic pre-treatment, which lasted about 1 year, an esthetically pleasing and functionally appropriate prosthetic restoration could be created (Fig. 8–11).

Third interface: orthodontic extrusion for tooth preservation

The extrusion of roots often makes it possible to preserve and restore fractured or deeply destroyed teeth [3, 5]: The background behind this has to do with the planned/existing dental post in non-vital teeth having to be surrounded by at least 2 mm of healthy hard substance (adequate ferrule design). For vital abutment teeth, however, a remaining abutment height



Figures 20 and 21 Interim denture with attached elastic bands at the beginning of treatment; frontal and occlusal views.



Figures 22 and 23 Uprighting of canines after 9 weeks of wear. A clear gap is visible between the clasp and tooth 33; frontal and occlusal views

of at least 3 mm is required. Furthermore, an adequate biological width must be maintained around the abutment teeth. In the existing case, the ceramic crown on tooth 21 was paragingivally fractured. The remaining abutment did not fulfill the conditions just described for a new crown which would have a favorable long-term prognosis. The neighboring teeth 11 and 22 displayed adequate restorations. Surgical crown lengthening was not an option due to esthetic reasons, as the previous gingival profile showed a harmonious appearance. In order to preserve the tooth, the root was extruded with the help of magnets. For this purpose, a magnet with flowable composite was attached to the vital abutment tooth. The magnet had to be reduced in size beforehand so that it matched the re-

maining abutment tooth (Fig. 12). Using a 1 mm thick placeholder, a second magnet was positioned on top of the first magnet and fixed to a previously fabricated Miniplast splint (Fig. 13). The supracrestal periodontal fibers were additionally cut with a scalpel under local anesthesia. In one to two weeks, the root was orthodontically extruded to the desired millimeter using magnetism. By moving the magnet twice inside the splint, with a renewed adjustment of 1 mm space between the magnets, the root could be extruded approximately 3 mm over a period of 6 weeks. The costs of this preliminary measure are not included in the service catalogue of the statutory health insurance companies, and must therefore, like any other orthodontic treatments in adulthood, be covered by the patients

themselves. Subsequent to this procedure, a core build-up with composite, preparation of the abutment and fabrication of a temporary crown ensued (Fig. 14). In order to prevent the tooth from migrating again, the temporary crown was fixed to the adjacent teeth with retainer wire for 4 months. After the retention period, the definitive zirconia crown could be fabricated with vestibular veneering and adhesively bonded to the abutment. Figure 15 shows the restoration half a year after placement. The tooth continues to react positively to the cold sensitivity test.

Another method to mobilize teeth is through forced extrusion using rubber bands. For this purpose, if required, bars are fixed occlusally to the adjacent teeth [14, 16]. The abutment itself is fitted with a dumb-bell-shaped device in the oro-vestibular direction. Elastic bands can then be hooked in with varying amounts of force (Fig. 16–18), so that the tooth root usually extrudes within a few weeks. The supracrestal separation of the gingival fibers prevents the fixed gingiva from moving with the root. When a coronal displacement of the soft tissue is also desired, the supracrestal fibers are not cut [16]. This applies to all extrusions, regardless of the procedure.

Fourth interface: conservative preparation by uprighting teeth before crown preparation

A well-known procedure and typical example includes the classical



(Fig. 1–4; 12–23: K. Grob, Fig. 5–11: S. Wolfart, Fig. 24: L. Wältenberger)

Figure 24 Appearance 3 years after cementation.

uprighting of a molar that is inclined towards a mesial gap. We would like to present the case of an innovative, simple, and patient-oriented approach for aligning two canines. A 67-year-old patient with a remaining dentition consisting of 33, 43, and 44 in the lower jaw required a new prosthetic restoration. Owing to the inclination of the canines, the patient could hardly insert and remove the existing clasp-retained removable partial denture (Fig. 19). Besides this, the patient no longer wished for the new restorative treatment to have visible clasps. After a detailed consultation, he chose a telescopic denture. In order to have achieved a common insertion path during the preparation of the 3 abutment teeth, the canines should have been devitalized. A treatment alternative was represented by the uprighting of the two teeth in a mesial direction. The orthodontic appliance could be integrated into the already existing interim denture by applying orthodontic elements into its structure. Also, in this case, the orthodontic treatment had to be privately covered by the patient and an additional private agreement for the treatment and cost plan was created, which contained just the orthodontic measures. In order to use the time to test the new vertical bite position by means of the interim denture, a guide groove for the elastic band was prepared in cooperation with the department of orthodontics on the canines in the distal, lingual and vestibular areas. In addition, the denture teeth 31 and 41 each received a knob vestibularly to avoid protrusion or retrusion. In this way, the patient was able to attach elastics on his own, which he changed daily (Fig. 20 and 21). After 3 months, the two canines were upright enough so that their preparation could be successfully accomplished, while maintaining a common insertion path and the vitality of the pulp (Figs. 22 and 23). The retention of the two teeth was ensured by the telescopic restoration. Figure 24 shows the patient after 3 years. The two canines still respond positively to sensitivity testing.

Conclusion

In summary, a purposeful combination of prosthetic and orthodontic treatment measures can achieve better esthetics and function in many cases. This is often accompanied by a reduction in treatment duration and costs. For optimal treatment outcomes, coordinated treatment planning between the orthodontist and prosthodontist is recommended before beginning treatment.

Conflicts of Interest

The authors declare that there is no conflict of interest as defined by the guidelines of the International Committee of Medical Journal Editors.

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