ASSESSMENT OF CRESTAL BONE LOSS AND DEGREE OF SUCCESS OF RITTER SPIRAL DENTAL IMPLANTS BASED ON RADIOLOGICAL MEASUREMENTS

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ABSTRACT

Introduction: After the implantation of dental implants and especially after the prosthetic load, the resorption of the alveolar ridge often occurs impairing the osseointegration. After numerous studies, dental implant manufacturers realized that the platform switching technique can lead to a reduction in resorption.

The aim of study was to show the overall level of crestal bone loss around the Ritter spiral implant after one year.

Materials and methods: The database of CBCT images were taken at the Faculty of Dentistry of the University of Sarajevo in the period from 2021 to 2023, where 73 CBCT images meeting inclusive study criteria were analyzed. The images were analyzed in the GALILEOS program, where the measurements were made in an axial cross-section, and the reference points for the measurement were from one side of the implant to the furthest point of bone loss on that side.

Results: The annual loss of the crestal bone is 0.81 mm. The greatest loss of crestal bone is on the distal side of the implant (0.93 mm) and the smallest on the vestibular side (0.63mm) of the implant. The greatest loss of crestal bone on an annual level had implants in the area of molars in the upper jaw.

Conclusion: All Ritter spiral implants were successfully osseo-integrated. It was proven the bone loss towards the sides of the implant and position in the jaw.

Key words: Crestal bone loss, dental implants, osseointegration

Introduction

In order for the implant to have a functional durability, good osseointegration of the implant is necessary thus creating its stability. After the placement of dental implants, and especially after prosthetic loading, the resorption of the alveolar ridge frequently occurs compromises the osseointegration and stability of the implant. Exceptional importance regarding osseointegration is the crestal bone around the implant influencing its integrity.

The challenge for a dentist is the constantly increasing aesthetic demands in the area of front teeth, the so-called "aesthetic zone", with the renewal of the natural anatomy surrounding the implant. However, resorption of the crestal bone will cause the gingival recession by affecting the outcome of therapy and aesthetics. (1)

Post-restorative reduction of bone height around the implant has been known for a long time to be a normal consequence of implant therapy with regard to two-part implants. It has been described that the level of crestal bone is typically located approximately 1.5 to 2 mm below the implant-abutment junction (IAJ) one year after implantation. Several factors contribute to remodeling of the bone around the neck of the implant, more precisely biological width, infiltration of bacteria, mechanical factors, implant design, surgical trauma, surface structure of the implant and platform switching. (2)

The horizontal component of biological width represents the halo around the implant in its most coronal aspect, and research shows being approximately 1.4 mm. Due to this established mean regarding horizontal dimension of direct crestal bone loss around dental implants, a problem arises when implants are placed in adjacent places in the mouth. If the implants are placed too close together, the overlapping of the horizontal components of the biologic width of each implant serves for the increase of the effective vertical loss of the crestal bone between the implants. (3)

Research indicates that in implant systems with superstructures attached with screws, bacteria can penetrate into the internal cavity of the implant. (4-7) Hermann *et al* discovered that on bone loss at the alveolar ridge significantly impacts the micromovement between the platform of the implant and the implant abutment, but not by size of the micro-gap of interface between the implant platform and the superstructure. That may be the consequence of the fact that micromovement increases the flow of bacteria from and into the micro-space, by causing the inflammation of the connective tissue in the area of the micro-space thus leading to the bone resorption. Bone resorption will progress vertically and horizontally until biological width is created and stabilized. (8, 9)

Several studies have shown that with two-part implants, changes in the level of the bone crest appeared depending on the location of the interface between the platform of implant and the supra-structure, if the interface was moved coronally from the alveolar bone, there would occur less bone loss, but if the interface was crestal or sub-crestal there were greater amounts of bone resorption present. (10-12)

Nickenig *et al.* compared the surfaces of implants of macro and microstructure at the marginal bone level during the period of healing without stress and under functional loading. Radiographic assessment of the marginal bone level with placed implants with micro threaded neck design or rough surfaces showed that implants with a micro threaded design have caused minimal changes in the level of crestal bone during healing (without stress) and under functional loading. (13)

The surface structure of the implant affects the process of osseointegration. The degree of surface roughness depends on the system of implant. The roughness of the surface is achieved by machine processing: sandblasting and etching, laser processing or applying of a layer of a special coating. The purpose is to increase the surface which, with such processing, can be increased about 6 to 10 times. Thus, the process of osseointegration itself is speeded up and an additional micromechanical connection with the surrounding bone is achieved. With smooth implant surfaces, osseointegration may not be present, and rougher surfaces are more prone

to ion emission and corrosion. The ideal implant surface is still being researched, and numerous manufacturers claim that the surface of their implants are optimal. Some surfaces behave better in specific conditions. The surface structure of the implant consists of nano-, micro- and macrostructure. Nanostructure refers to the chemical and biochemical properties of the implant surface and it may exert influence on the function and orientation of cells. Microstructure refers to the chemical, mechanical or physical structuring of the surface. Macrostructure refers to elements of design including threads, voids or pores. Studies have shown that physical properties of surfaces at the beginning accelerate tissue reactions and affect the processes such as adhesion and differentiation of cells in the tissue surrounding the implant. (14)

The aim of this research is to show the overall level of crestal bone loss around the Ritter spiral implant after one year.

