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## Implant supported restoration in single-tooth replacement

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### Abstract

**Background:** The implant-prosthetic restoration in single missing tooth is a viable treatment option for the functional rehabilitation of tooth loss. Several published studies show that the deadline and the type of functional loading of the implant for single missing teeth is not decisive for the survival and success rate of the implant. Although the conventional protocol is still the "gold standard", the immediate loading of dental implants in the fresh post-extraction socket of the aesthetic area has an excellent prognosis. Immediate functional loading is successfully adopted to minimize the treatment time with immediate and impact benefit on the patient's quality of life and satisfaction. The aesthetic result is not yet systematically included in the success criteria of the therapy through implant, although a trend for this is more common in recent publications, particularly in publications evaluating the implant prosthetic rehabilitation in the anterior maxilla and mandible. In order to obtain optimal aesthetic results, it is necessary to take into account the other aesthetic parameters, together with the chosen material for the fabrication of the implant-supported single crown and the type of prosthetic abutment.

**Conclusions:** The systematic review of the contemporary specialty literature examines the types of implantations and implant-supported restorations for single tooth replacement, the survival rates of the implant, the survival of the crown on the implant and the successful implant, incidence of biological, technical and aesthetical complications of the implants and prosthetic restorations on implants, the quality of life related to the oral health to patients with implant-prosthetic treatment.

**Key words:** single missing tooth, implant-prosthetic restoration, success rate, aesthetic result, complications.

### Introduction

Edentulism – a pathological condition characterized by the absence of one or more teeth in the dental arch – is a major health problem regardless of societies, regions, ethnicities and social stratification, has a multitude of socio-economic and health repercussions. The edentulism may be single (missing one tooth), partial (missing a group of teeth) and total (all teeth missing). The prevalence of a missing permanent tooth is 2.8-8.0% (the third molar is excluded), varying by ethnicity and population. The single tooth loss is the most common in the posterior areas of the jaws; the most affected teeth are the second lower premolar, followed by the upper lateral incisors, the second upper premolar and lower incisors [1, 2].

Aesthetic and functional restoration is the main motivation of major importance for the treatment of teeth loss. Traditional methods of solving these situations are: removable prostheses, fixed partial prostheses on the tooth support and prosthetic restorations on dental implant support. The last two approaches aim for long-term success and the best aesthetic and functional outcomes: masticatory capacity, aesthetics and patient's satisfaction [3, 4].

The results of multiple experimental and clinical scientific researches have shown that osteointegrated implants – the most modern and indicated replacement solution for lost teeth – are a beneficial alternative to dental bridges. In the last decades, prosthetic restorations on implants have expanded a lot [3, 4]. However, the method has advantages, disadvantages and contraindications. Advantages

of the implant-prosthetic complex: the adjacent teeth are not affected, the proximal spaces are maintained, no secondary caries appear at the prepared teeth, the alveolar crest bone is stabilized, the alveolar process is restored as a neoalveolar process, fixed prosthesis, physiognomic prosthesis. Disadvantages of the implant-prosthetic complex: long-term, but limited result, risk of prosthetic abutment unscrewing, fracture risk (crown, prosthetic abutment, implant, screw), difficulty in restoring the interdental gingival papilla, risk of decementation, 2 surgical steps, high cost. Contraindications of the implant-prosthetic complex: deep occlusions, modified spaces, poor bone supply, diseases that contraindicate the surgery [5].

**Types of implantations and implant – prosthetic restorations.** The primary purpose of dental implants is to act as an anchoring element for the prosthetic restorations, replacing one or more lost teeth. A necessary condition for a successful implant-prosthetic treatment is the creation and maintenance of osteointegration, defined as a "direct contact between the mature bone and the endobone implant carrying the loading and masticatory pressure". Osteointegration is dependent on fundamental factors: biocompatibility, primary stability provided by the design and characteristics of the implant surface, indicated surgical technique and general condition. Another important factor affecting osteointegration is the time of implantation and loading of the implant [6].

