RESULTS OF LONG-TERM OBSERVATIONS ON TUBEROPTERYGOID IMPLANTS

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Abstract

The purpose of the study was to generalize our experience of using tuberopterygoid (TPG) implants for prosthetic rehabilitation of patients with partial/ total maxillary/ mandibular adentia under immediate loading protocol. The study describes results of the treatment of 105 patients with total/ partial maxillary/ mandibular adentia, who, during 2012-2019 required dental implantation, which was performed using tuberopterygoid implants in combination with other types of cortico-basal implants, with a follow-up period of 5-2 years. Data was extracted from patient records, panoramic post-op X-rays or from interviews with patients. The employment of TPG implants demonstrates a high implant survival rate (95.7%) within 24-60 months of follow-up period. The high cumulative implant survival rate for TPG implants in immediate loading protocol indicates (within the limitations of this study) the reliability of this treatment approach in patients with partial/ total maxillary/ mandibular adentia, independently on their somatic or local status.

Keywords: total/ partial maxillary/ mandibular adentia, distal maxilla, tuberopterygoid implant, immediate loading.

1. INTRODUCTION

Rehabilitation of patients with distal maxillary adentia still remains one of the most challenging tasks of implantology and maxillofacial surgery. The reason for this is the complex anatomy and topographical vicinity of important structures, such as the maxillary sinus, the nerve and vessel bundles, etc., as well as the progressive resorption of the residual ridge.

Historically, a plethora of surgical techniques have been proposed to restore the atrophic posterior maxilla, including partial or complete osteotomies, bone grafting, sinus floor elevation, zygomatic fixtures, use of short implants etc. Since 1980, when Tulasne [1] described the original technique of placement of pterygoid implants, the engagement of cortical anatomical areas became a matter of interest for many dental practitioners, especially those working in the field of basal or cortical implantology [2-5], and since that period a notion about "Tuberopterygoid" ("Pterygomaxillary", "Pterygoid") implantation has appeared. In the late 1990s, a French implant manufacture, Victory (Nice, France) headed by prof. Scortecci, proposed a special cylindroconical root-form implant Fractal® with crestal emergence diameter of 4.5 mm which required at least 6 mm of bone width at the crest level of the tuberosity and compatibilty for use with any bone density [5]. In type I, II, and III bones, the implant can be screwed into place. In type IV bone, the implant can be impacted (press technique), thanks to the external micro-threads interrupted by four parallel guide channels, and then locked in place by slight rotation (the "press and turn" technique). A little bit later, in 2001, a Swiss implant company - Ihde Dental AG (Gommiswald, Switzerland) - developed its own design of tuberopterygoid implant (STC®/ TPG®), 19-23 mm in length and with a peculiar design of threads that engaged both the spongious bone of maxillary tuberosity and cortical layers of pterygoid process. Moreover, the great clinical success of this type of implants design urged the inventors to develop a shorter version (8-12-15 mm) of TPG® implants for their use in fresh extraction sockets and healed bone.

The purpose of this work was to generalize our own experience on the use of TPG® implants for prosthetic rehabilitation of patients with partial/ total maxillary /mandibular adentia under immediate loading protocol.

2. MATERIALS AND METHODS

Patients' characteristics. The study describes the long-term results of the treatment of 105 patients with total/ partial maxillary/ mandibular adentia, who addressed the Department of Surgical Dentistry and Maxillofacial Surgery of Lviv National Medical University during 2012-2019 regarding dental implantation done using TPG® (Ihde Dental AG, Switzerland) tuberopterygoid implants. The follow-up period for the patients was 5-2 years. 36 of them (34.3%) were males and 69 (65.7%) were females; the average age of patients was 30-86 (mean value 58.12±12.17) years. 12 (11.4%) of the patients were suffering from hypertension, and 3 (2.8%) - from *Diabetes mellitus*. 11 (10.4%) of the patients were smokers (1-2 packs per day) - Table 1. Criteria for inclusion in the study were: partial or complete defects of the dentition of the upper or lower jaw and presence of a sufficient number of teeth on the antagonizing jaw, to ensure full occlusion during installation of a fixed prosthetic structure. Features of the dental status of patients at the time of treatment are listed in Table 2. No patient was excluded from the study due to age, somatic pathology, "lack of bone tissue", etc. In cases of patients who had teeth with deep carious or periodontal lesions located at potential implant sites in accordance with the principles of Strategic Implant®, or elongated teeth on the opposite jaw, which prevented provision of the adequate occlusal plane, they were informed about the necessity to remove them. All patients were informed about the alternative treatment options, including bone augmentation techniques, sinus lifting, two-stage implantation with delayed loading, etc., and signed informed written consents for treatment in accordance with the concept of Strategic Implant®, in particular with the use of TPG® (Ihde Dental AG, Switzerland) tuberopterygoid implants.