Material and methods:

Within research, it was accessed to the database of CBCT images taken at the Faculty of Dentistry of the University of Sarajevo in the period from 2020 to 2023, for various dental purposes, where out of examined 83 CBCT images, 73 CBCT images were analyzed meeting the inclusion criteria of the study.

Inclusion criteria were:

1. acceptable quality of images
2. patients to whom were placed Ritter spiral implants length 8 and 10 mm.
3. plan of placement of implants performed exclusively by radiological measurement
4. in the database, there is a CBCT image before placement and 10 to 12 months after the placement of the implant.

The exclusion criteria were:

1. irregular bone volume and the presence of pathological changes in the region of measurement such as cysts, tumors, periapical lesions
2. peri-implantitis
3. patients under 18 years of age

According to age, patients were divided in 3 groups: patients aged 20 to 37 years, patients aged 37 to 47 and patients aged 47 to 65 years. According to dental status, the patients were divided into dentate, partially edentulous and totally edentulous patients.

CBCT images were taken by using an ORTHOPHOS SLX device. The nominal output power of this device is 2kW at 90 kV/16mA, nominal frequency 50Hz/60Hz. The tube voltage is 60-90kV (for 90kV max. 12mA), and the power in the tube is 3-16mA (for 16mA max. 69kV). The frequency of high voltage generation is 40-120kHz. The exposure time of the image is max. 14.9 seconds. Overall filtering of X-ray tube is > 2.5 mm Al/90 IEC 60522 0.3 mm Cu. The size of the focal point according to IEC 60336, measured in the central X-ray beam, is 0.5 mm.

The images were analyzed in the GALILEOS program, where the measurements were made in an axial cross-section, and the reference points for the measurement were from one side of the implant to the furthest point of bone loss on that side. Measurements were made on the images 12 months after implant placement on all 4 sides: vestibular, oral, mesial and distal.

Results:

In this research, we included 73 images of patients, out of which 37 were men with average age of 41.5 years (range: 23 to 60), and 36 were women with average age of 41 (range: 19 to 63). The most of the patients were in the age group 37 to 47 years (48%), then patients in the age group 47 to 65 (38.35%) and the least number of patients was in the age group 20 to 37 years (13.69%).

In the age group of 20-37 years, all patients had dentition; the group of patients aged between 37 and 47 had 3 dentate patients (11.53%), 23 partially edentulous patients (88.46%). The group of patients under the age of 65 has the largest number of edentulous patients (77.80%) and 2 patients were partially edentulous (22.2%).

The average value of the quantity of resorption measured with all patients and on all four sides around the implant was 0.8 mm.

Measurements were conducted on all four sides of the implants of all 282 implants and by arithmetic mean, the reference value of the loss of crestal bone on an annual level was obtained.

Table 1. shows the average value of resorption depending on the type of intervention.

Table 2 shows the quantity of bone loss according to the sex of patients, where we found that resorption of bone is slightly higher in women than in men.

The greatest loss of crestal bone is on the distal side of the implant (0.93 mm) and the smallest on the vestibular side (0.63mm) of the implant.

The greatest loss of crestal bone on an annual level had implants in the area of molars in the upper jaw at positions 16, 17, 26, 27. The least resorption was at implants at positions 31, 32, 35 and 41 in the lower jaw.

Type of intervention	Number	Mean value (mm)	Standard deviation	Percentage
Implantation	73	0.81	0.083	100,00%
Sinus lift with augmentation	8	1.23	0.25	10,95%
Augmentation	14	0.93	0.07	19,17%

Table 1. Quantity of resorption according to type of intervention

Sex of patients	Number of percentage	Number of implants	Mean value (mm)	Standard deviation
Male	37	165	0.72	0.05
Female	36	117	0.91	0.03

Table 2. Quantity of resorption according to gender

Mean value	Number of implants	Mean value (mm)	Standard deviation
M - mesial	282	0.75	0.09
D - distal	282	0.93	0.09
O - oral	282	0.89	0.08
V - vestibular	282	0.63	0.05

