UDC: 616.314-089.843(497.751)
Professional paper

INFLUENCE OF DIFFERENT RISK FACTORS ON PRIMARY DENTAL IMPLANT STABILITY ON TWO TYPES OF DENTAL IMPLANTS

Denis BAFTIJARI[1*], Mihajlo PETROVSKI[2], Florent BAFTIJARI[3]

[1]Department of dental medicine, Faculty of Medical sciences, State University of Tetovo*
[2]Facuty of medical sciences, Goce Delcev University, Stip, Republic of North Macedonia
[3] University Clinic St. Pantelejmon" Skopje – Department of fixed prosthodontics, Skopje, Republic of North Macedonia
**Corresponding Author: e-mail: denis.baftijari@unite.edu.mk*

Abstract

Introduction. The primary stability of dental implants may be impaired by the presence of systemic diseases, such as cardiovascular disease, osteoporosis, diabetes, hepatitis, severe periodontal disease and some conditions that compromise bone regeneration and integration. The main goal of this research was to determine the predictive values of different risk factors on the primary stability of dental implants.
Material and method. This clinical study was carried out in one dental clinic "Vita-Dent" in Tetovo. Two types of implants were used, Mis Seven implants and Straumann Standard plus and Bone level implants. The stability of the implants was measured by resonant frequency analysis using the instrument Osstell IDXTM (Osttell AB, Gothenburg, Sweden).
Results. The biggest influence on the primary stability in patients with Mis dental implants had smoking (Beta=-0.53), followed by HTA (Beta=-0.53), diabetes (Beta=-0.32), periodontal disease (Beta=-0.26), age (Beta=0.21), and gender (men) (Beta=0.05). Among the all, 50, no risk factors were registered in 30.00 %, 22.00 % were smokers, 12.00 % had diabetes, 20.00 % had HTA, 2.00 % had osteoporosis and 14.00 % had periodontal disease. The biggest influence on the primary stability on Straumann dental implants had the age of the patients (Beta=-0.27), followed by diabetes (Beta=-0.25), gender (Beta=0.25), periodontal disease (Beta=-0.20), smoking (Beta=-0.14), HTA (Beta=0.11), and osteoporosis (Beta=-0.07).
Conclusion. The most significant risk factors affecting primary implant stability, and hence the longevity of implants, are tobacco consumption, systemic factors such as diabetes and hypertension and the local negative impact of various forms of periodontal disease.

Keywords: primary stability, dental implants, stability, risk factors.

1. Introduction

In general, the failure of the implant therapy is quite small and the contemporary literature data states that there are no absolute contraindications for placing implants. Conditions that have been found to be correlated with an increased risk of failure should be considered in treatment planning. This paper is aimed towards the description of the various risk factors that can affect the primary implant stability, and hence the longevity of the implants.

Implant stability plays a major role in the success of osseointegration. Primary stability is a mechanical phenomenon that is related to local bone quality and bone quantity, type of implant, and placement technique. (Esposito et al., 1999). It has been proven that the stability during the implantation, as well as after a certain period, is of particular importance in the success of the implant therapy. Initial mechanical stability and the absence of any unwanted micro-movements are two vital elements needed to increase the survival of dental implants (Adell et al., 1990; Kumar & Narayan, 2013). It must be noted that the goal of many researchers is to assess the risk factors that influence the success of implant therapy.

The general risk factors, among patients with dental implants according to Buser et al. (1990) are divided into:

- Medical risk factors: bone diseases affecting inadequate bone healing, immune diseases, patients receiving steroids, uncontrolled diabetes, cancer patients, etc.

• Periodontal risk factors: active periodontal disease, patients with a history of any periodontal disease, genetic predisposition.
• Oral hygiene factors: patients with poor hygiene, gingival inflammation.
• Occlusal factors: bruxism.

In 1997, Meredith et al. (1997) introduced a non-destructive vibration testing method called Resonant Frequency (RF). Since 1999, this analysis method has been commercially available as Osstell equipment – integrated diagnostics (Gothenburg, Sweden). Glauser et al. (2003) found that failure of implants shows a continuous decrease in the stability of the implants until they fail completely.

The risk factors related to implant therapy are represented by all general and local conditions that, through various mechanisms, can increase either the short-term or long-term risk of failure. The primary stability of dental implants can be impaired by the presence of chronic or systemic diseases, such as cardiovascular disease, osteoporosis, diabetes, hepatitis, severe periodontal disease, chemotherapy or radiotherapy, positive human immunodeficiency virus (HIV) infection, pregnancy or lactation and reconstructions that compromise bone regeneration and integration.