From a historical point of view, the recommended implant installation protocol consists of 2 surgical steps with

the implant placement after a healing period without mechanical loading of 3 months for the mandible and 6 months for the maxilla. However, with increasing requirements for less invasive and rapid procedures that optimize the aesthetic requirements, a single surgical step with immediate prosthetic loading was adopted. Immediate loading can be defined as installing the crown on the implant within one week after surgery. The installation of single implants can also be classified as functional or non-functional, depending on the occlusal contact with the antagonist teeth [7].

For the treatment of single missing tooth, the implant can be installed immediately or post-extraction (immediately or within 48-72 hours after extraction), early or immediately-delayed (4-8 weeks after extraction), delayed or late, or in the formed alveolar process (4 to 6 months after extraction) [8, 9]. Implant-prosthetic restoration may be temporary (provisional) or permanent. Functional implant loading can be immediate (1 week after implant placement), early (between 1 week and 2 months after implant placement) and delayed or conventional (2 months after implant placement) [10, 11, 12, 27]. The prosthesis restoration procedure can be positioned in occlusion (immediate functional loading) or inoclusion (non-functional loading). The difference between these two procedures is the force exerted on the implant by the fixed prosthetic restoration [8].

A Cochrane review of the literature, which included 26 controlled randomized clinical studies with a total of 1217 participants and 2120 implants, assessed whether the loading period of the implant had relevant clinical implications, because the treatment period could be drastically reduced to the patient's benefit. The authors assessed the effects of immediate functional loading (1) (during 1 week after implant placement), early (between 1 to 2 months after the implant placement) and conventional (2 months after implant placement) of osteointegrated implants; (2) immediate occlusal loading as against the non-occlusal loading and early occlusal loading as against the non-occlusal loading; (3) direct loading as against the immediate, early, and conventional progressive loading. Overall, there was no convincing evidence of a clinically significant difference in prosthesis deficiency, implant failure or bone loss associated with different loading times for implants. However, the findings should be treated with caution because of the low quality of evidence [27].

Systematic reviews of the literature, controlled randomized clinical studies and comparative studies (transversal, cohort, prospective) that evaluated different implant installation procedures and prosthetic restorations for the treatment of single missing tooth in the aesthetic (anterior) or posterior area did not find any statistically significant difference in the survival and success (tissue integration, bone resorption, frequency of implant losses and biological or technical complications), different periods of installation and restoration of the implant, including deadlines and type of functional loading. Thus, there is insufficient evidence to determine the possible advantages and disadvantages or to

recommend the immediate approach, the early approach or delayed approach of implant installation and restoration [8, 9, 12]. However, some authors have mentioned that implants installed immediately and early may be at a higher risk of implant failure and complications development than delayed implants, while the aesthetic result may be better at immediate implant installation after dental extraction. In addition, the immediate restoration procedure is possibly more promising in terms of healing time and costs and is associated with a higher rate of patient's satisfaction [11, 12].

Thirty years of research of ceramics on zirconium has led to significant improvements in the biomedical field, particularly in dental implantology. Now, zirconium is used not only as a veneering material, but also for the manufacture of dental implants that have improved the aesthetics and functionality for patients. Zirconium oxide dental implants, due to excellent mechanical properties, good biocompatibility and aesthetically acceptable color, have emerged as an attractive non-metallic alternative for titanium implants. Experimental studies on animals have found excellent bone-implant contact, but not under functional loading conditions [40]. The use of zirconium dioxide abutments (materials of crown support) compared to titanium abutments showed a better aesthetic result, although the differences were not statistically significant. However, more technical complications have been noted in the use of zirconium oxide abutments [41, 42].

Cement-retained single-implant restorations have become a major pillar, but there is a renewed trend towards the use of screw-retained crowns on implants. Current evidence indicates that screw-retained single-implant restorations deserve greater attention and offer clear benefits in many cases. A review of the specialty literature has revealed the following advantages of the screw-retained single-implant crowns compared to the cement-retained single-implant crowns:

1. Predictable retention and retrievability.
2. No potential for biological consequences associated with residual cement.
3. As with cement-retained restoration, the choice between metal ceramics or all ceramics.
4. Only one margin at the implant / abutment interface.
5. A single abutment / crown ceramic margin that can extend gingivally to the implant interface.
6. Nearly imperceptible blend of a composite resin in the ceramic abutment access openings.
7. One component instead of two, which may simplify the restorative process [42].