Table 1. Patient's characteristics

Number of patients	105	
Number of implants	234	
Age	30-86 (58.12±12.17)	
Gender		
Male	36	34.3 %
Female	69	65.7%
Hypertension		
Yes	12	11.4 %
No	93	88.6 %
Diabetes		
Yes	3	2.8 %
No	102	97.2 %
Smoking		
Yes	11	10.4 %
No	94	89.6 %

Table 2. Peculiarities of local dental status of patients on admission

Local dental status	**Number of patients**	%
Total maxillary adentia	15	14.3
Total mandibular adentia	2	1.9
Free-end (uni-, bilateral) maxillary defects	37	3.2
Free-end (uni-, bilateral) mandibular defects	0	-
Bounded maxillary defects	31	29.5
Bounded mandibular defects	1	0.95
Generalized aggressive maxillary periodontitis	18	17.1
Generalized aggressive mandibular periodontitis	1	0.95
Single tooth defects	0	-

Implant characteristics. To replace partial or complete defects of the dentition of each patient we used tuberopterygoid implants TPG® (Ihde Dental AG, Switzerland) in combination with other

types of cortico-basal implants - KOS®, BCS®, TPG® Uno (Ihde Dental AG, Switzerland), at the choice of the treatment provider. TPG®implants are compression screw implants with a machined surface and a double-featured intraosseous part – consisting of a thick aggressively threaded proximal zone for fixation in the spongy bone/ extraction sockets and thin compressively threaded apical part for fixation in the cortical/ basal bone. The diameter of TPG®implants is 4.1 mm, and the length varies from 8 to 23 mm. For these implants, a number of abutment options are provided to establish cement or screw fixation of the prosthetic structure. In this study, TPG® implants were used predominantly in the tuberopterygoid - 169 (72.2%) and upper premolar area - 20 (8.5%), much less often - in the distal parts of the mandible - 2 (0.85%), and in the body of the zygoma - 1 (0.43%). In 2 patients, total rehabilitation of the upper jaw was performed using only TPG® implants, and in 4 patients - total rehabilitation of the lower jaw (using All-on-6, All-on-7, All-on 8 techniques, respectively) - Table 3. The parameters of the implants used in the study are shown in Table 4. It is obvious that long TPG® implants (17-19-21 mm) were used in the tuberopterygoid area with fixation of their apical part in the cortical layer of the pterygoid processes of the sphenoid bone, while shorter implants (8-12-15 mm) were used in the extraction of sockets or frontal parts of the jaws.

Table 3. TPG® implant's location

Implant's location	**N**	%
Tuberopterygoid area	169	72.22
Area of upper premolars	20	8.5
Zygoma	1	0.43
Distal mandibular area	2	0.85
Total maxilla	14	6.0
Total mandible	28	12.0

Success and failure criteria and data acquisition. After the installation of fixed prosthetic structures, the follow-up examination of patients was performed 3, 6, 9, 12, 18, 24, 36, 48, 60 months after surgery, either in a dental chair, *via* an X-ray examination or by telephone conversation. Criteria for survival and success were: no pain, no mobility, no observed/ reported detectable infection, and no bone loss visible on the panoramic picture. The patients were asked to turn up regularly for follow-up examinations. Not all patients did this during the observation period; however, if they appeared later on for control during the observation period, they were not left out from the study and their last control appointment became the date of last control. All patients ever treated in the clinic were enrolled automatically into the study; however, not all of them were available for clinical or radiological inspection when data for this study was collected. Hence, the reported outcome is based on different observations: X-ray control, clinical inspection, and report of the patient through E-mail or by a phone interview on the following questions:

Do you feel any pain or discomfort in connection to your implants?

Can you eat all the food which you would like without any limitations?

Are you limited in your social or private life due to problems with your teeth/ bridges?

Did your speaking function change and were you able to adapt your speaking function?