Also, the risk factors for surgical implants can be divided into two categories. The first category is related to the surgical technique, the type and location of the implant, the waiting time between tooth extraction and implant placement and between placement and loading of the dental implant. The second category refers to patient characteristics, such as uncontrolled diabetes, alcohol and smoking consumption, and other systemic factors. It has been noted in the current literature that several risk factors can impair the long-term survival of the implants, the most significant of which are the following: the location of the implant in the jaw (frontal region vs. posterior region and maxilla vs. mandible), implant dimensions (in terms of implant length, diameter and design) or bone augmentation procedures, local bone density at the implant site and patient-related risk factors such as age, smoking, history of periodontal disease, diabetes mellitus and osteoporosis.

Recognizing potential risk factors in implant therapy can help reduce the frequency of failure and prevent earlier implant loss.

Age is considered to be a prognostic factor in the success of the implant. Older patients have a longer healing time, systemic health risk factors and relatively poor bone status are present (Mohajeran et al., 2017). Hickin et al. (2017) shown that age is associated with implant failure, if they are implanted in individuals aged 18 to 30, showed a lower failure rate than expected, while those aged 51 to 70 who showed a higher failure rate. However, patients in the oldest age group (over 70 years) did not indicate a higher failure rate.

Gender was shown to be a significant predictor of implant therapy failure with a higher risk in men, suggesting that, however, this may be related to other variables. The increased risk may be due to the increased bite force in male patients, however, the risk of failure is also higher even before loading with prosthetic devices. Patient failure factors for dental implants, other than male gender, also include smoking, presence of autoimmune disease, and penicillin allergy, conditions that show a trend toward higher failure rates. The results of one study from Hickin et al. (2017) proved that implant therapy failures are significantly more common in females, which contradicts the findings of the previously mentioned data by Moy et al. (2015), who did not report any difference in the relative risk of implant treatment failure between males and females. According to Krebs et al. (2015), gender does not affect implant failure rates, but implants in men have a lower longevity.

Osteoporosis is a clinical term that refers to the presence of decreased bone mass that can lead to bone fracture with minimal or insignificant trauma. (Becker et al., 1997). Osteoporosis, with a high prevalence in the elderly population, is often considered a risk factor due to the low bone mineral density caused by the disease, and this may impair the quality and quantity of alveolar bone at implant sites. While a numerous studies have evaluated the impact of smoking, radiotherapy, as major risk factors, studies on the impact of

osteoporosis on the failure of implant therapy are inconsistent. The use of oral bisphosphonates by patients suffering from osteoporosis appears to be a partial or relative contraindication to dental implant treatment, and the patient must understand the need for a longer follow-up period. (Budu et al., 2022).

The initial assessment of any patient with hypertension should include a detailed family history of cardiovascular disease, a description of the history of hypertension, medication use, duration of antihypertensive therapy, severity of the disease, and its complications. Before starting of any dental treatment, the clinician should assess for the presence of hypertension and changes in treatment may be required. Hypertensive patients are at increased risk of adverse effects in the dental office during surgical placement of dental implants (Chaudhry et al., 2016). Moy et al. (2005) placed 1365 implants in patients with coronary artery disease or hypertension, and found no increased risk of implant failure reported in a retrospective analysis of 4680 implants placed in 1140 patients over 21 years.

Patients with diabetes have an increased frequency of periodontal disease and tooth loss, and diabetes is also considered a risk condition for the placement of dental implants given the fact that it is associated with tissue healing, the prevalence of microvascular disease, and with an impaired response to infection. Therefore, diabetes remains a relative contraindication for implant therapy, but well-controlled diabetic patients may be considered suitable for implant therapy, while diabetic patients lacking good glycemic control may be denied the benefits of implant therapy. The placement of dental implants in non-diabetic and diabetic patients does not statistically affect implant failure rates (Ibbott et al., 1993).

Measuring the stability of implants is a very important clinical procedure in modern implant therapy. Determining the primary stability is significant, because it will determine when an implant can be loaded and ready for further prosthetic rehabilitation.

Based on the above mentioned, the main goal of this research was set - to determine the predictive values of the analyzed risk factors on the primary stability of dental implants.

2. Material and method

This clinical study was done in a private dental clinic "Vita-Dent" in Tetovo. It included patients over 18 years old. The implants were surgically implanted by a specialist oral surgeon, the stability of the implants also was determined using a modern diagnostic instrument that analyzes the resonant frequency.

Two types of implants were implanted in the patients, Mis Seven implants with internal hexagonal shape and Straumann Standard plus and Bone level implants from ITI Academy with internal octagonal shape.

