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STANDARD METHOD OF IMPLANT PLACEMENT. A RETROSPECTIVE STUDY OF THE SUCCESS RATE OF STANDART MID-SIZED IMPLANTS PLACED IN THE MANDIBLE, AT A PERIOD OF MORE THAN 7 YEARS POST IMPLANT PLACEMENT

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ABSTRACT

The present study is focused on the particularities of the standard implant placement protocol, emphasizing the results of the treatment in dynamics, evaluated according to the succes criteria established by Alrektsson et al. **Aim of the study:** Evaluation of implant-prosthetic rehabilitation results over time, by approaching the standard implant placement protocol. **Material and Method:** The retrospective and prospective study (2008-2017) included 110 patients (47 males and 63 females) aged 21-82 years old (mean age – 45,2 years old, SE ± 1,08, SD 11, 35), which addressed for implant-prosthetic rehabilitation. 404 dental implants were inserted into the mandible, in the alveolar ridge with sufficient bone supply, corresponding to type A, B + after Misch, with delayed insertion of the implants (type IV) and delayed functional load. **Results:** Average per patient – 3,7 implants. Average implant sizes: 4,0 mm in diameter and 12.0 mm in length. Resorption: 0,31 mm mesial and 0,32 mm distal at the stage of uncovering of the 319 implants; 0,74 mm mesial and 0,75 mm distal at 1 year of function, continuing with a nonessential resorption in the following years, stabilized around the depth of 1 mm at 5 years and more than 7 years. **Conclusion:** The conventional implantation protocol is predictable, with favorable results over time, with a high rate of implant success over a surveillance period of over 7 years.

Keywords: dental implants, standard protocol, mandibular, resorption, success rate.

INTRODUCTION

Tooth loss is the basic phenomenon of dental morbidity. In addition to a whole range of causes of tooth loss, such as complications of dental caries, trauma, developmental defects or genetic disorders, the most common cause remains periodontal disease [4]. Once the teeth are lost, the dimensions of the alveolar bone are considerably reduced due to the lack of physiological stress (Wolf's law), due to the masticatory pressures and, last but not least, due to the trauma during the actual extraction, if this occurred [10]. The degree of atrophy depends and is directly proportional to the post-surgical time elapsed until implant-prosthetic rehabilitation. With reference to the degree of atrophy, Misch classifies the edentulous ridge into 4 types [8, 10]:

1. Type A — sufficient bone with a width > 6 mm, height > 12 mm, available space for crown ≤ 15 mm;

2. Type B —available bone is at the limit, divided into 2 groups B + (width 4-6 mm) and B-w (width 2,5-4 mm), height > 12 mm, available space for crown < 15 mm;

3. Type C — insufficient bone vertically (C-h height < 12 mm) or horizontally (C-w 0-2,5 mm), occlusal angulation > 30^0, coronary space > 15 mm;

4. Type D — complete atrophy of the alveolar ridge accompanied by basilar edge

atrophy, flat maxilla, thin blade type mandible, available crown space > 20 mm.

Subclass A corresponds to available bone, sufficient in all sizes. As the bone is resorbed, the available bone width is first reduced from the vestibular surface. The cortical bone is thicker on the lingual surface of the alveolar bone, especially in the mandible. During the first 3 years after tooth extraction, the bone width is reduced by about 40%. Subclass B offers enough available bone. As the bone resorption occurs first in bone width and then in height, subclass B continues to resorb in width and becomes insufficient to insert implants. This procedure continues and the available bone then decreases in height. Once the bone has lowered its height, the basal bone begins to decrease in turn in width. The available bone of subclass C is deficient in one or more dimensions (width, length, height, angulation, or crown/implant ratio). Thus, long-term bone resorption can lead to complete loss of the alveolar bone, accompanied by basal bone atrophy. The clinical status of the alveolar crest of subclass D is described by severe atrophy. Loss of the basal bone leads to a completely smooth maxilla or to a pencil mandible. The nasal spine and palate resorption may occur at the maxilla up to the zigomatic-alveolar ridge. The mandibular arch can present with the mental foramen and parts of the mandibular canal on the ridge crest [10].

The rehabilitation of edentulous patients has been dominated in the recent years by the use of dental implants, replacing classical methods, which include fixed and mobile prostheses. The poor performance of the latter, with it's consequences, compared to the high success rate and the favorable prognosis of the dental implantation procedures, are at the basis of a vertiginous development of the already well-known scientific concept, named implant-prosthetic rehabilitation. In the context of this concept, predictive clinical results are based on the principle of osteointegration, a term introduced for the first time by Brånemark et al. in 1960 and used to explain the stable fixation of titanium to bone [6].