On X-rays, the following parameters were observed:

The marginal bone level close to the implants shaft on the panoramic overview picture.

The integration of the load transmitting parts of the implants observed through the visible direct contact between bone and the vertical implant part on the radiograph.

The radiologic observation of the healing of sockets containing implants.

Technique and treatment protocol. In 78 (74.3%) of patients, all implants were placed under local anesthesia, and in 27 (25.7%) under local anesthesia, with sedation provided by anesthesiologist. In cases of placement of 169 TPG® implants in the tuberopterygoid area, the primary aim was anchoring of the load transmitting apical threads in the resorption free second/ third cortical layers of the distal part of the maxillary tuber and pterygoid process of the sphenoid bone, while the aggressive threads of the implant were rigidly fixed in the porous spongious bone of the maxillary tuber. This was achieved by angulation of the drilling direction approx. 45-55° to the Francfort plane and 5-15° to the vertical plane,

according to the morphometric [6-9] and clinical [10-14] investigations of different scientists. Obviously, due to the level of bone atrophy, the size of maxillary sinus and other topographic-anatomic peculiarities of these angulations could differ slightly. In this respect, the findings of Rodriguez *et al*. indicate that a mesiodistal inclination of the pterygoid implant at 70 degrees relative to the Frankfort plane following the bony column of the pterygoid region decreases the non-axial loads of the rehabilitations and exhibits good long-term survival [15].

In the area of upper premolars, placement of TPG® implants was performed toward the nasal floor, taking into account the location of the maxillary sinus. In other situations, TPG® implants were placed directly into extraction sockets after their curettage or in the healed bone, after its sequential drilling with pilot and contouring drills of different diameters. All other kinds of implants used together with TPG® were placed according to the IF Consensus [16]: BCS® implants with obligatory cortical anchorage of the load transmitting thread at least in the second/ third cortical, compression screw implants KOS® - with the primary aim of achieving stability through compression of the trabecular bone along the vertical (endosseous) axis of the implant. Treatment was provided on the basis of panoramic pictures or of computed tomography data.

In all cases, the implants were splinted with a metal-acrylic stable (circular or segmental) bridge within maximum 3-5 days. It is important to emphasize that segment bridges and full bridges in both jaws were installed in full functional loading, according to the prosthetic concept described by Ihde and Ihde [17,18] in a peculiar manner: all TPG® implants had screwing fixation of prosthetics using PA STI castable abutments, while all other implants had cementum fixation (Fuji® Plus, GC, Japan; Cem Implant®, BJM, Israel) of bridgeworks. During every follow-up examination of patients in a dental chair, we checked the reliability of screw fixation of the prosthetic structure on TPG® implants. Replacement of metal-acrylic bridgeworks onto metal-ceramics was performed in 68 (64.8%) patients not less than after 12 months while, in other patients, correction of grinded occlusal surfaces on the acrylic teeth was done.

Statistical methods. To assess the survival and success rate of implants, pairwise comparison, one-way ANOVA test and exact F-test were applied. A 0.05 significance level was selected for comparison between groups. Computation of data was done with a SPSS program, version 25 (Manufacturer: IBM Corp., Armonk, NY, USA).

3. RESULTS

Although different kinds of implants (TPG®, KOS®, BCS®, TPG® Uno) were used in partial/ total maxillary /mandibular rehabilitation of patients, this particular investigation was focused on TPG® implants. Thus, out of the 234 TPG® implants installed, 10 (4.3%) were lost within the 12-18 month follow-up period. The survival rate of other implants was 95.7% within 24-60 months of follow-up - Table 4. Among 10 of the lost implants, 4 (1.7%) were located in the tuberopterygoid area, 2 (0.85%) – in the upper premolars area and 4 (1.7%) – in the frontal maxillary area. A possible reason of failure of TPG® implants in the tuberopterygoid area was the incorrect direction of implants placement, as revealed on post-op OPGs (too horizontal insertion of implants without engaging the corticalized pterygoid processes of the sphenoid bone). A supposed reason of failure of TPG® implants in upper premolars and frontal area was the absence of bicortical fixation in the maxillary sinus or nasal floor, with location of the implants in the spongious bone of the alveolar process. Interestingly, all lost implants were placed into the healed bone, and not into the extraction sockets or in the periodontally compromised areas. Moreover, all patients with lost TPG® implants experienced no clinical symptoms such as pain, discomfort, soft-tissue infection around the implants etc., and no signs of implants disintegration were revealed during control roentgenological investigations 3-6-9 months postoperatively. The failure was confirmed in the stage of changing of temporary prosthetics onto permanent ones 12-18 months after implantation, and was manifested as mobility (rotation) of the implants with notable