Innovations in implant and ceramic technologies now give screw-retained prostheses the potential for esthetic, functional and biological outcomes that are comparable to those for cement-retained prostheses, while providing the advantages of predictable retrievability and avoidance of residual cement. Partial filling of the abutment access channel with the support screw can help reduce the extrusion of the excess of cement in peri-implantary tissue. Angled

implants, however, remain a major indication for prostheses [42, 43].

A meta-analysis of studies published between 1995 and 2015 showed a less marginal bone mass loss and a greater survival for the cement-retained implant prostheses, but the differences were small and could not be clinically significant [44].

**Survival rates of the implant and crown.** In order to make the right decision about treatment, it is important to know survival rates and the incidence of technical and biological complications not only for implants but also for prosthetic works. The implant survival rate has always been the main criterion for the success of any implant-based restoration procedure, but in recent years the implant dentistry has significantly evolved to optimize the aesthetic appearance, and the preservation of hard and soft peri-implant tissues is now mandatory [13, 34].

In order to evaluate the clinical outcomes of current implant systems, the following success criteria are used: implants inserted must be immobile at the clinical examination (clinical stability), functional and without any discomfort, without suppuration, infections, peri-implant osteolysis zones on the X-ray and fracture of the implant. The loss of marginal bone mass in the first year after the application of the prosthesis should be less than 1.5 mm. After one year of functional loading of the implant, the vertical loss of bone mass should be less than 0.2 mm per year, irreversible and / or persistent signs or symptoms of pain (at palpation, percussion or function), infection, neuropathies, paraesthesia or perforations of the mandibular canal must be missing. At the end of the 5-year and 10-year observation periods, the success rate must reach 85% and 80% respectively [14].

The success of the implant with immediate functional loading is defined according to the criteria proposed by Buser and modified by Albrektsson: (1) absence of persistent pain, dysaesthesia or paraesthesia in the implant area; (2) absence of peri-implant infection with or without suppuration; (3) absence of perceptible implant mobility and (4) persistent absence of peri-implant bone resorption greater than 1.5 mm in the first year of loading and 0.2 mm annually in the following years [15].

Implant failure criteria are due to the following factors: periodontal disease, smoking, systemic diseases, infections, aging, short implants, inadequate implants, number of implants, lack or insufficiency of integration with hard and soft tissues, inappropriate prosthetic design [16].

Dental implants can be classified according to several parameters: size, material used for manufacturing, type of implant-abutment connection and treatment steps, the latter being the most frequent. A review of the Cochrane literature identified 40 controlled randomized clinical studies and compared 18 types of different implants with a follow-up period of 1 to 5 years. The authors concluded that there is no evidence that any type of dental implant has a higher long-term success rate compared to another type [17].

Ignoring the different clinical situations, the types of

implant and implant restoration, cumulative survival rates of single tooth implants, reported in the specialty literature, are within 90.7-100% after one year of follow-up [11], 97.6% (including 99.4% for the implants placement in healed alveolar ridges and 95.6% for the implants placement in post-extraction sockets,  $p = 0.004$ ) for the first year of functional loading [18], 99.0% for the implants installed in the healed alveolar ridges and immediate prosthesis (temporary crown installed on a temporary titanium abutment and functionally loaded 24 hours after surgery, final prosthesis was functionally loaded within 6 months after the implant placement) after 1 year of functional loading [19], 96.9-97.86% for the first year of functional loading of dental implants installed transgingival, regardless of the type of restoration - immediate or delayed [11, 12], 97.6-98.4% at 2 years [8, 11], 96.1% at 3 years [20] and 95.6% at 5 years [21] for conventional loading and immediate functional loading, 96.2-100% at 5 years for implantation and conventional functional loading with different neck designs [22], 98% at 5 years of implants installed in the healed alveolar ridges (up to 3 months after dental extraction) or in post-extraction sockets of the anterior maxilla with immediate functional loading [23], 95.7% at 5 years, and 95.7% at 10 years for immediate placement of implant with immediate functional loading [24].