Implant-prosthetic rehabilitation involves both the installation of endoosal implants and the subsequent manufacture of the prosthetic superstructures. Compared to the classical methods, implant-prosthetic rehabilitation presents a number of major advantages, including: increased stability of prosthetic structures; high functionality in speech and mastication; reduced rate of resorption of alveolar ridges over time; the natural restoration of physionomical function; prevention of occlusal dysfunctions by horizontal or vertical migrations of the remaining teeth [10]. There is a large number of studies regarding dental implants, especially reffering to their variety and indications of use. In addition to the constructive and componential features of an implant, which directly influence the success rate of rehabilitation with dental implants, Albrektsson, Zarb, Worthington and Eriksson proposed in 1986 the well-known 5 criteria of implant success. We recall them, with the purpose of highlighting the importance of their knowledge and their ongoing applicability. Thus, these are:

1. An individual, unattached is immobile when tested clinically;
2. That a radiograph does not demonstrate any evidence of peri-implant radiolucency;
3. The vertical bone loss be less than 0,2 mm annually following the implant's first year of service;
4. That individual implant performance be characterized by an absence of persistent and/or irreversible signs and symptoms such as pain, infections, neuropathies, paresthesia or violation of the mandibular canal;
5. That, in the context of the above, a successful rate of 85% at the end of a five-

year observation period and 80% at the end of a ten-year period be a minimum criterion for success [1].

The implant success rate is in direct relation to the implantation method chosen or dictated most often by the diversity of clinical situations in which the state of the edentulous stomatognathic system is characterized by varying degrees of bone tissue atrophy and unfavorable gingival biotypes. In a relatively large number of cases, these tissue biotypes create difficulties or even the impossibility of an implant-prosthetic rehabilitation. This includes the presence of posttraumatic, postoperative defects, congenital malformations, etc. Speciality studies demonstrate that according to the Albrektsson et al. implant success criteria listed above, under the conditions of sufficient/favorable bone supply (types A and B + according to Misch classification), implantation using standard implants guarantees the best prognosis in time. As a result of our own clinical experience, we have come to the same conclusion. Moreover, during the study process of a relatively diverse and large number of clinical cases which underwent implant-prosthetic rehabilitation, we allowed ourselves to differentiate the implantation process into two distinct categories. Thus, we will refer to the implantation under conditions of sufficient bone supply, with the use of standard mid-size implants as to standard implantation method, and to the implantation under conditions of bone insufficiency, with or without bone reconstruction and the use of undersized or angled implants as to alternative implantation method. In the present study we will elucidate the particularities of the standard implantation protocol with emphasizing the outcomes of the treatment in dynamics, evaluating them according to the known criteria of the implant success rate.

Aim of the study: Evaluation of the implant-prosthetic rehabilitation results over time, by approaching the standard implant placement protocol.

MATERIAL AND METHOD

In this retrospective and prospective study were included 110 patients (47 men and 63 women) aged 21 to 82 years old (mean age – 45,2 years old, SE ± 1,08; SD 11,35) who were addressed to the "Omni Dent" Dental Clinic (Chisinau, Republic of Moldova) for implant-prosthetic rehabilitation during the 2008-2017 years. The criteria of inclusion in the study were: the presence in the pacients of single-tooth edentations, partial extended and complete edentations in the mandible, with edentulous alveolar ridges with sufficient bone supply corresponding to type A, B + after Misch with delayed insertion of implants (type IV) and postponed functional load; overall good health; satisfactory oral hygiene; older than 18 years of age; informed consent given by the patients for examination in dynamics and the use of data in scientific studies. Exclusion criteria from the study were: general and local contraindications to planned surgeries, as well as patients' disagreement on the use of study data. All patients enrolled in the study were informed and signed the agreement to enroll in the study.

The distribution of patients and implants was studied through descriptive statistical analyzes. There were calculated values of the quantitative and qualitative variables (sex, patient age, peri-implant bone resorption), standard deviation, median values, confidence interval (CI), and implant-related variables (insertion site, surgical protocol, bone quantity and quality, length and diameter of the implant). To the peri-implant bone resorption was given a basic role, considered to be an important criterion in

determining the prognosis of treatment and the rate of implant success. Resorption data were analyzed on OPG images by examining the peri-implant bone apposition/resorption from mesial and distal (Figure 1) at the ridge level, using the method proposed by the authors, based on the size adjusted for the known size of the implant [14, 15]. The resorption level was established at different postimplantar periods as well as after functional loading. The whole calculus was performed using a statistical sheet (Excel 2016®, Microsoft, Redmond, WA, USA).

Clinical and paraclinical preoperative examination. Patients were examined, subjective and objective, thus establishing the diagnosis and treatment plan. Similarly, ambulatory medical records were studied and radiological investigations (OPG) were performed in order to obtain a complete information and perform the calculus required for the study. At the beginning of the study (2008-2012) radiological planning was performed only on the basis of OPG image [3, 9, 11, 13]. With the onset of computed tomography (CBCT), it has begun to be performed in all new enrolled patients, but also in those already present in the study, at the following stages of dynamic examination. Computed tomographies (CBCT) were performed with the three-dimensional evaluation of the radiographic bone anatomy in order to gather more detailed information. The three-dimensional evaluation was performed with the SIRONA Ortophos SL, with a minimum dose of irradiation. CBCT data was analyzed in the Sidexis 4.0 program. Implant insertion planning was done in the Galaxis / Galileos Implant program. This program has given us the opportunity to plan in detail the number, angulation, diameter and length of the implants, taking into account the quantity and quality of available bone, adjacent anatomical structures, antagonist teeth, surgical versus optimal orthopedic position of implants insertion. In some patients, planning was complemented by photographic examination, analysis of study casts and/or performing surgical templates.

