Restoration of the Upper and Lower Dental Arches with Monolithic Zirconia-fixed Detachable Prostheses: Clinical Report after Three Years of Use

Summary

In the case of fixed detachable dental prostheses some problems arose for patients, dental technicians and dentists. The most frequently emerging general problem is loosening or breakage of the occlusal screws. Further problems turned out to be wear and detachment or breakage of the resin teeth from metal acrylic blends, the breakage of porcelain from metal and ceramic or zirconia and ceramic blends as well as breakage of the framework in some free-end prostheses.

For this type of prosthesis it is necessary to leave the implants in a position that enables occlusal or lingual access to not impair the aesthetics.

This clinical report describes the case of a patient with a complete restoration of fixed detachable, maxillary and mandibular prostheses out of 100% zirconia (*monolithic zirconia*). It includes the incisal and occlusal areas on angled dental implants with buccal access and an aesthetic prosthesis solution, for which no clinical complications in the patient's mouth have been reported after 3 years.

Keywords

Dental implants, zirconia framework, fixed detachable prosthesis, monolithic zirconia

Introduction

Restoring the entire mouth of a patient with dental implants and residual dentition is a challenge if there is a strong vertical and horizontal bone resorption, since this includes the '*pink aesthetics*' and restricts the position of the implants. Although it is possible to achieve large transplantations of bone-forming and soft tissue to recover a bone substructure - whereby the implants can be placed into the desired position and suitable soft tissue can be obtained to recover the "*pink aesthetics*" in a natural way - an alternative is to use fixed detachable prostheses which show the function and the "*pink and white aesthetics*", making the case much easier for the patient and less expensive at the same time.

Various materials were used for implementing this kind of restoration with different advantages and disadvantages. We can find prostheses made of metal/acryl, of metal/ceramic and zirconia/ceramic. For more than 21 years titanium frameworks were used as an alternative to cast gold alloys.[1, 2]

Fixed detachable dental prostheses made of metal/acryl pose the following problems: Loosening of the acrylic teeth, a lack of natural colour primarily in the '*pink aesthetics*' area, as well as wear and tear with time, requiring replacement teeth and constant repairs as a consequence. Prostheses made of metal/

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porcelain offer excellent aesthetic results, however with the disadvantage that the porcelain can break, the entire restoration becomes endangered and they are therefore considered a difficult solution.

Prostheses made of zirconia/ceramic showed the problem of ceramic breakage or breakage of the zirconia framework and made the repair impossible. In addition, if the implant is in an angled position because of the anatomy of the bone, the access to this implant takes place buccally via the prosthesis in the aesthetic area. In a buccal wall between two restorations or in the connection of restoration to gingiva, it is very difficult to achieve an aesthetic result at the end of the long-term treatment, since it is necessary to implement composites which impair the aesthetics in this area.

Also, for patients with a '*gingiva smile*', the treatment of the '*pink aesthetics*' with acryl or ceramic is important.

This report describes the case for a complete restoration using a fixed detachable upper and lower prosthesis. Both upper and lower fixed detachable restorations include the entire occlusal surface, and the incisal edges are made of 100% zirconia (*Prettau zirconia, Zirkonzahn*) to prevent breakage, as with conventional ceramic, which is then coloured with Colour Liquid (*Zirkonzahn*) to achieve the desired "*pink and white aesthetics*". In addition, within the upper section, two sub-structures were made of 100% zirconia (*Prettau zirconia, Zirkonzahn*), which, as far as the palatal region is concerned, are screwed at the fixed detachable prosthesis to solve the angulation problem of some implants, which make it necessary to access the restoration through the buccal area. In such a way the advantages are evident in similar cases, where individual facings are cemented in the macro structure, because it is easier to unscrew than to remove the cement when checks need to be made or problems with the implants have to be treated.

This clinical report describes a case where monolithic zirconia was used for this kind of restorations.

Clinical Report

A 52-year-old patient with residual dentition and bone loss due to advanced periodontal disease (*Fig. 1*) without impairment of general health, who would like to have "*fixed teeth*".