"dull" sound on impaction. No differences were found in the failure rate as a function of implants lengths (failed TPG® implants were 21, 19 and 15 mm long) - Table 5. In several patients who had not visited the clinic for control check-up during a long period of time (up to 2 years) due to obvious problems concerned with the pandemic situation worldwide (COVID-19), unwinding of the prosthetics fixating screws (STI) on TPG® implants was revealed, without any negative influence on the stability of implants and segmental or circular temporary bridgework. The signs of 2-3 mm bone loss along implant's shafts were revealed around 16 (6.84%) out of 234 TPG® implants on OPGs performed 12-24 months after implantation, without any visible symptoms of peri-implantitis owing to smooth (machined) implants surface. Moreover, this level of bone resorption was not increased in all these 16 implants even after a 3-5 year follow-up

Table 4. Success rate of 234 TPG® implants depending on their location (n (%))

Area	Number of implants	Radiological follow-up	Clinical inspection as follow-up	Patient report as follow-up
Tuberopterygoid area	169	169 (100)	165 (97.63)	168 (99.4)
Area of upper premolars	20	20 (100)	18 (90)	20 (100)
Zygoma	1	1 (1)	1 (100)	1 (100)
Distal mandibular area	2	2 (100)	2 (100)	2 (100)
Total maxilla	14	13 (92.86)	10 (71.43)	14 (100)
Total mandible	28	28 (100)	28 (100)	28 (100)
Significance (p value) *area depent*		0.996	0.964	0.997

Table 5. Parameters of TPG® implants (mm) and survival rate

Implant's specification	Frequency (n)	Percentage of all (%)	Survival rate (n / %)
4.1/8	2	0.85	2 / 100
4.1/12	19	8.1	19 / 100
4.1/15	8	3.4	7 / 87.5
4.1/17	10	4.3	10 / 100
4.1/19	86	36.75	82 / 95.35
4.1/21	109	46.6	104 / 95.41
Significance (p value) *Length dependt*			0.674

Clinical case

Patient S., born in 1965, was admitted to the Department of Maxillofacial Surgery and Surgical Dentistry at the Lviv Regional Clinical Hospital on July 07, 2018 with complaints of pain in the area of tooth 13, partial adentia on the upper jaw on the left side, difficulty in eating and aesthetic problems. According to the anamnesis, there was a gradual loss of teeth. Objectively, in the area of the upper jaw on the

right side - a metal-ceramic bridge supported by 21,12,13,18 teeth was observed. (Fig.1).