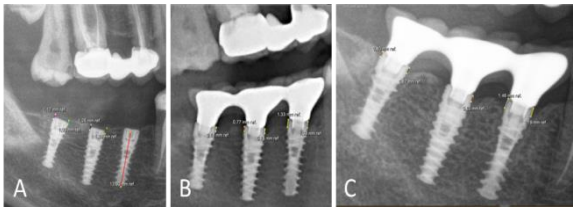

Figure 1. Measurements of peri-implant apposition/resorption, from mesial and distal. A) OPG image at the implant uncovering, 6 months postimplantation (implant size adjustment at the level of the 45 tooth; the presence of bone apposition from mesial and distal to implants at the level of 46, 47 teeth; the absence of apposition/resorption at the implant level of the 45 tooth); B) OPG image of the implant-prosthetic denture at 1 year of functional loading (the presence of insignificant resorption from mesial and distal at the level of all the implants); C) OPG image of the implant-prosthetic dentures at 5 years of functional loading (the peri-implant resorption level observed in all implants is maintained constant compared to it's level at 1 year of functional loading, a phenomenon corresponding to the formation of the biological space, also demonstrated by the visible remodeling of the interimplant bone).

Used implants: 404 dental implants were inserted into the mandible, out of which 39 were Dentium Superline (South Korea) and 365 AB (Israel). In all clinical cases In all of the clinical cases the flap technique (open field insertion, incision and muco-periosteal

flap displacement) was used. In all cases the bone supply was sufficient, so no bone addition was required, allowing the use of standard implant placement protocol.

The dimensions of the implants are various, but in this study we used the sizes shown in Table 1: length – 8,0 mm (20); 10,0 mm (106); 11,5 mm (112); 12,0 mm (21); 13,0 mm (144); 16,0 mm (1) and diameter - 3,5 mm (3); 3,6 mm (5); 3,75 mm (182); 4,0 mm (21); 4,2 mm (161); 4,5 mm (12); 5,0 mm (20). The statistical analysis of these data gave us the following information: the minimum diameter was 3,5 mm; maximum was 5,0 mm; standard mean value – 4,0 mm; SE ± 0,03; SD 0,28; the minimum length was 8,0 mm and maximum 16,0 mm; standard mean value – 12,0 mm; SE ± 0,11; DS 1,14. Evaluating these data with reference to the length and diameter of the implants used in the study, we can state that the standard mean diameter of 4,0 mm and length of 12,0 mm are within the standard mean values of the standard implant placement protocol concept. The implants with a length of 8,0 mm were considered short implants until the ITI Consensus Conference from 2015 [12], currently being considered standard length implants. A number of 20 implants with 8,0 mm diameter, which account for only 5,0 % of all the implants in the study, do not affect the results of the study, the same as 8 narrow implants, which account for only 2,0 % neither affect the results of this study. Narrow and short implants were not used unitarily in this study, but only in combination with implants of longer length and diameter and were necessary in order to solve certain clinical situations of insufficient bone supply.

We emphasize that the low number of undersized implants and their use only in combination with the standard mid-sized ones can not influence the criteria for assessing standard size implant use.

The implants were inserted in accordance with the implantation requirements, respecting both the ratio of bone width to implant diameter as well as the implant length to the bone crest height [11,18].

Surgical protocol: All patients were pre-treated before intervention (professional hygiene, treatment of caries and their complications). Preoperative patients were given oral baths with antiseptic solutions and also antibiotics for the prophylaxis of infectious complications. In all patients, insertion of implants was performed under local anesthesia with a 4% articaine solution supplemented with epinephrine (1: 100 000).

In postponed implantation in a healed alveolar ridge (type IV), illustrated in the clinical cases of Figures 2 and 3, the alveolar crest exposure was performed through a wide incision in the middle of it, supplemented with two vertical incisions of clearance. In this context, we prefer the incisions made without traversing the gingival sulcus, in order not to disturb the morphology of the structural elements of the gingival sulcus and not to allow the dissemination of the infection from this level to the operating field. The muco-periosteal flap displacement is performed sufficiently to provide an optimal visual field for further surgical manipulation. The neoalveola creation is initially done with a 2.0 mm drill. Thereafter, increased diameter drills are used, as indicated by the manufacturer of the implant system. The final drill depends on the anatomical situation (available quantity and quality of bone), in this way the neoalveola can be created with bone underpreparation (density D4) or overpreparation (density D1). To avoid overheating, at 500-600 t/min irrigation with saline solution is done.

Irrigation is omitted during the use of the last drill at 50 t/min, but also when extracting the drill from the neoalveola, in order to enable the collection of bone chips from its surface [10]. Figure 2 shows a clinical case in which AB implants were used, while Figure 3 shows the use of Dentium implants (SuperLine).

Depending on the clinical situation, different lengths and diameters of the implant may be used. In all cases insertion of the implants was performed with the physiodispenser, which allows a precision control of the force of the torque. In case of obtaining a torque <40 N/cm the covering screw or the healing screw was applied, the wound was sutured and the loading was postponed. When the insertion torque is > 50 N/cm, in order to prevent bone compression and implant block, it is recommended to perform reverse rotations using the manual wrench. Subsequently, for the complete insertion of the implant, we continue to use the manual wrench, alternating the direction (twisting in/detwisting) or even widening the neoalveola, using a larger diameter drill. Depending on the predetermined treatment plan, each of the patients was inserted from one to twelve implants.

