Laboratory Evaluation of the Fit of Anti-rotational Elements at the Hybrid Implant Abutments Used in Prosthetic Dentistry

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Abstract. Hybrid implant abutments join the features of standard metal-ceramic implant abutments and custom made pure ceramic ones. They are made of zirconium oxide in CAD/CAM technology and are combined with a base made of titanium, supplied by the manufacturer of the implants. The aim of the study was to evaluate the marginal seal at the border of the implant and hybrid abutment, as well as the degree of fit of these elements. Both marginal seal and the degree of matching between the Replace Select 4.3 (Nobel Biocare, Sweden) implant and the hybrid abutment fall within the limits described in the literature.

Keywords: Implant · Hybrid implant abutment

1 Introduction

The discovery of osseointegration in bones allowed for the use of predictable and long-term treatment with dental implants for patients with missing teeth. The development of CAD/CAM technology at the end of the 20th century made it possible to obtain customised implant abutments made of zirconium oxide. The use of the ceramic abutments creates a possibility to obtain geometry that is similar to the shape of the prepared tooth and allows for customised shaping of the emergence profile. The disadvantage of these fillers is, however, the difficulty of establishing proper thickness of the abutments' walls due to characteristic features of the material they are made of. The long-term success of the prosthetic rehabilitation by using dental implants is determined by a number of factors,

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Fig. 1. Standard hybrid abutment

including tightness and stability of the connection between the implant and the prosthetic abutment [1,2].

Standard hybrid abutments are commonly made by joining titanium base with a ceramic ring, most frequently made of zirconium dioxide (Fig. 1). The process of combining these two is completed by using chemo- and light-curing composite cements such as Panavia F (Kuraray, Japan), Multilink Implant (Ivoclar Vivadent, Liechtenstein) or Vita Duo Cement (VITA, Germany) [3,4].

Hybrid implant abutments join the features of standard metal-ceramic implant abutments and custom made pure ceramic ones. They are made of zirconium oxide in CAD/CAM technology and are combined with a base made of titanium, supplied by the manufacturer of the implants (Fig. 2). The advantage of this method is the possibility of full customisation of the abutments' shape.

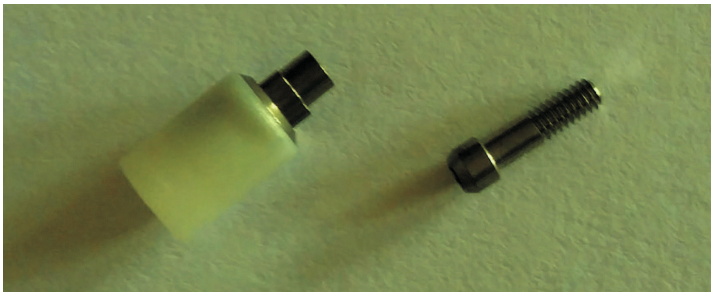

Fig. 2. Custom made hybrid abutment

2 Methodology

The aim of the study was to evaluate the marginal seal at the border of the implant and hybrid abutment, as well as the degree of fit of these elements. To determine the degree of fit, the scanning with the electron microscope (SEM) Zeiss Supra 35 with the SE type detector was used in the study. Due to the lack

of conductivity of the tested samples, their surfaces were subjected to a process of spraying with a layer of gold. The study involved the system consisting of an implant and a hybrid abutment. It included an analysis of the connection surface of the Replace implant platform with a hybrid abutment made of Robocam material. The analysis was conducted at a random point of connection and then the measuring point was changed, and the pitch angle of the measurement amounted to 120°. The analysis of the dimensions of the implant socket and the stabilising element of the abutment was based on the measurements of the inner diameter of the socket of the implant (tube), the outer diameter of the stabilising element (tube), and the linear dimensions - width (D) and height (H) of the anti-rotational elements (Figs. 3 and 4).

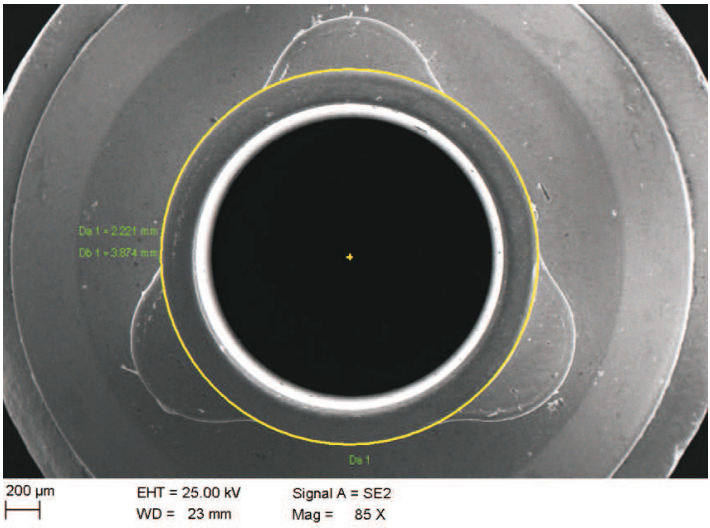

Fig. 3. Measurement of diameter of the socket of the anti-rotational element (tube) in the hybrid abutment

3 Results

Based on the survey, differences in the width of the gap (d) between the implant platform and the abutment were found. For a hybrid abutment the average width of the connection amounted to 16.37 [µm], (min.10.12 [µm], max 21.68 [µm]) (Δ = 11.56 [µm]) (Table 1). The internal diameter of the inlet socket of the implant and the outer diameter of the stabilising element (tube) of the abutments (Table 2) were also subjected to comparison. Additionally, the linear dimensions of anti-rotational elements and sockets in the implants were compared. In the conducted test, the differences in the diameters of stabilising element (tube)