Where advanced bone loss has been detected, an X-ray has to be taken and the possibility of inserting dental implants in the still existing bone will be considered, although not in the lower posterior

region on both sides. A complete restoration of the entire mouth will be planned by using fixed detachable prostheses, which are supported by dental implants.

The treatment is divided into different phases, in order to control the function and the aesthetic appearance of the patient at any time.

In the first state, tooth extractions are carried out and the positioning of the interim complete denture is made immediately to recover the vertical dimension4 , and to determine some aspects of the aesthetics.

In the 8th to 12th week stage (*Fig. 2*) the positioning of the 8 upper and 6 lower Astra-Tech Implants (*Astra Tech AB, Mölndal, Sweden*) (*Fig. 3,*) is done by using a duplicate of the prosthesis as a surgical drilling template and then by inserting straight gingiva formers (*Healing Abutments Astra Tech AB, Mölndal, Sweden*) which show clearly the angulations of some the implants and the future emergence for the buccal areas. After stitching up, the interim complete dentures are adapted, so that they do not touch the healing abutments during the osseointegration process.

After the osseointegration, the healing abutments are replaced by solid titanium abutments of 3 mm height for screw retained restorations (*20º UniAbutments Astra Tech AB, Mölndal, Sweden*) in each implant (*Fig. 4*). The final abutment level impressions

Fig. 1

Fig. 2

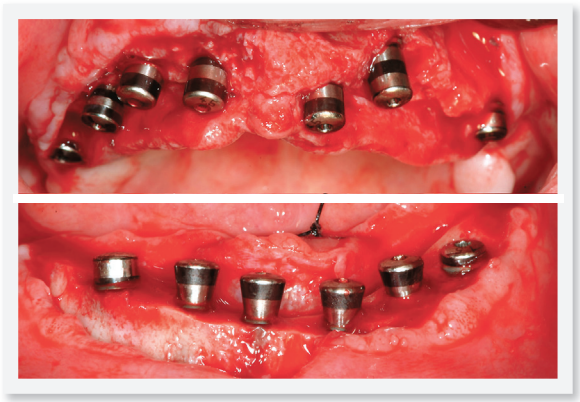

Fig. 3

are then taken and the closing copings (*20º ProHeal Cap Astra Tech AB, Mölndal, Sweden*) are placed on them, in order to cover these abutments.

The maxillar relation is taken with the face-bow and, then the vertical dimension and the bimaxillary relation will be transferred to a semi-adjustable articulator. Two master cast were fabricated. A metal framework was manufactured at the lower fixed detachable prosthesis which is built into the prosthesis together with some temporary cylinders (*Temporary Cylinder Uni 20º Astra Tech AB, Mölndal, Sweden*). This bar does not have to be fastened to these cylinders; however, the cylinders and the bar are built in the acryl, in order to guarantee a high resistance in the area of the free end prostheses (*Fig. 5*). Afterwards two fixed detachable provisional upper and lower restorations are manufactured (*Fig. 6*). Through this, the terminal parameters of aesthetics and function are determined.

The analysis of the "patient smile" showed how the commissural line did not run parallel to the bipupillary line, and the lip showed some asymmetries when relaxing and asymmetrical movements at different moments during the smile, which made the analysis difficult. The necessary modifications are carried out at these provisional fixed detachable restorations; the incisal edges of the central maxillary incisors are shortened and the line of the patient's smile is drawn in relation to the lower lip. The coronal part is also heightened by adding light-cured composites to compensate for the incisal