All patients were prescribed antimicrobial treatment (amoxicillin + clavulanic acid, 1 g twice a day, for 5 days), antimycotic treatment (0,15 g on the 3rd day), analgesic (depending on the pain degree) and vasoconstrictor medication (nasal spray, 2-3 times a day, for 2-3 days) in cases of sinusitis. Similarly, oral baths with solutions containing 0.12% chlorhexidine, 2-3 times a day, were recommended for the entire healing period. For each patient, the first control visit for the dynamic examination was scheduled 24 hours after surgery. Totally edentulous patients having mobile prosthetis dentures were recommended not to wear them after implantation.

During the second stage, after the osteointegration period, the implants were uncovered, with the placement of healing screws or temporary crowns in order to create the gingival profile, with their subsequent change in final prosthetic dentures.

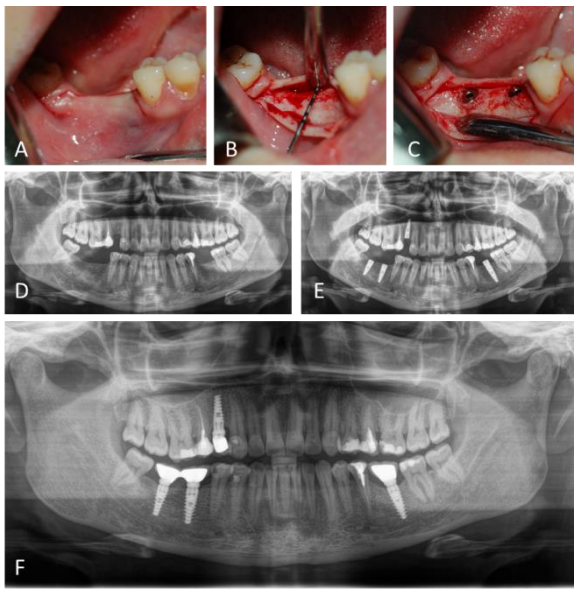

Figure 2. Clinical case of the standard implant placement protocol using AB implants. A) Image of the edentulous mandibular alveolar ridge in the posterior region, after incision; B) Intraoperative image after the mucoperiosteal flap displacement (sufficient alveolar ridge bone supply is determined, sufficient gingival thickness, both subjectively, visually appreciated and objectively, by measurements); C) Insertion of two implants at the level of teeth 46 (length – 13,0 mm, diameter – 4,2 mm) and 47 (length – 11,5 mm, diameter – 4,2 mm), generous bone supply is determined, implants inserted at crestal level; D) preoperative OPG image; E) Immediately postoperative OPG image with the implants inserted; F) OPG image at 5

years of function - the radiological aspect of implant-prosthetic dentures.

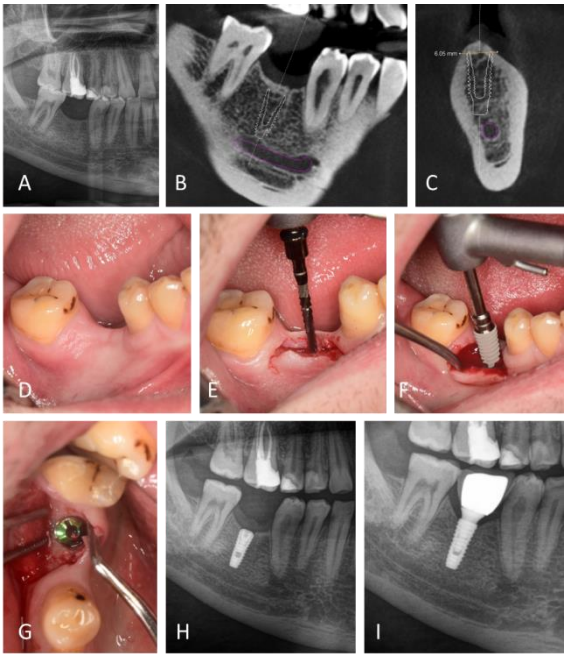

Figure 3. Clinical case of the standard implant placement protocol using the Dentium implant (SuperLine). A) Preoperative OPG image with a single-tooth mandibular edentation at the level of tooth 46; B, C) Images of longitudinal and sagittal CBCT with visible bone morphology and mandibular canal, consequent planning of implant dimensions, position and angulation; D) Image of edentulous mandibular alveolar ridge in the posterior region; E) Intraoperative image, after the mucoperiosteal flap displacement - marking the site of neoalveola creation and initiation of the drilling; F) The insertion of the implant at the level of tooth 46 (length – 12,0 mm, diameter – 4,0 mm); G) Intraoperative image after insertion of the implant and application of the covering screw; H) Postoperative OPG image, immediately postimplantation; I) OPG image at 3 years of function - the radiological aspect of the implant-prosthetic denture.

RESULTS AND DISCUSSIONS

A total of 404 implants were inserted into the mandible, following the standard implant placement protocol, under a sufficient bone supply, in mature, healed bone type IV, with delayed functional loading.