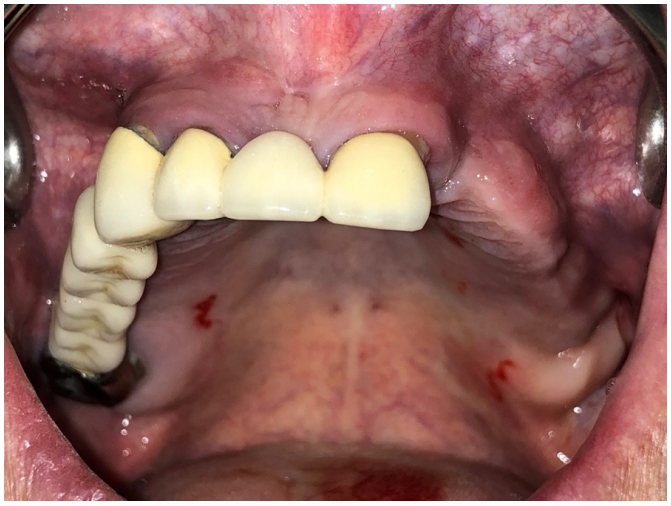

Fig. 1. Intraoral view of the maxilla. Patient S., 56 years

The bridge prosthesis was made 10 years before, so that its current fixation was found unsatisfactory. OPG revealed some periapical changes in the projection of the root of tooth 13, the defect of the maxillary dentition in the form of absence of 17, 16, 15, 14, 11, 22, 23, 24, 25, 26, 27, 28 teeth (Fig. 2). For prosthetic rehabilitation, we recommended the following: extraction of teeth 21, 12, 13, 18, sinus floor elevation on the left side, followed by (after 8-10 months) installation of 6 two-stage cylindrical dental implants in the area of missing 16, 14, 12, 22, 24, 26 teeth; after 6-8 months: installation of an implant-supported metal-ceramic bridge prosthesis. As an alternative treatment plan, it was proposed to remove teeth 21, 12, 13, 18, to install 8 cortical (strategic) implants, namely 6 compression screw implants (KOS®, Ihde Dental AG, Switzerland) anteriorly to the maxillary sinuses, and 2 tuberopterygoid implants (TPG®, Ihde Dental AG, Switzerland) as distal supports, posteriorly to the maxillary sinuses. In this case, no sinus floor elevation was required, and implants could be immediately loaded with temporary metal-acrylic bridge prostheses. Considering the possibility of immediate restoration of the functional and aesthetic status if cortical implants were used, the patient preferred the latter one.

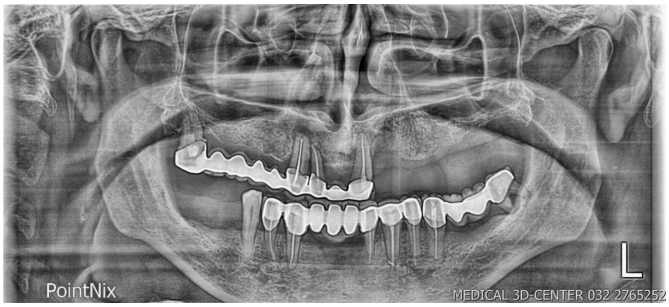

Fig. 2. Pre-operative OPG of patient S., 65 years

According to the principles of bioethics, the patient was informed about the advantages and disadvantages of the method, access and course of the operation, the feasibility of preoperative preparation and local anesthesia, and signed a written consent for surgical treatment. On July 11, 2018 extraction of teeth 21, 12, 13, 18 was performed under local anesthesia and with pre-medication, as well as bone curettage and partial bone reduction in the maxillary frontal area. 6 KOS® implants were placed in the frontal maxillary area in the projection of missing 15, 14, 11, 22, 24, 25 teeth. As distal supports, 2 tuberopterygoid implants TPG® with a diameter of 4.1 mm and a length of 19 mm were used (Fig. 3). Immobilization of the mucoperiosteal flap and wound suturing with Glycolon® 4.0 (Resorba, Germany) were performed. After wound suturing, the transfers were used for transfer molding; the silicone mass Speedex® (Coltene, Switzerland) was used for impressions/ working casts to make a temporary metal-acrylic bridge. Postoperatively, the patient was administered an antibacterial (Dalacin C 300 mg 3 times a day for 3 days), anti-oedema (Dexamethasone 4 mg 2 times daily for 2 days) and analgesic (Dexalgin 0.25 mg if needed) therapy, and oral rinsing with a chlorhexidine solution.

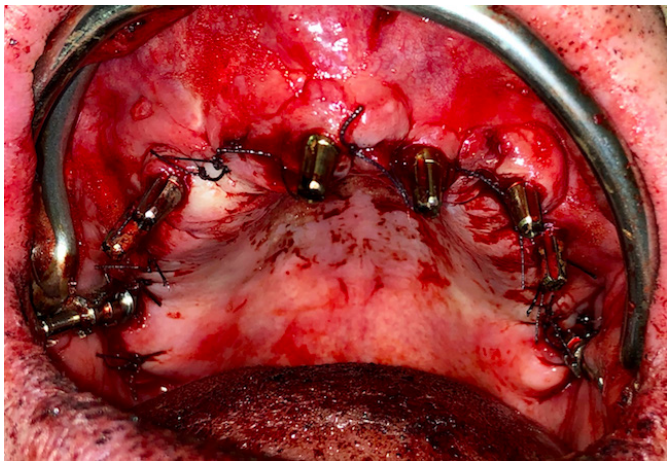

Fig. 3. Intraoral view. Placement of 6 KOS® and 2 TPG® implants. Wound suturing

On the 4th day after surgery, the stitches were removed and a provisional metal-acrylic bridgework with 12 teeth (from 16 to 26) was fixed on KOS® implants with Cem-Implant® (BJM, Israel), cementum and fixation screws STI on TPG® implants, followed by adjustment of the acrylic occlusal surfaces to the antagonizing teeth (Fig. 4). The patient was informed about the necessity of obligatory follow-up visits 1, 3, 6, 12 months postoperatively. None of the patients complained of pain, discomfort, problems with chewing, etc. during the follow-up period. No fixation screws loosening was observed on TPG® implants. The OPG control performed 12 months after surgery revealed complete healing of the extraction sockets, as well as integration of all 8 implants (Fig. 5).