Fig. 4

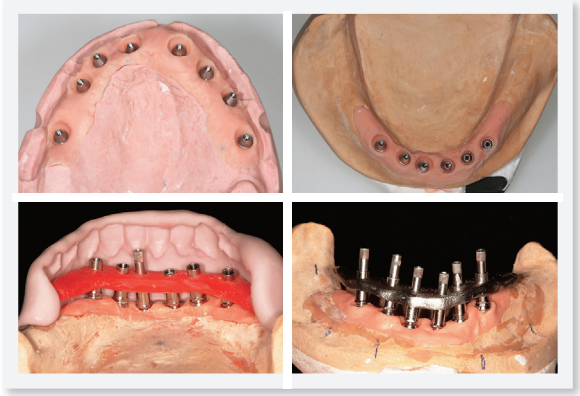

Fig. 5

Fig. 6

wear and to reduce the gingiva area, which becomes visible when smiling (*Fig. 7*). When all aesthetic and function parameters for the patient were reached, the upper and lower alginate impressions were taken, and the upper and lower models, as a copy of the provisional fixed detachable restorations, were then manufactured. Afterwards the prostheses of the patient are unscrewed and the upper prosthesis is screwed into the articulator and the lower model will be installed. Afterwards the upper model will be mounted with the same vertical dimension against the lower model already installed. From this form the dental technician can manufacture the upper resin prosthesis for the fitting by using the lower model as an antagonist to be able to control the occlusal plane, the middle line and the smile line. As soon as the two prostheses made of white resin (*Frame, Zirkonzahn*) are manufactured (*Fig. 8*) they will be screwed in the mouth of the patient, in order to evaluate the perfect occlusion and aesthetics, since any kind of changes can still be carried out during this phase of the treatment (*Fig. 9*).

After having controlled all aesthetic and functional aspects, the white acryl prostheses are copied into full zirconia prostheses in the laboratory (*Figures 10, 11*) and then coloured with appropriate colours, selected for teeth and gingiva (*Figures 12, 13 and 14*). The gingival colour was selected for the patient by means of a colour chart for the pink coloured ceramic (*Ceramic Tissue, Zirkonzahn*).

Fig. 7

Fig. 8

Fig. 9

Fig. 10

Fig. 11

Fig. 12

Fig. 13

Fig. 14

The passive fit of the restorations on the abutments can be evaluated in a different way; pressure is applied first on one end abutment and then on the other side[5] without noticing any movements of the prostheses. Then a visual check is carried out and with the assistance of an explorator, the fit could be evaluated[6] and, during the radiological analysis,[7] the continuity between the zirconia prostheses and all abutments will be verified (*Fig. 15*). By accomplishing

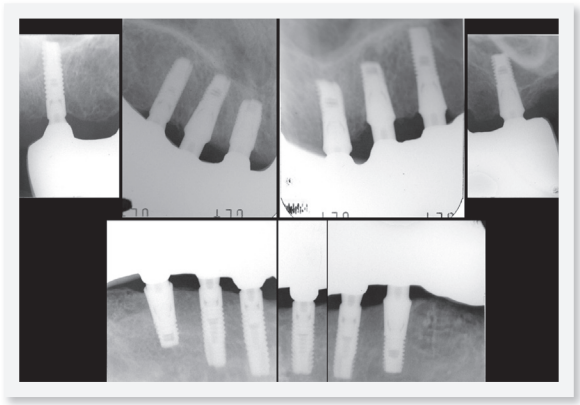

Fig. 15

the passivity test with only an individual screw (*One screw test*)[8] in one of the end abutments, no movement in the restoration can be noticed and the restoration remains in its position in the opposite end abutment.

The final lower fixed detachable prosthesis made of 100% zirconia (*Prettau zirconia, Zikonzahn*) is screwed together and tightened with a torque of 15 Ncm. The screws will then be covered with gutta-percha and the access with pink composite, provided that it is in the area of the gingiva, and with white composite, similar to the colour of the teeth, if the access takes place via the lingual area. In the upper prosthesis, at first the macro structure and then the sub-structures, which cover the access to the angled implants, are screwed together with a torque of 15 Ncm and these sub-structures are also screwed together over the palatal area with a torque of 15 Ncm (*Figures 16, 17*). Afterwards the accesses are covered with gutta-percha and composite.

The initial X-ray control (*Fig. 15*) shows the fitting of the fixed detachable restorations on the abutments and the bone at the level of the implants. The X-ray control after 3 years (*Fig. 18*) from the time of the use of the prostheses did not show any changes to the level of the bone compared with the initial X-rays. The soft tissue remained steady, neither an inflammation nor bleeding arose within any region, and in the restorations no change could be determined, neither a breakage within the occlusal or incisal areas nor any wear could be recognized. The patient did not report any problems (*Figures 19, 20*).