Out of the total of 404 implants, the average per patient was 3,7. There is a correlation between several authors' opinions, which we have determined from several studies and which presents the relationship between variables: age, type of edentation, bone offer, number and size of implants required for implant-prosthetic rehabilitation. According to these, for the middle-aged patients prevail moderate extensive edentations, with sufficient bone supply, that allow insertion of standard implants. We have established the same relationships between these variables in the present study, as a proof serving the mean number of implants calculated per patient. Therefore, the average implant size used corresponds to similar researches and is 4,0 mm in diameter and 12,0 mm in length. This average falls within the standard implant placement protocol proposed by C. Misch. The implant size range and frequency of use are shown in Figure 3, while the totals per length and diameter, as well as the number of implants with small/medium/large diameter and small/medium/ long lengths are shown more representative in Table1.

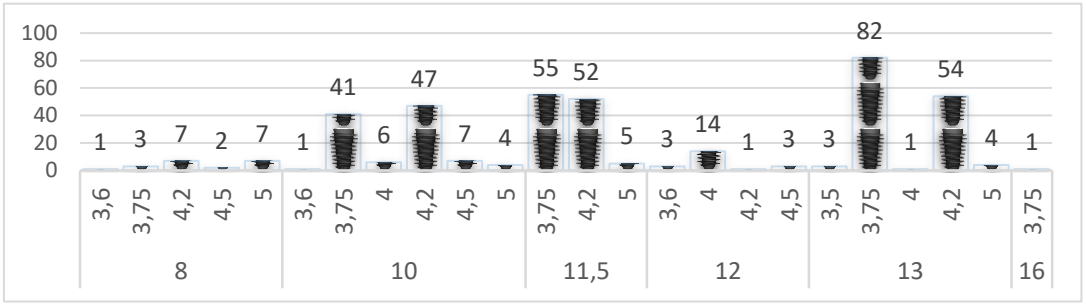

Figure 4. Distribution of the implants by length and diameter.

Figure 4 shows a quantitative representation of the number of implants inserted according to the length and diameter and allows us to analyze implant distribution according to the available bone supply. In our study, the most commonly used implant sizes (diameter/length) were: 3,75 mm/10,0 mm; 3,75 mm/11,5 mm; 3,75 mm/13,0 mm; 4,2 mm/10,0 mm; 4,2 mm/11,5 mm; 4,2 mm/ 13,0 mm. From the diagram in Figure 4, we can see that the short 8,0 mm and the long 16,0 mm implants are used less frequently, as well as those with small diameters, such as 3,5; 3,6 mm and 4,5; 5,0 mm.

By explaining the results from Table 1, which are color coded, we can state that a total of 377 (93,0%) standard medium-sized implants were inserted under the conditions of sufficient bone supply, while the others, the undersized once, completed the treatment plan in the expected implant-prosthetic reconstruction. These data confirm again, objectively, the anteriorly mentioned assertions that in this study, because of the prevalence of younger patients, the rehabilitation processes were performed predominantly by conventional implantation, using standard medium-sized implants, in a sufficient bone supply, without the need of bone growth.

Table 1. Correlation between diameter and length of the implants

Implant diameter/ length (mm)	3,5	3,6	3,75	4	4,2	4,5	5	Total
8		1	3		7	2	7	20
10		1	41	6	47	7	4	106
11,5			55		52		5	112
12		3		14	1	3		21
13	3		82	1	54		4	144
16			1					1
Total	**3**	**5**	**182**	**21**	**161**	**12**	**20**	**404**

Legend: The colors in the table are the following: red - thin and short implants; brown - total number of thin implants; yellow - total number of short implants; light green - the most commonly used implants of standard mid-size; dark green - total number of implants of standard mid-sizes, by diameter and length.

The distribution of the implants according to their position in the mandible, depending basicly on the position of the tooth where they were inserted, from 1 to 7, is represented in Figure 5. Out of the total of 404 implants inserted into the mandible, the most (in decreasing order) were inserted at the level of teeth 6 (157 implants); 7 (105 implants); 5 (75 implants); and the fewest implants were inserted at the level of the tooth 4 (39 implants); 3 (17 implants); 2 (11 implants) and no implant inserted at the level of tooth 1. The insertion of implants in the lateral regions of the mandible is performed more

frequently, this being determined by the higher prevalence of edentations at this level. The functional load in the lateral regions is greater, causing premature tooth loss, so there appears a cause/effect logical correlation between the frequency of the edentation and a larger number of implants inserted at this level.

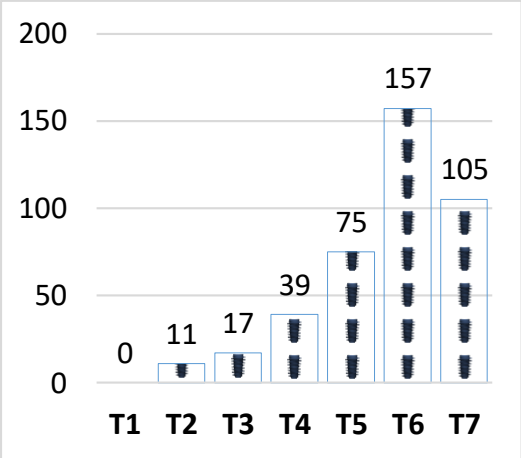

Figure 5. Distribution of the inserted implants in the mandible, depending on the position of tooth.