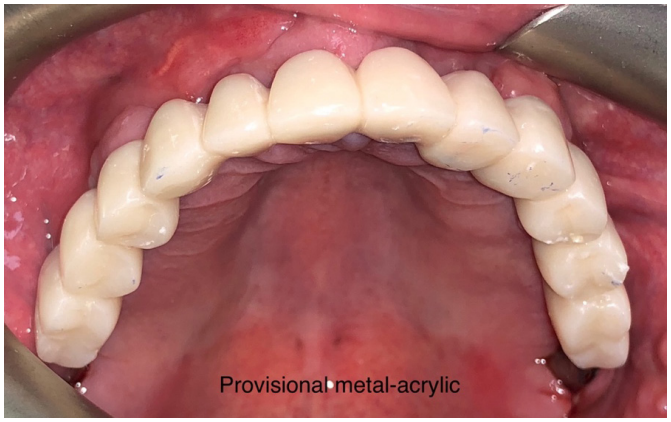

Fig.4. Intraoral view. Provisional metal-acrylic bridgework fixed 4 days postoperatively

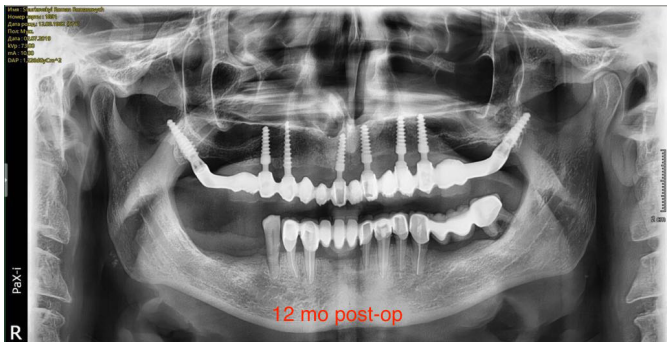

Fig. 5. OPG control of patient S., 56 years, 12 months postoperatively

The metal-acrylic bridgework was removed, impressions were taken once again and permanent metal-ceramic restoration was fabricated and fixed with Fuji Cem® (GC, Japan) cementum and STI fixation screws (Fig. 6).

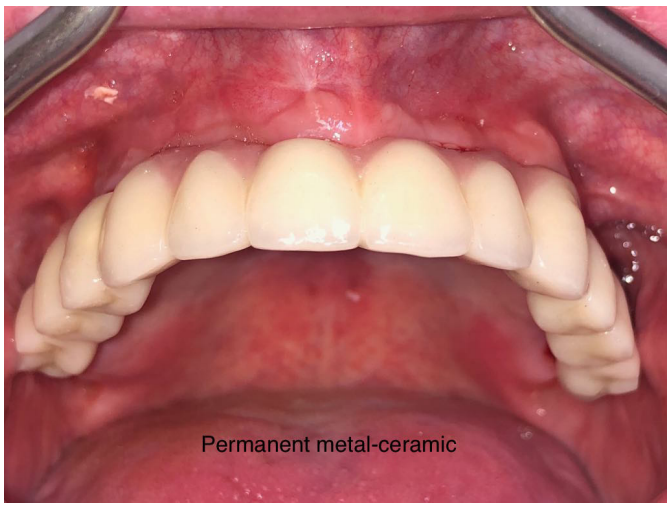

Fig. 6. Permanent metal-ceramic bridgework fixed 12 months postoperatively

4. DISCUSSION

It is well known from the history that the fifties and eighties of the 20th century seemed to be the "golden era" of bone transplantation and jaws reconstruction, especially for the need of further implants placement in augmented areas - challenging aspects of oral cavity as distal maxilla. In 1977, Bell *et al*. proposed the technique of Le Fort 1 maxillary osteotomy for improving the interalveolar relationship before implants insertion [19]. In 1992, Tidwell *et al*. perfected an

osteotomy procedure by simultaneous "inlay" maxillary grafting with autologous bone for the placement of endosteal implants [20]. Autogenous bone from intra- and extraoral sites has been successfully used for jaws augmentation, with no regard for the obvious disadvantages of higher morbidity and expenses.