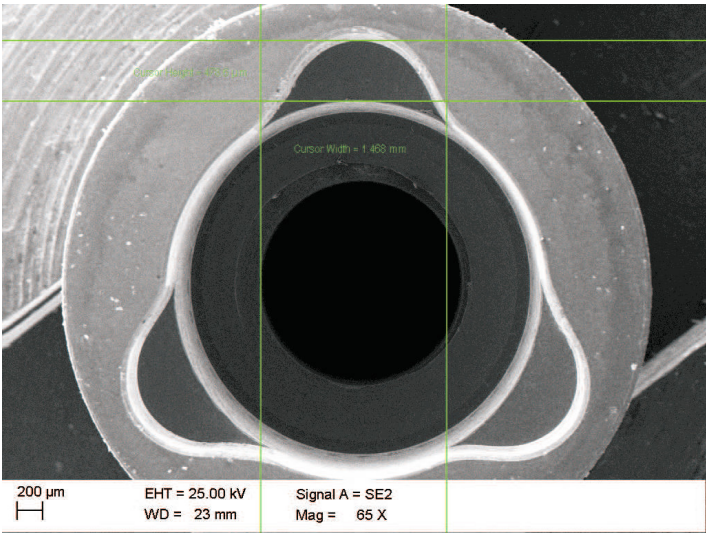

Fig. 4. Measurement of linear dimensions of the anti-rotational element (ear) in the implant Replace Select 4.3 (Nobel Biocare, Sweden)

Table 1. The width of the gap between the implant platform and abutment in micrometres. A, B, C – consecutive positions of the measurements, pitch angle of the measurement at 120°

Implant - hybrid abutment			
No.	A	B	C
1.	21.68	14.37	18.90
2.	12.47	14.43	18.90
3.	11.96	10.12	17.71
4.	18.21	12.31	13.27
5.	15.24	20.31	11.68
6.	18.14	17.44	19.10
7.	15.67	14.88	17.72
8.	15.12	12.11	17.99
9.	10.45	15.54	16.39
10.	10.45	15.01	13.79
Average	**15.52**	**15.02**	**16.37**

between the tested abutment and the groove of the implant were shown. These values amounted respectively for the hybrid abutment to min. 2.215 [mm], max. 2.315 [mm] ($\Delta = 2.241$ [mm]), while the diameter of the groove implant Replace Select 4.3 (Nobel Biocare, Sweden amounted to min. 2.676 [mm], max. 2.688 [mm] ($\Delta = 2.680$ [mm]).

Table 2. The fit degree comparison obtained by measuring the diameter of the external and internal anti–rotational elements

No.	External diameter hybrid abutment, mm	Internal diameter implant, mm
1.	2.221	2.681
2.	2.229	2.676
3.	2.227	2.678
4.	2.215	2.688
Average	**2.241**	**2.680**

Table 3. Comparison of fit degree of external and internal anti–rotation elements

No.	Linear measurements: hybrid abutments		Linear measurements: implant	
	D_h	H_h	D_i	H_i
1.	1.165	353.5	1.430	478.8
2.	1.105	324.4	1.427	447.4
3.	1.090	320.2	1.468	478.6
4.	1.127	350.7	1.432	466.1
5.	1.109	330.0	1.429	457.3
Average	**1.123**	**335.7**	**1.437**	**465.6**

The height (H) of the element and the length at its base (D) were also measured. For the hybrid abutment, the length of the rotation element measured at the base D_h amounted to min. 1.090, max. 1.185($\Delta = 1,123$), and the height H_h of the element measured from its base to the tangent running to its edge amounted to min. 320.2 [mm], max. 353.5 [mm] ($\Delta = 335.7$).

The measurement of the length of the internal anti-rotational D_i elements of the implant Replace Select 4.3 (Nobel Biocare, Sweden) amounted to min. 1.427 [mm], max.1.468 [mm] ($\Delta = 1.437$), while its height H_i amounted to min. 447.4 [mm], max.478.8 [mm] ($\Delta = 335.7$) (Table 3).

4 Conclusions

Implant abutments used in dental prosthodontics play an important role in achieving positive results during long-term implant prosthetics treatment. Prevention of the prosthetic failures, such as the loosening of the superstructure, fractures or several biological complications may depend on proper adjustment of the connecting elements, geometry, the size of the abutment and the crown, as well as the distribution of forces exerted to the construction [5–7]. The marginal seal tests conducted in the present study showed differences between the values achieved at different points of measurement for the hybrid abutment. According to different authors, the satisfactory gap ranges from 23 to 150 [µm] [8,9].

Therefore, the results obtained in this study can be considered as very good. The degree of the implant fit with the abutments' connection should allow for longitudinal rotation by 3°, which can prevent brittle fracture, but at the same time it can lead to greater risk of deformation during chewing. Subsequently, this can lead to periodic expansion of the marginal gap and transferring more pressure to the *abutments*' screw [10,11]. The authors consider the distance between 0 and 300 [μm] as a good result, therefore the average distance for a hybrid abutment obtained in this study should be regarded as satisfactory. Both marginal seal and the degree of matching between the Replace Select 4.3 (Nobel Biocare, Sweden) implant and the hybrid abutment fall within the limits described in the literature.

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