According to the results from the analysis in Figure 5 we determined that the insertion of the largest number of implants was achieved at the level of tooth 6, followed by the tooth 7 and 5. Continuing the analysis of the results with reference to the implants inserted in the mandible at the level of tooth 6, we can explain the greater number of implants inserted at this mandibular level by an assumption, namely that the mandible teeth 6 are lost more frequently, for various reasons, thus requiring to be rehabilitated in larger numbers.

In a qualitative aspect, he mandibular bone has a bone density D1 in the anterior region, decreasing to the distal, from D2 to D3. We support these data from the perspective of the obtained results, thus density D2 was established at the insertion of 237 implants, and D3 at 167 implants. These data are in direct correlation with the larger number of implants located in the lateral mandibular regions. In quantitative terms, the edentulous alveolar crest showed the following sizes: between 8,1 mm and 19,2 mm, with an average of 13,91 mm in length and between 4,2 mm and 8,3 mm with an average of 5,9 mm in width. These data are within the limits of sufficient bone supply, Class A and B + after Misch. The gingivomucosa on the ridge of the alveolar crest exhibited a varied thickness and width of the keratinized area, comprising the values: 1,0-4,0 mm, with an average of 1,78 mm in thickness and 2,0-7,0 mm, with an average of 3,63 mm in width, these values being characteristic for a favorable mucogingival supply.

The delayed application of the healing screws with delayed implant loading was performed in all 404 implants in the study. At this stage implant stability was clinically appreciated in all study implants, but also through periotest values, appreciating values from -1 to -8, with an average of -5,13 units. These values show good implant stability, characteristic for optimal osteointegration of the implants.

At the osteointegration stage, out of 404 inserted implants, we studied the resorption at 319 of them, in patients who addressed for the second stage, after implantation. We continued to determine the peri-implant resorption after one year of function for 181 implants, after 3 years for 146 and after 7 years respectively for 51 implants. The average of the addressability period for the second stage (the osteointegration period) was 9.08 months. For the detection and measurement of the peri-implant resorption using the Sidexis 4.0 measuring instrument, we measured the medial and distal resorption level from the platform of each implant to the deepest point of the radiographically visible area of radiotransparency from the panoramic

radiograph (OPG). The data obtained at these time intervals are shown in Table 2.

Analyzing the data from this table, we note that out of 404 implants studied, the majority, in a number of 319 (78.96%) were analyzed at the next stage, after which was attested a decrease in the number of implants analyzed, proportional to the increase of the postimplantation monitoring period. The second step determines both bone apposition and peri-implant resorption. At the second surgical stage (at the displacement of the mucoperiosteal flap for the application of healing screws), bone apposition was clinically evaluated in 96 (30,1%) implants from the mesial and 92 (28,8%) implants from the distal out of the total of 319 implants studied. Bone apposition can be explained by intraoperative trauma, the presence of small bone fragments, the subcrestal insertion of implants in non-uniform alveolar ridges at the crest level, all of which have a role in stimulating osteogenesis, which has resulted in bone growth above the implants, with a maximum of 2,47 mm mesial and 2,32 mm distal. The mean value of apposition above implants is 1,18 mm mesial and 1,17 mm distal and the average for all implants studied is 0,35 mm mesial and 0,33 mm distal, respectively. In this way we can conclude that 1/3 of the implants were covered by bone in the second stage. In some cases, the bone formed had a thickness greater than 2 mm, which required milling it, causing a new surgical trauma, which required extra time, additional tools and could damage the edge of the implant, or even serve as a subsequent peri-implant resorption factor.

Table 2. Peri-implant apposition/resorption follow-up

	6 months (osteointegration period)				1 year of function		3 years		5 years		> 7 years	
	Apposition		Resorption		Resorption		Resorption		Resorption		Resorption	
	mesial	distal	mesial	distal	mesial	distal	mesial	distal	mesial	distal	mesial	distal
No. of examined implants	319	319	319	319	182	182	181	181	146	146	51	51
No. of implants (Apposition or resorption)	96	92	66	70	117	107	125	113	100	84	33	25
Percentage ratio of all implants with resorption/apposition to all examined implants	30,1 %	28,8 %	20,7 %	21,9 %	64,3 %	58,8 %	69,1 %	62,4 %	68,5 %	57,5 %	64,7 %	49,1 %
Mean resorption/apposition of the concerned implants (mm)	1,18	1,17	-1,47	-1,48	-1,16	-1,28	-1,29	-1,35	-1,48	-1,56	-1,41	-1,44
Resorption/ Apposition (min)	2,47	2,32	-0,47	-0,37	-0,2	-0,25	-0,03	-0,25	-0,3	-0,21	-0,35	-0,17
Resorption/ Apposition (max)	0	0	-4,57	-3,65	-2,69	-3,18	-5,1	-4,79	-3,54	-3,89	-3,5	-3,64
Mean resorption/apposition reported to all examined implants (mm)	0,35	0,33	-0,31	-0,32	-0,74	-0,75	-0,89	-0,84	-1,01	-0,89	-0,91	-0,71