The sinus floor elevation procedure through a classical lateral window approach (open sinus-lift) and bone marrow substitution to gain a vertical bone height in posterior maxillary area was proposed in 1980 by Boyne and James [21]. Later on, the technique was developed actively by other investigators with success rates ranging from 82.0% to almost 100.0% [22]. As a less invasive alternative, in 1994, Summers introduced a method of sinus membrane elevation with osteotome through a crestal approach, and simultaneous graft and implant placement (closed sinus-lift) [23]. The formation of new bone around the implant apex and complete osseointegration of implant after 3-6 months postoperatively was confirmed by several investigations. When considering the indications for this or for the sinus-lift technique, Misch classification [24], which includes 4 subantral classes, was widely used:

SA1 - Bone height of more than 12 mm allows implantation without any additional augmentation;

SA2 - Bone height of about 10 mm allows implantation after local sinus-lift procedure;

SA3 - Bone height of 5-8 mm allows an open sinus-lift procedure with simultaneous implantation;

SA4 - Bone height less than 5 mm requires a two-stage approach: a sinus membrane elevation and implantation after 6-10 months [25].

To avoid the need of sinus-lift and to create a reliable support for proper prosthetics in distal maxillary areas, the use of frontozygomatic buttress as a target point for the so called trans-zygomatic implantation of very long (up to 40 mm) implants, directed obliquely from the hard palate *via* the maxillary sinus and anchored in the zygoma body, was described [26]. As an alternative to the above-mentioned invasive procedure, an original technique of external positioning of the zygomatic implants avoiding sinus opening was proposed [27-29].

Since early 21th century, the use of short implants (less than 10 mm long) as a viable and simple option to avoid augmentation procedures with a relatively high survival rate was described in a series of publications [30,31]. In general, a minimum width of 5 mm and a height of 7-10 mm are accepted by most clinicians as adequate parameters for short implants placement. But, honestly, does the majority of our patients match these criteria, especially in the distal maxillary area?

Taking into account the above-mentioned considerations, the use of available corticalized areas of the facial skeleton, especially facial buttresses distributing forces along the solid bone structures and protection of the craniofacial cavities, which are always present independently on the level of jaw-bone resorption, became a separate direction of maxillofacial implantology [11,25,32-38].

The use of pterygomaxillary buttress for implants placement was first proposed by Tulasne [1] in 1989, and later on perfected by a lot of clinicians worldwide [5,10-15]. According to the original technique, the 15-20 mm long implant should be directed from the maxillary tuber posteriorly, superiorly and medially, thus avoiding sinus perforation and damage of the major palatal canal, being strongly anchored in the pterygoid process. Taking into account the poor bone quality in the tuberosital area, as well as the unfavorable three-dimensional quantity characteristics of distal maxillary aspects, engagement of dense cortical layers of pyramidal process of palatine and pterygoid process of the sphenoid bone is of utmost importance for initial implant stability. In a recent investigation comparing the survival rate for short (7-13 mm) and long (15-18 mm) Branemark implants (NobelBiocare, Yorba Linda, CA), the proponents of traditional bullet-type implants insist now on the necessity of cortical layers penetration behind the tuber by implant apex for better primary and secondary stabilization [39]. The authors also emphasize the need of splintage of pterygomaxillary implant with other implants for an adequate distribution of the functional loads. A systematic review and meta-analysis of clinical outcomes of pterygoid implants performed by Araujo *et al*. indicated that, in

previous investigations, there was no consensus as to pterygoid implant angulation insertion [10]. The antero-posterior angulation axis varied from 45 to 75 in relation to the Frankfort plane [11,15]. However, in all studies, the buccopalatal angulation axis had a mean of 80 degrees, in relation to the Frankfurt plane. There was no significant difference in pterygoid implant survival rates among these studies, compared to implant angulation. All included studies reported high pterygoid implant success rates, varying from 97.1% to 89.1% [11,15,39].

The issue is that the overwhelming majority of the above-mentioned literary publications were about the employment of traditional 2-stage implants with rough "specific" surfaces (*e.g.*, SLA, Ti-Unite, etc.) and their delayed loading.

