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FACTORS AFFECTING THE ABUTMENT SCREW LOOSENING

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SUMMARY:

Aim of the study: To establish the influence of various factors upon the loosening of abutment screw.

Material and Methods: The current study has analyzed the factors leading to loosening of the abutment screws implant-supported restorations. 116 patients have been examined with 234 setting implants for a period of 2 to 9 years. Factors related to the planning of implant prostheses such as area of implantation, available bone volume have been registered, as well as those related to the functional loading of dental implants. The impact of their effect has been calculated.

Results: Abutment screw loosening has been registered in 6.8% of the monitored cases. Regarding the type of connection between the implant and abutment a higher prevalence has been reported in connection with an internal octagon - 4.7% compared to the conical connection - 2.1%. It was found that the type of prosthesis, bruxism, cantilevers, non-balanced occlusion, crestal bone resorption and time of this complication setting in are factors of statistically significant influence.

Conclusion: It has been concluded that the optimal choice and number of implant positions, the design of prosthesis, achieving optimal occlusion as well as reporting cases of bruxism, leading to functional overload of dental implants are of particular importance in order to avoid bio-mechanical long-term complications.

Keywords: abutment screw loosening, implant complications, occlusal load, bruxism, bone resorption

INTRODUCTION

For the last years the usage of dental implants to replace missing teeth and restoration of masticatory function has been accepted as a routine method in clinical practice. Along with the high success rate, biological and biomechanical complications are observed in some cases [1-3]. Long term studies have demonstrated that loss of osseointegrated implant can be caused both by secondary infections (peri-implantitis) and by functional overload [4, 5].

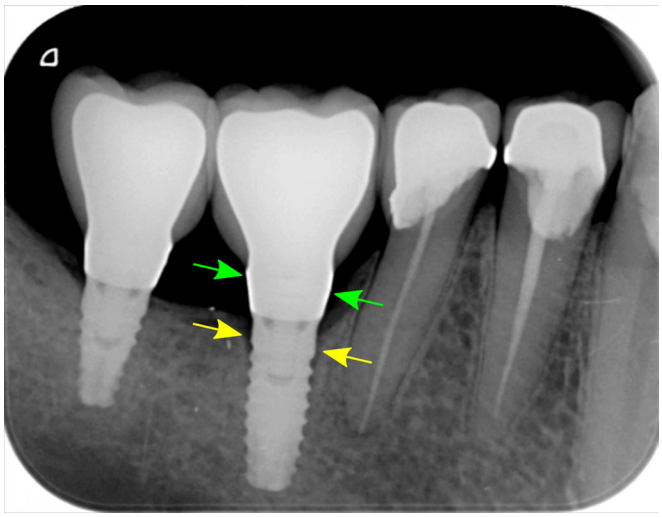
Loosening of abutment screw is one of the most common mechanical complications breaking the integrity between the implant and abutment. The incidence varies between 4.3 and 10% [6] and occurs in a relatively short period after functional loading of implants.

The reasons for such loosening may turn out to be inadequate initial tightening of the screw, the impact of occlusal forces of unfavorable direction and size as a result of incorrect occlusion and cantilever extensions as well as material fatigue [7-10].

Sahin and Ayyildiz's studies [11] indicate that the loosening of abutment screw can be brought about by the presence of microleakage between the implant and abutment, permitting fluid penetration around the abutment screw. As a consequence of this the permeability is increased which provokes the occurrence of bacterial infection as well as peri-implantitis in some time [12].

Factors, such as unfavorable occlusal loading, microleakage in the field of implant-abutment connection and bacterial infiltration undoubtedly are bound up with the loss of marginal bone [13] (Figure 1).

Fig. 1. Case of loosening of the abutment screw in the area of lower right first molar. There is a micro gap between abutment and implant, which is marked with green arrows. With yellow arrows had shown the first X-ray signs of marginal bone loss.



It was found in a number of studies that the type of connection between the implant and abutment may be essential for the incidence of loosening [14, 15]. The increased load upon the implants as a result of parafunctional activity after an initial successful integration is regarded as one of the reasons for biomechanical

complications [16-18].

The aim of the current research is to determine the influence of various factors on the abutment screw loosening between the implant and abutment.