Analyzing the 319 implants, we noticed that these impediments were predominantly

encountered in (AB) implants with hexagon connection and the covering screw which entirely covers the crestal surface of the implant, which were a total of 281 (88.08%). In Dentium implants, 38 in number (11,91%) with a conical connection with "switch platform" bone apposition did not generate additional osteotomy surgery because the abutment respects the size and configuration of the covering screw at the level of the implant [7]. Apposition at the following stages was not measured, considering the implant platform as the "zero" or the initial plane, us being interested only in resorption. We can not neglect the possible bone growth especially after loading the implants, knowing Wollf's law about function and structure, the peri-implant bone constantly remodeling under the action of masticatory forces. Our attention was though directed to peri-implant resorption. This depends on a multitude of factors, and the determination of these factors, as well as the appreciation of the depth, character, periodicity and other resorption characteristics will highlight prophylaxis and treatment behavior using dental implants. The resorption present at this stage, compared to the apposition, was found in fewer cases. From the mesial it was found in 66 (20.7%) implants, and from distal in 70 (21.9%) implants. The mean resorption value, relative to the implants concerned was 1,47 mm from the mesial and 1,48 mm distal. If we report the average resorption to the total implants in the study, then it is 0,31 mm from the mesial and 0,32 mm distal. The maximum resorption depth analysis was 4,57 mm from the mesial and 3,65 mm distal. The respective depth of resorption occurred in some of the implants who developed complications (mucositis, peri-implantitis) during the osteintegration period [2]. Excluding clinical cases which developed complications and deep resorption, the total mean resorption of up to 0,3 mm denotes a minimal resorption, which may represent a physiological remodeling process, with the formation of biological space. The resorption present at only 1/5 of the implants denotes that under standard implantation conditions the degree of resorption is insignificant, both in frequency and depth.

Our study continued after loading the implants. Analyzing the resorption values during the follow up visits, in comparison to the osteointegration period values we observed a significant change, both in frequency and depth. We noticed the following: over the years, the rate of resorption after functional loading was detected at about 2/3 of the implants, compared to 1/3 which presented resorbtion after the osteointegration period. Also, the depth of resorption progressively increased up until the 5^{th} year after the implant placement, exceeding 1 mm, both from the mesial and the distal. In some implants we also encounter a depth of resorption of up to 5 mm during these examination periods, which is caused by the occurrence of peri-implantitis complications.

Analyzing the data from this study group, referring to the frequency and depth of resorption, we can conclude that it is minimal and does not exceed the values reported in other publications of this type. Moreover, analyzing the mean resorption on the concerned implants, it was revealed that the initial resorption, after the osteointegration period, namely 1,47 mm mesial and 1,48 mm distal, remained practically unchanged during the following periods of examination (1 year , 3 years, 5 years and more than 7 years), which indicates the steady, constant character of bone remodeling changes (Figure 6).

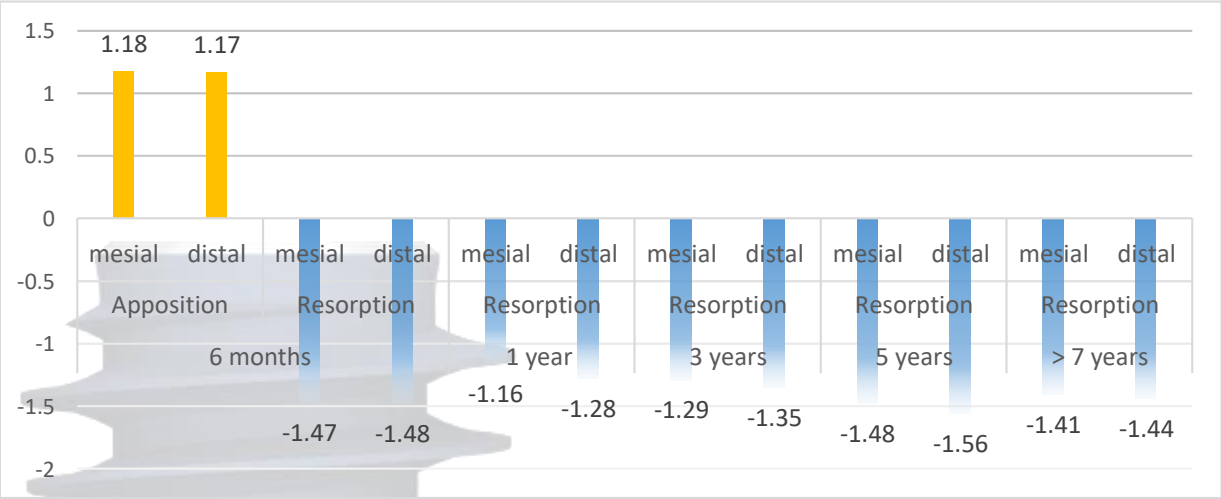

Figure 6. Mean resorption/apposition of the concerned implants (mm), examined in dynamics, determined from mesial and distal

A more clear idea can be made out of the diagram in Figure 7, which illustrates the average resorption/apposition concerning all examined 404 implants (mm) analysed during follow up visits, determined from mesial to distal and where we found a progressive increase in resorption dynamics from 0,31 mm mesial and 0,32 mm distal at the implant uncovering stage, 0,74 mm mesial and 0,75 mm distal 1 year after implantation, continuing with nonessential resorption in the following years, and stabilizing around the depth 1 to 5 mm in more than 7 years. We believe that this is due to the peri-implant bone remodeling phenomenon over time. Moreover, the minimal resorption attested in this study allows us to assume a good osteointegration of the studied implants, with a favorable prognosis over time, due in our opinion to the generous supply of bone and mucogingiva, the use of standard mid-sized implants and compliance with the conventional implantation protocol.