The obtained outcomes were comparable to single tooth rehabilitation data using conventional long-term functional loading. Three previous meta-analyses reported survival rates of implants estimated from 94.5% to 97.2% at 5 years and from 89.4% to 95.2% at 10 years for the single tooth replacement. These results suggest that immediate function in rehabilitation of a single tooth is long-term predictable, after short-term confirmation in a meta-analysis of the absence of survival difference or marginal bone resorption between conventional functional loading and immediate functional loading [13, 25, 27].

Therefore, the implant-prosthetic treatment for single missing tooth was documented as a successful procedure with predictable results during 5 years and, to a limited extent, up to 10 years of follow-up. However, a follow-up period of 5-10 years is too short to get clear information on survival rates and complication rates [13, 25]. Data on the survival of dental implants over longer periods is very limited. A retrospective observational study revealed that the cumulative survival rate of the osteointegrated implant for the single tooth replacement in maxilla and mandible was 97.1% after 25 years of follow-up. There were observed differences in survival rates between implants with different types of surfaces: for maxilla single missing tooth during 15 years and 10 years, this indicator was 95.8% for processed surfaces (plane) and 98.5% for moderately rough surfaces and for the mandibular single missing tooth during 10 and 25 years - 95.1% and 97.2%, respectively. Therefore, implant-prosthetic treatment in the single tooth gap is a long-term predictable treatment with a lower failure rate for implants with moderately rough surfaces in the maxilla implant placement [26].

A systematic review of the specialty literature, published in 2016, found that immediate placement and restoration of implant in single tooth replacement in the anterior maxilla (8 different implant systems) resulted in success (97.96%) and survival rate (98.25%) higher after an average follow-up period of 31.2 months. Single permanent crowns were restored from 3 to 6 months after the implant placement [9].

A recent meta-analysis compared the implant survival to patients with immediate functional loading or conventional functional loading of implants placed in the posterior mandible. The authors did not find a statistically significant difference between the two functional loading forms (immediate or conventional) for an average monitoring of 31.2 months on the implant survival (91.7-100% and 96.6-100% respectively;  $p > 0.05$ ) [7].

A systematic and recent review of the literature evaluated the efficacy of the treatment of the maxillary and/or mandibular posterior implant supported single tooth restoration. The observation period ranged from 4 to 96 months. The survival rate, success rate (marginal bone mass loss, bleeding around the implant when palpating around the implant, deep probing around the implant), and the average amount of loss of bone mass for implants with immediate functional loading and delayed functional loading were, respectively, 96.9% (from 82.64% to 100.0%), 100% and 0.85 mm (from 0.48 mm to 1.31 mm), 96.8%, 94.1% and 0.55 mm. The survival rates, success rates and average amount of loss of bone mass in the studies, which compared implant placement with immediate functional loading with delayed functional loading, were, 96.8% (from 95.7% to 100.0%), and 96.3% (from 95.5% to 100.0%), 85.8% (from 66.7% to 100.0%) and 93.3% (from 83.3% up to 100.0%),  $0.57 \pm 0.57$  mm (from  $0.41 \pm 0.57$  mm to  $0.90 \pm 0.3$  mm) and  $0.55 \pm 0.37$  mm (from  $0.04 \pm 0.46$  mm to  $0.88 \pm 0.2$  mm), respectively. Although the data published over the last 5-8 years show a slightly lower success rate for delayed functional loading implants, the differences in survival and success rates between implants with immediate functional loading and delayed functional loading were insignificant [14].