MATERIAL AND METHODS:

This study included 116 patients with partial or complete edentulism with 234 implants inserted during the period 2007 - 2016. Prosthetic based approach was strictly complied with when selecting sites for implantation. Implants were used with diameters from 3.2 mm to 5.0 mm in accordance with the recommended dimensions for the respective zones. Shaping the implant lodges was performed applying an open surgical procedure and following the sequence of drilling described in the protocols of manufacturers. The following implant systems were used: Ankylos® (Dentsply Implants - Germany), TBR Connect®, Z1-Connect®, Periosave® M and Z1-M (TBR Implants Group - France) and Straumann® Bone Level implants (Straumann - Switzerland). All cases were traced with successful osseointegration, no complications were observed during or after the first and second surgical stage. Custom-made prostheses were fixed. An analysis of anatomical features in the implantation sites was carried out: upper molars, upper premolars, upper front teeth, lower molars and lower front teeth. The available bone volume was recorded as well as the final positions of dental implants and their characteristics – mesio-distal and vestibulo-lingual inclination. We tracked out the characteristics of restorations – their type (single crowns, splinted crowns, bridge implant - implant and bridge implant - natural teeth) and type of connection between the implant and abutment (internal octagon or conical connection). From a functional point of view it was reported the presence of biomechanical or physiological overloading involving bruxism, cantilever, non-balanced occlusion, an insufficient number of implant supports and improperly selected implantation sites. By means of clinical check-up and X-ray examinations the following complications were recorded: degree of marginal bone loss, loosening or fracture of the abutment screws, fracture of the bodies of dental implants as well as the time of such complications setting in.

Statistical data processing was performed using IBM SPSS Statistics 20. Descriptive evaluation methods were applied - variational analysis of quantitative variables and frequency analysis of qualitative variables (nominal and ranks) which includes absolute and relative frequencies.

In order to study the relationship between abutment screw loosening and possible influence of other track-out factors we carried out a correlation analysis taking into account the rank correlation coefficient Spearman Rho.

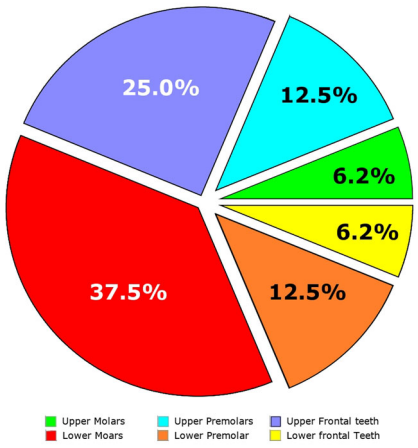
In order to verify the hypothesis that the type of connection between the implant and abutment, bruxism, non-balanced occlusion, marginal bone loss, the type of prosthesis and the time of complications setting in do not affect the cases of abutment screw loosening we used the test of Kruskal-Wallis. To determine the effect of individual factors and the magnitude of their effect Mann-Whitney's post hoc test was done in relation to the examined indicator. The outcomes were reported using Bonferroni correction coefficient related to the number of groups (Bonferroni corrected post hoc Mann-Whitney test).

RESULTS:

The results were obtained by monitoring 116 patients with 234 implants inserted during the period 2007 - 2016. 81 of the implants (34.6%) were placed to females and 153 (54.46%) to males.

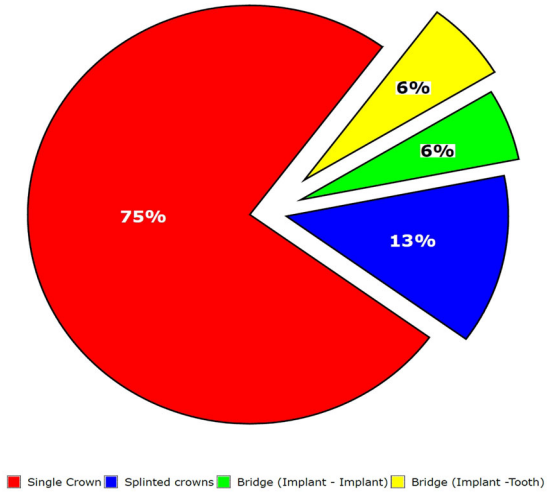
Abutment screw loosening was detected in 16 cases - 6.8%. Besides the distribution of this indicator by gender is similar for both sexes - 3.0 % in females and 3.8% in males. In reference to the type of connection between the implant and abutment we found higher frequency in connection with an internal octagon - 4.7%, compared to the conical connection - 2.1%. As regards the implant areas most cases were reported at the lower molars (2.6%) followed by the upper front teeth (1.7%). In other zones such has been observed relatively rare - from 0.4% to 0.9% (Figure 2).

Fig. 2. We present the percentage distribution in cases of screw loosening according the areas of implantation.



Concerning the type of prosthesis most frequently registered case was that with single crowns - 5.1%, while in other types of prostheses: splinted crowns, bridge implant - implant and bridge implant - natural tooth - less than 1% was recorded (Figure 3).

Fig. 3. Percentage distribution in the case of loosening of the abutment screw in relation to the type of prosthetic restorations.