Oppositely, a group of practitioners from the International Implant Foundation (Munich, Germany) has however over decades been working successfully on the concept of Strategic Implant described in this publication, which had already 20 years, utilizing fully machined implants inserted into the cortical or basal layers of jaws with their immediate functional loading, according to the Consensus of 16 approved methods of placement of cortico-basal implants, similarly to the principles widely used in trauma surgery (osteosynthesis) [16,34,36,40].

In the present study, out of the 234 TPG® implants installed in different locations (tuberopterygoid area, frontal maxilla, distal/ frontal mandible, etc.) and under different conditions (healed bone, extraction sockets) 10 (4.3%) were lost within the 12-18 month follow-up period. The survival rate of other implants was 95.7% within 24-60 months of follow-up. This observation appears to agree with the previous experience made with a similar type of cortically anchored implants [40]; the devices seem not to lead to peri-implantitis, as quite often seen around conventional two-stage implants. The signs of 2-3 mm bone loss along implant's shafts were revealed in 16 (6.84%) of the 234 TPG® implants on OPGs performed 12-24 months after implantation, without any visible roentgenological symptoms of peri-implantitis caused by smooth (machined) implants surface.

To accomplish immediate functional loading, a metal-acrylic prosthesis was placed within maximum 3-5 days after implant placement. The patients were informed preoperatively about the possible provisional nature of these bridges and also that the necessity to replace them later for various reasons might arise. All occlusal contacts were placed inside the supporting polygon created by the most posterior implants and the canine implants in both jaws [17]. Since always a distal support was placed (as TPG® in tuberopterygoid area of maxilla), distal cantilevers were avoided, for not overloading osteolysis around single distal implants.

No patient selection was done at all regarding the available bone height, for available bone width, or for any pre-existing diseases or medications. All patients requesting treatment were consecutively treated.

No patient was withdrawn from the study, and all 105 subjects with 234 immediately loaded TPG® implants were followed for up to 24-60 months. If they passed away during the observation period, their implants and constructions were counted as successful until the month during which they died, that is their implants remained in the statistics in the same month, while others continued "aging". The implants of these patients did not drop out from the study.

In this study, patients who had missed one or several control appointments were not excluded, all of them being at least interviewed at the end of the observation period.

It must be emphasized, as well, that the traditional contraindications considered for traditional two-stage implantology do not apply to the Strategic Implant®. Indications and contraindications as a setup for trauma and orthopedic surgery seem to be valid borders for Strategic Implant® treatment [16,18].

5. CONCLUSIONS

• The employment of TPG® implants in combination with other kinds of cortico-basal implants (KOS®, BCS®, TPG® Uno (Ihde Dental AG, Switzerland) for the replacement of segmental/ total maxillary/ mandibular tooth arch defects in immediate functional loading protocol demonstrates a high TPG® implant

survival rate (95.7%) within 24-60 months of follow-up period.

• There was no statistically significant evidence of TPG® implants failure depending on their placement in different anatomical areas (tuberopterygoid area, frontal maxilla, frontal/ distal mandible), as well as on the conditions of placement (healed bone, extraction sockets, periodontally compromised areas, etc.).

• There was no statistically significant evidence of TPG® implants failure depending on patient's somatic status (hypertension, diabetes) and bad habits (smoking).

• There were clinical and/or roentgenological signs of peri-implantitis seen around 234 TPG® implants placed after 24-60 months of observation.

• The tilted insertion of TPG® implants in tuberopterygoid area maintains sinus integrity, provides the functional component of treatment naturally by distributing the chewing forces along pterygomaxillary buttresses and avoiding cantilevers.

• Unwinding of prosthetics fixating screws (STI) on TPG® implants after 12-24 months of exploitation requires regular (every 6-12 months) check-ups for the control of fixation security.

• The procedure of TPG® implants placement in tuberopterygoid area is a technically sensitive one, requiring deep knowledge of the anatomy of cranio-maxillofacial area, and must be performed by highly skilled specialists.

• The high cumulative implant survival rate for TPG® implants in immediate loading protocol and the technology of the Strategic Implant® in general indicates (within the limitations of this study) the reliability of this treatment approach in patients with partial/ total maxillary / mandibular adentia independently on their somatic or local (periopathology) status.

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