The authors concluded that the prognosis for the single tooth implant placement in the molar area offers a viable treatment option for the single missing tooth in the maxillary and mandibular posterior areas [14, 28]. There is no significant difference in the survival rates of immediately and delayed implants placement, although the success rates were slightly higher to patients with delayed functional loading. The rates of survival and success of the implants placement in the posterior quadrant, regardless of the loading protocol, are comparable to those of the implants placement in the previous regions [14].

Based on two meta-analyses, the survival of implants with a single crown constituted 96.8-97.2% after 5 years of function and 95.2% after 10 years of function. The survival rate of implant-supported single crown consisted of 94.5-96.3% after 5 years of function and 89.4% after 10 years of function [2, 13, 25]. The survival rate of metal-ceramic

crowns (95.4%) was statistically significantly ( $p = 0.005$ ) higher than the survival rate of full ceramic crowns (91.2%) [13].

A systematic and meta-analysis of the specialty literature reviewed the effectiveness of screw-abutments with internal or external implant-abutment connection for single tooth replacement. There were studied 586 implants with external connection and 1113 implants with internal connection. The estimated percentage of single-tooth implants without complications after 3 years was 97.3% for implants with external connection and 97.6% for implants with internal connection. The authors concluded that the geometry of the implant-abutment connection does not affect the incidence of loosening of the screws. However, most of the studies included were of a short duration and can not be extrapolated on long term [39].

The survival, success and stability of the implant, as well as the aesthetic results of the prosthesis on the implant support, depend on several factors: the anatomical place, the osteotomy protocol, bone quality and quantity at the implant place, the length, diameter and color of the dental implant, characteristics and texture of the dental implant surface, axial load, correct oral hygiene, keratinized gingiva width, soft tissue level, oral bone thickness [9, 16, 20, 36, 37]. A special feature of immediately restored implants is the immediate correct modeling of the peri-implant soft tissue in the healed alveolar ridges, by the correct morphological shape of the abutment and / or the cervical portion of the single temporary crown [9, 38]. It is possible to improve gingival aesthetics by coloring in pale pink the implant's neck and abutment, irrespective of the type of implant, obtaining a more red peri-implant mucous and closer to the natural gingival color [37].

Therefore, several published studies show that the deadlines and the types of implant placement and loading in single tooth gap are not decisive to the survival of the implant, and the success rate is, at least, comparable to published data for single tooth implants placed in accordance with the standard protocol in the healed alveolar ridges.

**Complications of the implants and prosthetic restorations on implants.** Technical complications denote the mechanical damage of the implants, implant components and / or suprastructures [13], but biological complications – the lesions of peri-implant soft tissue and the loss of marginal bone tissue [25].

The systematic reviews of the literature and the meta-analyses of the studies, described above, conclude that, although the survival rates of implants and crowns for single tooth gap are high, biological complications (loss of osteo-integration, signs of mucosal inflammation, fistulas, peri-implant mucositis, ache, haemorrhage at palpation, suppuration, dehiscence of soft tissues, progressive loss of bone mass  $> 2$  mm, occlusal disorders), technical (fractures of the components – implant, support, crown and support screw, loss of crown retention, weakening of the support screw, decementation) and aesthetics (soft tissue recession  $> 1$  mm,

an unfavorable crown, visible crown margins, absence of the papilla) are frequently encountered [13, 29, 30].

A meta-analysis of the longitudinal studies evaluated a total number of 3223 implants to patients aged between 13 and 94 years. Were analyzed the implant survival, the survival of single crowns on implant support (irrespective of the reconstruction material and crown fixation method on the implant) and the incidence of biological, technical and aesthetic complications for an average follow-up period of at least 5 years. The evaluation of the biological complications found a cumulative rate of the soft tissue complications of 7.1% and a cumulative rate of complications for implants with bone loss > 2 mm of 5.2%. Technical complications have reached a cumulative incidence of 8.8% for the loss of screw stability, 4.1% for the loss of retention, and 3.5% for the fracture of the veneered material. The cumulative rate of aesthetic complications was 7.1% [25].