Cantilever has been detected in 30 implants and in 9 of them with loosening of the abutment screw. In 11 implants of patients with bruxism we reported that in 6 cases abutment screw loosening was observed within the first year. In all identified cases of such complication - a total of 16 we detected crestal resorption as well, expressed in varying degrees - up to 3 mm – in 14 cases and more than 3 mm - in 2. The distribution and frequency at the studied indicators showed that their values do not have a normal distribution. This necessitated the use of nonparametric methods for results statistical processing.

By Spearman's correlation analysis statistically significant relationships have been found in cases of abutment screw loosening and the impact of the following factors: type of prosthesis, the presence of bruxism, cantilevers, non-balanced occlusion and marginal bone loss around the implant as well as the onset of these complications. Only three of these factors have great impact - the presence of bruxism, usage of cantilevers and the time of such complication setting in. Spearman Rho for the established cases of parafunctional activity is as it follows: rho (234) = .316, $p < .001$ when there is cantilever available as well as when the time of the complication set in is taken into account - rho (234) = .336, $p < .001$. Positive correlation sign indicates that the increase in the size of factors enhances the possibility of loosening the abutment screw. We found that the size of the effects of the above indicators is close to typical as we used Cohen's guidance book [19].

The influence of related factors was traced using Kruskal-Wallis' test. The results showed a statistically significant difference in the analyzed parameters: according to the type of prosthesis - $\chi^2(1) = 5.218$, $p = .022$, with respect to bruxism - $\chi^2(1) = 23.204$, $p < .001$, according to the presence of cantilever - $\chi^2(1) = 26.283$, $p < .001$, depending on the available non-balanced occlusion - $\chi^2(1) = 4.441$ $p = .035$, in accordance with marginal bone loss - $\chi^2(1) = 14.951$, $p < .001$ and the onset of complication - $\chi^2(1) = 26.248$, $p < .001$.

In order to establish the size of the effect of these factors the above data was processed using the corrected by Bonferroni Mann-Whitney's post hoc test for each separate group. The results are presented in Table 1.

Table 1. Mean values of the effect size of statistically significant factors leading to the loosening of abutment screw for the entire sample

Comparison of indicators	Total:(p-value)	SS	ES
Type of prosthetic restorations	.022	-	.149 (M)
Parafunctions (clenching and grinding)	.001	*	.315 (T)
Cantilever	.001	*	.335 (T)
Non-balanced occlusion	.035	-	.138 (M)
Marginal bone loss	.001	*	.253 (M)
Time of complications setting in	.001	*	.335 (T)

Notes: SS – statistical significance is reported with Bonferroni correction coefficient at ± = 0.05 for 6 groups only if p α .003, **ES** - effect size; higher values reflect the greater importance of the factor concerned (-1.00 - minimum value, 0.00 – mean value, 1.00 – maximum value); Data is processed by Mann-Whitney U test; the size of the effect is calculated based on Cohen's coefficient "r" and interpreted in values > 0.70 as much higher than the typical (B), 0.50-0.70 as high (B), 0.30-0.50 as mean or typical (T), from 0.10 to 0.30 as low or lower than the typical (M) according to Cohen (Cohen, 1998).

DISCUSSION:

The current studies show reduction in the incidence of abutment screw loosening. This is probably related to the technological improvement of the connection between the implant and abutment and the design of abutment screws. It is in a range of 2 to 8% unlike previous studies which have reported higher values [20].

The results of the conducted tests showed that parafunctional activity, cantilevers and the time of complications setting in have a statistically significant impact with typical effect size in observed cases of abutment screw loosening (Table 1). This is in compliance with the

opinion of some authors [16-18] that bruxism has a significant impact upon the incidence of biomechanical complications, including screw loosening due to repeated static and dynamic loading. Such loadings can be both along the axial axis in clenching the teeth and in less favorable lateral directions in grinding the teeth. The increased loading leads to fatigue and subsequent loosening and fracture of abutment screw [21-23]. The obtained results revealed also a strong connection between the cantilever extensions and cases of screw loosening. This does not support the opinion of Romanos GE et al. [24], who claim that distally located cantilever units can be applied successfully in implant prosthetics. Any kind of cantilever extension causes rotation and towing forces of direction different from the axial axis of the implant [15] and increases the likelihood of mechanical complications.

Regarding the time of this complication setting in the results from the present study confirmed the results found in the literature [25], namely such complication occurs in the first 1-5 years after the implants loading in a greater percentage of cases.

CONCLUSION:

The outcomes of conducted analysis indicate that as a separate factor crystal resorption has little impact on abutment screw loosening while in combination with other factors it may be relevant to it. In all observed cases of screw loosening crystal resorption has been established in varying degrees. In this context it is necessary to give a timely diagnosis and solve this problem regarding prevention of marginal bone loss and related consequences.

In our study we found out that the type of prosthesis and non-balanced occlusion affect less in such cases. However, their accumulation in combination with the action of other factors can lead to the occurrence of bio-mechanical complications in treatment with dental implants.

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