Table 3. Quantity of resorption according to sides of implants

Position of implants	Number of implants	Mean value (mm)	Standard deviation	Percentage
11	17	0.72	0,05	6.02%
12	8	0.73	0,06	2.83%
13	13	0.82	0,04	4.60%
15	14	0.78	0,05	4.96%
16	22	0.95	0,03	7.80%
17	10	0.91	0,03	3.54%
21	14	0.71	0,06	4.97%
22	7	0.70	0,06	2.48%
23	13	0.83	0,05	4.70%
25	12	0.79	0,05	4,24%
26	14	0.95	0,02	4.97%
27	9	0.89	0,06	3.19%
31	12	0.70	0,06	4.24%
32	9	0.71	0,04	3.19%
33	8	0.79	0,04	2.83%
35	17	0.70	0,08	6.02%
36	16	0.79	0,05	5.67%
37	11	0.81	0,06	3.90%
41	11	0.71	0,06	3.90%
42	9	0.74	0,22	3.19%
43	9	0.80	0,04	3.19%
45	13	0.79	0,02	4.60%
46	14	0.81	0,05	4.96%

Table 4. Loss of crestal bone according to position of implant marked by FDI

Discussion

In this research, the main goal was to determine the amount of crestal bone loss on an annual level and to show the success rate of implants by radiological measurement. In this research we used the implants of Ritter Dental Implant System, made out of grade 5 titanium, with self-tapping threads and a nano surface for quick osseointegration. They are available in 3 specific models, in different lengths and diameters and suitable for all types of bones and surgical applications. Ritter Dental Implant System is intended for the replacement of one or more missing teeth in the upper or lower jaw in order to restore a patient's lost function of chewing. (15, 16)

The change in the level of the marginal bone in the first year after implant placement should not be higher than 1 to 1.5 mm. (17) The measured arithmetic mean of bone loss around the implant from the mesial, distal, vestibular and oral sides was less than the specified critical values. The mean value of crestal bone loss after one year was 0.80 mm, specifically 0.88 mm for 170 implants placed in the maxilla, and 0.75 mm for 112 implants placed in the mandible. These results to some extent match with the research of Ajanović *et al*, who obtained average values of resorption of 0.47 mm to 0.67 mm in the maxilla, and 0.48 to 0.96 mm in the mandible. They did not find any statistically significant difference in bone loss between maxillary and mandibular implants. They conducted measurements around implants Bredent blueSKY® with a diameter of 4.0 x 8 mm and 3.5 x 10 mm. The measured mean level of resorption around dental implants with a diameter of 4.0 x 8 mm was lower than around those with a diameter of 3.5 x 10 mm, but the difference was not statistically significant. (18)

In this research, measurements were conducted for implants with a replaceable platform. Numerous authors find lower values of crestal bone loss in implants with a replaceable platform than in implants with a conventional platform. (19-21) On the other hand, Pan *et al* obtained higher values of crestal bone loss with implants having a replaceable platform than with a conventional platform at 6, 12, and 36 months after the implant placement. The value of the vertical loss of marginal bone after one year was: 0.99 ± 0.95 for implants with a replaceable platform and 0.89 ± 0.58 mm for implants with a conventional platform. The horizontal bone loss for implants with a replaceable platform and conventional platform were 1.16 ± 0.59 and 1.00 ± 0.51 mm, respectively. (22) Therefore, the type of platform can be an additional significant factor influencing the remodeling of the crestal bone.

Rasouli *et al* in their research conducted on Nobel Biocera implants reached the result that the total resorption was 0.935 mm, therefore slightly higher resorption than in our research. For the distal crestal resorption, they obtained a value of 0.688 mm, and the mesial resorption was 0.665 mm. However, there is no statistically significant difference between those values. In addition, they did not find a statistically significant difference in relation to the implant position, bone quality, region of implantation, implant design and technique of bone augmentation that was used. (23) Other authors also do not find a difference between mesial and distal resorption. (18, 24, 25) The values of distal resorption in our research totaled 0.93 mm, while the smallest resorption was on the vestibular side of the implant (0.63 mm). With regards to augmentation techniques, the resorption following the sinus lift with augmentation was the highest (1.23 mm), while the lowest was with implantation without augmentation. Kim *et al* state that local procedures of bone grafting may provide an adequate quantity of bone for the implant placement, but it should be taken into consideration that the pattern of resorption, especially in the front part of the maxilla, is unpredictable and individual. In their research, sinus lift surgery with augmentation did not demonstrate a connection with an increased risk factor for implant cancellation, unlike other risk factors, such as for example smoking habits. (26)

Conclusion

Based on the conducted measurements, a conclusion was reached that the annual loss of the crestal bone is 0.81 mm. Thereby, each of those

implants is successfully osseo-integrated and functionally loaded. Regarding the bone loss towards the sides of the implant, the results show that the greatest bone loss is on the distal side of the implant. Measurements of the bone loss were conducted according to the position of the implant in jaws. The greatest loss of crestal bone is in the positions where molars are located, both in the upper and lower jaw. A greater quantity of resorption is in the upper jaw than in the lower jaw.

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