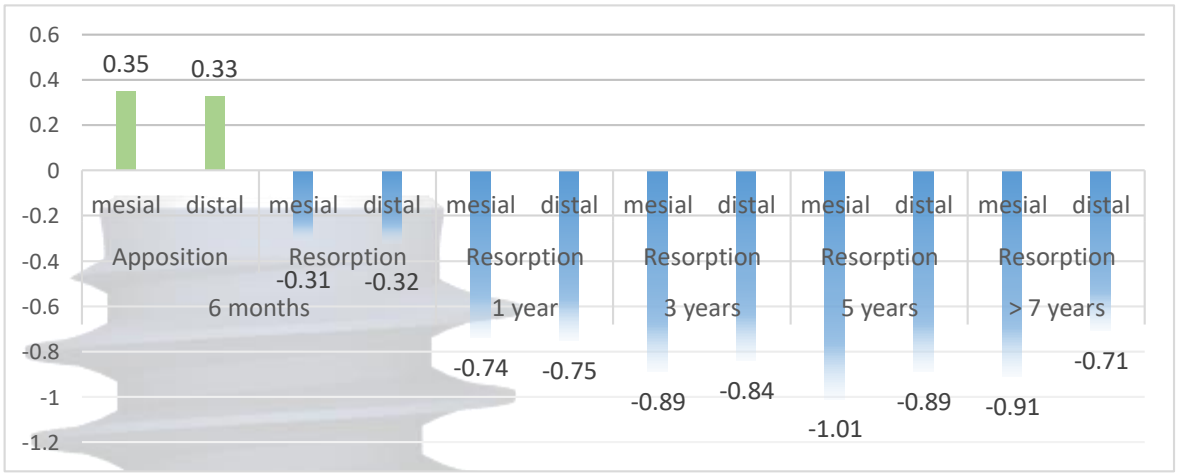

Figure 7. Mean resorption/apposition of the total implants (mm), examined in dynamics, determined from mesial and distal

During the studied period, there were no lost implants, but there occured biological complications (mucositis, peri-implantitis) caused by either poor hygiene, inadequate

adaptation of the implant-supported restoration, residual cement around implant-supported restorations, or the presence of bone pockets at the neighboring teeth affected by periodontal disease [2, 5]. These complications occurred in 43 (10,6%) implants out of the total of 404 studied. These 10,6% of complicated implants served to increase the depth of peri-implantitis resorption, reaching a maximum of 5,1 mm.

Analyzing the results of the overall treatment with the use of standard implantation from the point of view of the 5 criteria of implant success proposed by Albrektsson, Zarb, Worthington and Eriksson since 1986, we obtained the following data:

1. During the clinical examination, no implant mobility was detected;
2. Peri-implant radiotransparency space was determined at the crestal level from the mesial at 20,7% implants and from the distal at 21,9% implants, at a depth of 0,33 mm mesial and 0,31 mm distal, appreciated at the uncovering of implants, after the osteointegration period;
3. After the first year, vertical bone loss constituted 0,74 mm from mesial and 0,75 mm from distal, with a difference of 0,4 mm from the previous stage, being a minimal bone loss characteristic for the formation of biological space;
4. The function of each individual implant was characterized by the absence of any persistent and/or irreversible signs and symptoms pain, infection, neuropathy, paraesthesia, or violation of inferior alveolar neurovascular (IAN) bundle;
5. Based on these criteria, the survival rate in this study constituted 100% at the end of a 5-year dynamic follow-up and remained unchanged for more than 7 years, the overall success rate being 89,4%.

Clinical cases for which is done additional pre- and/or proimplantation interventions for bone reconstruction and soft tissue volume gaining, with immediate or delayed implantation, as well as clinical cases for the rehabilitation of which it is possible to use only implants, either undersized or angulated, are to be analyzed and incorporated into a separate study, to which we will refer in another article. This approach is required by the greater complexity of treatment in such circumstances, with a number of distinct features such as: special working conditions, additional tools, additional skills of the surgeon, etc., which deserve a separate analysis.

CONCLUSIONS

1. The conventional implantation protocol is predictable, with favorable results over time, with a high rate of implant success, in the present study representing 100% over a surveillance period of more than 7 years.
2. Resorption correlated to the total of implants in the study (404) was manifested by a progressive increase in dynamics, from 0,31 mm mesial and 0,32 mm distal upon uncovering of the 319 implants from a total of 404, to 0,74 mm mesial and 0,75 mm distal 1 year after implantation, continuing with nonessential resorption in the following years, stabilizing around a depth of 1 mm to 5 years and more than 7 years.
3. The peri-implant resorption in the standard implantation, determined in this study, evaluated in these implants indicates that the initial resorption after the osteointegration period, namely 1,47 mm mesial and 1,48 mm distal, remained basically unchanged during the following examination periods (1 year, 3 years, 5 years and over 7 years), which indicates the steady, constant character of bone remodeling changes.

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