A previous meta-analysis and included in the meta-analysis described above, revealed that during the 5-year observation period, the peri-implants and soft tissue complications occurred adjacent to 9.7% of single crowns and 6.3% of implants had a bone loss of > 2 mm. For this follow-up period, the cumulative incidence of implant fractures was 0.14%, the cumulative incidence of screw and support abutment weakening was 12.7% and 0.35%, respectively. For crown complications, the cumulative incidence of ceramic fractures was 4.5% [13].

The marginal bone level around an implant is an important criterion for the success of the treatment. The loss of marginal bone tissue following the implant placement poses not only a risk of implant failure, but reduces the chance of achieving an optimal aesthetic result, which in turn, can affect the patient's satisfaction. A systematic and recent review of the prospective studies, published in 2016, based on periapical radiographs found that the average loss of marginal bone tissue around the implants placed immediately or early from the initial time up to the most recent follow-up visit (between 1 and 10 years) was lower by 1.5 mm. The authors conclude that immediate or early implant placement after one tooth extraction can be a viable treatment, with long-term survival rates and conditions of the marginal bone level corresponding to those implants conventionally placed in the healed alveolar ridges [46]. A study found that the local bone loss at the immediate functional loading of the implant placed either in the post-extraction sockets or in the healed alveolar ridges, was similar. The average value of marginal bone loss was  $0.267 \pm 0.161$  mm during 1 year,  $0.265 \pm 0.171$  mm during 3 years and  $0.213 \pm 0.185$  mm during 5 years after the implant placement in the extraction sockets,  $0.266 \pm 0.176$  mm during 1 year,  $0.219 \pm 0.175$  mm during 3 years and  $0.194 \pm 0.172$  mm during 5 years after the implant was placed in the healed alveolar ridge. The results of this study showed that there is no significant difference in bone mass loss between the two investigated groups. However, a significant reduction in marginal bone loss was more pronounced in implants placed in the healed alveolar

ridges ( $p < 0.041$ ), compared to implants installed in fresh extraction sockets ( $p < 0.54$ ) [47].

A systematic review of the literature, which evaluated the clinical result of the immediate implant placement in the aesthetic area, revealed that the deadlines and the type of functional loading (immediate, early, delayed) were not associated with the implant survival results, which allow for immediate functional loading after the immediate implant placement. Regarding the risk factors for marginal bone level change, the immediate functional loading was associated with bone mass loss that is a clinically relevant observation. In addition, the use of a flap or conjunctive tissue graft was significantly associated with greater bone loss. Unfortunately, the few randomized clinical studies included, were based on the results of a short follow-up period (1 year). Therefore, studies with longer follow-up are required to predict the long-term aesthetic result [72, 24].

A recent study has prospectively evaluated the result at 12 years of implant-based restorations for single tooth replacement. Initially, through a two-step protocol, were placed 45 Astra Tech TiOblast ST self-tapping implants on 40 subjects with an average age of 40.9 years. The abutment connection was performed at 3 months for the mandible and at 6 months for the upper jaw after the implant placement, and the metal-ceramic prosthetic crown was fixed by cement approximately 4 weeks after connecting the abutment. At 12 years, 31 patients and 35 implants were available for evaluation. Cumulative failure was 10.3% at the subject level and 9.1% at the implant level. The total average value of bone loss was 0.67 mm at the subject level and 0.47 mm at the implant level. Nine implants (25%) showed clinical signs of inflammation, three subjects (10%) and three implants (8.6%) were diagnosed with peri-implantitis (signs of inflammation in combination with  $\geq 2$  mm bone loss radiologically assessed). Five subjects presented technical complications: 3 incidents of weakening of the abutment screw retention in the first 5 years and 2 minor ceramic fractures of the crown between 5 and 12 years of follow-up. Aesthetic complications have not been reported. The authors concluded that the use of Astra Tech dental implants is a valid treatment alternative for the single tooth replacement (48).