The prosthesis made of 100% zirconia gave the patient both function and aesthetic appearance.

Fig. 16

Fig. 17

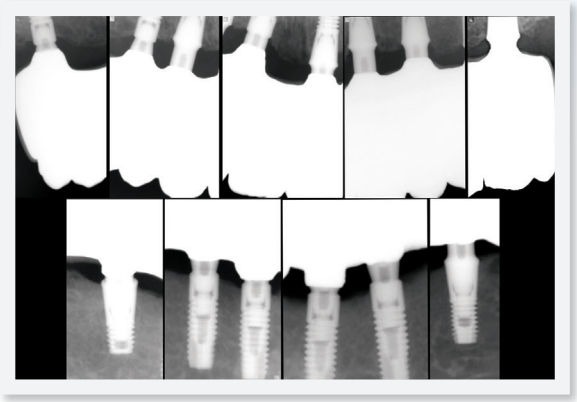

Fig. 18

Fig. 19

Fig. 20

Discussion:

Previous reports and studies are about fixed detachable prostheses made of metal/acryl, metal/ceramic or zirconia/ceramic, however, they are not about prostheses made of 100% zirconia. In the case of these studies, which were made with hybrid prostheses using frameworks of various materials, different kinds of complications arose. In 1999, Bergendal reported in a study, performed over a period of 5 years, in which he compared titanium frameworks and gold alloys,[3] on several breakages of titanium frameworks and on slightly more breakages of artificial teeth than of teeth made of gold alloys. In 2000, Örtorp and his collaborators reported in a 1 year prospective study on no mechanical complication except for some breakages of the resin facing.[9] In a prospective study regarding a clinical test over a period of 36 months, Duncan reported in 2003 that sixty-eight per cent of patients who were provided with fixed detachable prostheses had complications. For the majority of patients this concerned a breakage of the resin teeth, more frequently within the front area than within the rear area and with a larger tendency approximately after 1 year of use.[10] In 2009, Örtop reported in a comparative follow-up study on supervision over a period of 15 years, in which laser welded titanium frameworks were compared with gold alloy frameworks, that the breakage of the resin or acryl teeth and the inflammation of the soft tissue were the most usual complications with hybrid prostheses implemented with titanium frameworks. Breakages

in the titanium framework were detected in 15.5% of the patients. More breakages were detected in the case of titanium work compared with gold alloy work.[11]

Some clinical reports on the use of porcelain, which was merged with zirconia prostheses, did not result in mechanical complications.

There are only a few reports on hybrid prosthetic restorations with zirconia frameworks. Those, which belong to the FPDs (*fixed partial dentures*), have shown that breakage of the porcelain facing is caused by the strain in the framework, since most of the breakages arose in the interface between framework and the layer of porcelain.[12, 13] There are some long-term clinical studies about frameworks made out of zirconia oxide, which were used in fixed partial prostheses.[14.15.16] Moreover there are some reports concerning cases with frameworks made out of zirconia on natural teeth[17] and others concerning hybrid prostheses on implants using zirconia frameworks without any complication during a monitoring period of 6 months.[18,19]

An article in German and French describes the manufacturing process of a complete fixed prosthesis in an edentulous mandible, supported by seven implants. Two prostheses were made, one of a titanium framework with resin veneers and another from zirconia framework, experimentally with ceramic veneers.[20]

As far as the author has knowledge, no clinical report was published about the complete fixed detachable restoration made of 100% zirconia.

In this case report, no complications were evident after using the prostheses made out of 100% zirconia from a monolithic zirconia over a period of 3 years. There were no breakages in the framework, neither were there breakages in the cusps nor wear or tear in the occlusal surfaces, or loosening of the screws. There was no presence of tartar, and the bone level remained stable during the X-ray analysis of all implants.

In the future long-term studies must be carried out, in order to compare this kind of material with the materials existing on the market and to determine the advantages, which were discussed in this report.

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