Based on the findings of 10 clinical studies, with a follow-up period of more than 5 years, a systematic review of the literature estimated an average failure rate of 4.8% of implant-supported restorations for single tooth replacement [25]. However, long-term studies (10 years and more) that document failures and various types of complications of replacement procedures for a missing tooth are insufficient [49]. In a systematic review of the literature, was described the incidence of biological and biomechanical complications associated with the use of implants to replace a single tooth. The authors concluded that while all prospective longitudinal studies (over 5 years) included reports on the frequency of implant loss, only a limited number of publications have presented conclusions related to the biological and technical complications. Because the prevalence of

complications may increase with the implant function time, there is a clear need for long-term data (10 years and longer) from prospective studies of implant-supported restorations for single tooth replacement [50].

A study, which evaluated the results for a follow-up period of more than 10 years for the Astra Tech single dental implants placed in the anterior maxilla, reported an average loss of marginal bone of 0.75 mm, a subject (5%) with bone loss > 2 mm and three subjects (15%) with bone loss between 1 and 1.4 mm, findings comparable to the previous study [51].

Another study assessed 40 subjects and 44 implants (Brånemark) up to 18 years. The average value of marginal bone loss from the moment of crown placement was 0.4 mm. A recent publication, which evaluated the survival rate after 10 years of function of 86 implants (Biomet 3i) with immediate restoration for single missing tooth in the anterior maxilla, found an average bone loss of 1.01 mm [52].

Several long-term prospective studies (10 years and more) reported an incidence of technical complications varying between 7% and 30% [48], 2 recimented crowns (10%), 2 minor fractures of ceramic crown (10 %) and weakening the capacity of retention of the abutment screw in 2 cases (10%) [51], 2 (3%) patients with weakening of the retention screw of the abutment and 3 (4%) patients with minor fractures of the ceramic crown [83].

Following the immediate implant placement, the recession of the peri-implant mucosa > 1 mm occurs in 9-41% of cases between 1 and 3 years, whereas early implant placement has a very low risk for recession > 1 mm [34]. The level of the peri-implant papilla for a single tooth in the anterior maxilla is mainly influenced by the interproximal bone crest level of the adjacent tooth. The marginal mucosa level is affected by several factors: peri-implant biotype, facial bone crest level, implant angle, interproximal bone crest level, and implant platform depth and bone-implant primary contact level [35].

The overall cumulative rate of complications after 18 years of follow-up was 57% and 1/3 of these complications require the renewal of at least one component. Over 50% of the complications occurred during the first 5 years of the study. In total, 36% of restorations were affected by technical complications, 24% - aesthetic complications and 20% - biological adverse reactions. The study confirms an over time increase in complications. The weakening of the support screw, a previous frequent complication, was significantly reduced by the implementation of CeraOne support abutments [29].

Dental restoration is a difficult procedure, because physicians and patients have established strict success criteria. This standard has placed the focus of research on improving the results of hard and soft tissues, the aesthetics of restoration and patient's satisfaction. In order to evaluate the complete aesthetic restoration, are widely applied the "white aesthetic score" of the implant, the "pink aesthetic score", to accurately describe all the features of the adjacent soft tissues,

"the aesthetic index of the implant crown" – objective index that measures the aesthetic result of the implant crown for one single tooth (shape, color, superficial characteristics) and of the related mucosa. These indicators became popular and a standard tool for assessing the aesthetic result of implant restorations in the anterior aesthetic area, determined mainly by the shape of peri-implant pink soft tissues, the contour and color of the permanent crown [12, 19, 23].

However, a review of the international specialty literature has revealed that although there seems to be a growing interest in aesthetics in implant therapy, there are still no well-defined and universally accepted assessment criteria for aesthetic outcomes. A wide variety of parameters, methods, units of measurement, and time points used to evaluate the aesthetics, were found in different studies, which influences the validity and requires prudent interpretation of the results in comparison of the studies. Generally, until 1990, researchers were primarily interested in the functional aspects of the implant therapy; the evaluations of aesthetic results among the criteria for success only appear in more recent studies and refer mainly to the rehabilitation of the implants in the anterior maxilla area. It is obvious that the peri-implant mucosa has a significant influence on the aesthetic outcome of the therapy with dental implants [45].

The replacement of the affected teeth of the patient with immediate fixed implant-supported prostheses with functional loading represents a major achievement in the reconstructive dentistry. In recent years, the implant dentistry has increasingly supported the concept of immediate functional loading, even in the restoration of a single implant. This operative procedure is a viable and safe treatment option for both the maxilla and the mandible and has several advantages for the patient. Firstly, it eliminates the removable prosthesis, and secondly, it allows that most work times to be concentrated during a single visit, due to the computer assisted surgery. Many authors have pointed out that immediate functional loading protocols allow for better aesthetic results compared to delayed functional loading, especially in post-extraction implant placement, are able to maintain the original aesthetics of soft tissues. The restriction of bone remodeling, reduction of procedures number, shortening of the treatment period, rapid restoration of function and aesthetics contribute to the shortening of the recovery period with functional, cosmetic and psychological benefits, and reducing discomfort for patients [6, 12, 14, 18, 30].

Several comparative studies (transversal, cohort, prospective), based on the preliminary clinical and radiographic results, found that after 2 years, about 26% of cases were esthetic failures (pink aesthetic score <8 and / or white aesthetic score <6), 13% of cases showed almost perfect aesthetic results (pink aesthetic score ≥12 and / or white aesthetic score ≥9) and 61% of cases showed acceptable aesthetic results. Although the rate of aesthetic failure is quite high, the indicator falls within the range of specialized publications (5-34%) [10, 31, 32]. Thus, the early and conventional implant-prosthetic treatment of the single missing

tooth has comparable aesthetic results. The result is considered satisfactory if the pink aesthetic score is  $\geq 8$  and perfect if the pink aesthetic score is  $\geq 12$  [10].

**Oral health-related quality of life in patients with implant-prosthetic restorations.** In the field of implant dentistry, there is an increasing emphasis on the results reported by the patient. Patient's satisfaction is also essential for achieving this goal and can truly indicate the success of implant-prosthetic treatment from the patient's perspective [12, 19, 23]. The quality of life related to the oral health is defined as the effect of deficiencies, disabilities or handicap from an oral condition to frequent daily activities (masticatory function, speech, tooth cleaning, sleep, smile and social contact) [33].

Several prospective randomized clinical studies have comparatively evaluated the patient's satisfaction based on the Oral Health Impact Profile (OHIP-14) questionnaire on immediate functional loading and delayed functional loading of dental implants for single tooth replacement in the anterior maxilla. After 12 months, has been found a statistically significant overall improvement in the quality of life related to the oral health for both groups. Significant improvement is, probably, a result of increased comfort during the ingestion of the food, and a lower sense of insecurity and embarrassment [6, 19].

The OHIP-14 score for patients with implants placement in the healed alveolar ridges or fresh extraction sockets decreased from 0.50 at baseline to 0.17 at 6 months of follow-up ( $p < 0.001$ ) - an improvement in all the aspects. For both groups, the score remained stable for up to 5 years ( $p = 0.41$ ). However, after 5 years, the OHIP-14 total score showed a statistically significant greater improvement in the group with implants placed in the healed alveolar ridges, compared to the group with implants placed in the extraction sockets ( $p = 0.027$ ) [23].

### Conclusions

1. The implant-prosthetic restoration in single tooth replacement is a viable treatment option for functional restoration of tooth loss. Several published studies show that the time and the type of implant functional loading of single tooth replacement are not decisive to the survival and success rate of the implant.
2. Although the conventional protocol is still the "gold standard", immediate restoration of the implants placed in the post-extraction sockets of the aesthetic area has an excellent prognosis. Immediate functional loading is successfully adopted to minimize the treatment time with immediate benefit and relevant impact on the patient's quality of life and satisfaction.
3. The aesthetic outcome is not yet systematically included in the success criteria of implant therapy, although a trend for this is more frequent in recent publications, particularly in publications evaluating the implant-supported single tooth restorations in the anterior maxilla and mandible.

4. The chosen reconstruction material and the type of abutment for manufacturing the implant restoration do not ensure aesthetic results, if all parameters are not taken into account.

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