The stability of the implants was measured by resonance frequency analysis using the instrument called Osstell IDXTM (Osttell AB, Gothenburg, Sweden) integrated diagnostics. Implant Stability Quotient (ISQ) – is the measurement unit of this diagnostic instrument, the measurement units range from 1 to 100, the higher the values that will be displayed on the instrument, the better the stability of the implants will be. The results of the conducted analyzes were recorded accordingly in the implantology-anamnestic card, required for statistical analysis.

In order to obtain a complete picture of the reasons for which the implants are placed in the patients, as well as to obtain data on the existing risk factors, a detailed medical and dental anamnesis was taken for each of the patients. From the anamnesis, data were obtained regarding the demographic characteristics of the examined population, data regarding the gender of the subjects, age, general health, oral health and the presence of allergic diathesis.

Before performing the anamnestic procedure of the studied population, an appropriate adaptation of the level of communication was made to the appropriate level and by using adapted terminology, the details regarding the examination and the research objectives were given. Interviews were conducted only after obtaining the written consent of the patient to participate in the study.

For the appropriate subsequent analysis of the data obtained from the anamnesis, adapted questionnaires were used, which, together with the clinical examination cards, are kept in the office's file cabinet.

Clinical examination

An extraoral examination of the face and neck was performed on the subjects in order to note visible changes in the given region. An intraoral examination was performed in order to objectively observe the changes, as well as the state of oral health in the patients as a whole. In all subjects, an X-ray follow-up was done in order to assess the place where the implants would be placed. The most commonly used were orthopantomographic images. Orthopantomograms were the choice because they are easily available and inexpensive. The same images were also used to plan the localization of the implants to be placed.

Implant insertion procedure

After determining the indication and making a treatment plan, a surgical procedure for inserting the dental implants was performed on each of the patients. All implants are inserted according to the two-phase implantation protocol, with delayed loading. In each of the patients, the implant is inserted into the bone and covered with a mucoperiosteal flap. In the second phase, the implant is revealed and the sulcus former is placed on it, and after healing, the superstructure itself is placed.
The measurement technique is based on a small transducer that is screwed onto the implant and tightened, according to the manufacturer's specifications, to 10 N-cm of torque. Since all implant systems are not the same and have different shapes and designs, the Mis Seven - internal hexagon implants also have a different internal connection, which is hexagonal. In this study, a transducer or pin Smartpeg type with number 32 was used, which is used only for one patient. In patients with Straumann Bone Level implants with a diameter of 3.3 mm, a transducer or pin -Smartpeg 53 was used, in Straumann Bone Level implants with a diameter of 4.1 and 4.8 mm, a transducer or pin Smartpeg type 54 was used. In patients with Straumann Standard plus implants with diameters of 3.3, 4.1, and 4.8 mm, a transducer or pin -Smartpeg 4 was used. The wireless device with its measuring probe approaches the transducer a few millimeters without touching it. An audible signal is received from the instrument when the stability loading is obtained and the results are shown in the display. The resulting ISQ values represent the resonant frequencies of the electromagnetic waves. Four measurements were performed for one implant from the mesial, distal, buccal and palatal/lingual sides and these were recorded in the appliance. It is normal for the stability of the implants to be the same in all directions, but sometimes the bone around the implant can vary, which can cause the stability to be different in different directions. This is also the case with bone defects on the buccal side, in those areas it is normal to have reduced ISQ values. That's why the Osstell manufacturer and research forum suggested we take four measurements from all sides around the implant.
The data was registered on a computer, which was transferred to the Osstell IDX Software v.3.0 program via a USB cable.
Data analysis was performed in Statistica 7.1 for Windows and SPSS Statistics 17.0 statistical software.

3. Results and discussion

At the beginning, the data relating to influence of risk factors on the primary stability of dental implants for placed Mis dental implants will be presented.
From all 50 patients, 15 (30.00 %) patients had no registered risk factors, 13 (26.00 %) were smokers, 2 (4.00 %) patients had diabetes, 15 (30.00 %) patients had HTA, and 5 (10.00%) patients had some periodontal disease. (Table. no. 1)

Table 1. Presence of risk factors

Risk factors	No	Cumulative	%	Cumulative %
None	15	15	30,00	30,00
Absence	13	28	26,00	56,00
Smoking	2	30	4,00	60,00
Diabetes	15	45	30,00	90,00
Periodontal disease	5	50	10,00	100,00
Missing	0	50	0,00	100,00

The results shown in table No. 2. refer to the investigated relationship between the primary stability of dental implants as a dependent variable and gender (men), age of patients, smoking, diabetes, HTA and chronic periodontitis as independent variables.

Table 2. Influence of risk factors

R= 0,64 ; F(6,43)=4,91 and p<0,000						
	Beta	Std.Err. of Beta	B	Std.Err. of B	t(44)	p-level
Intercept			61,23	5,03	12,18	0,000
Male	0,05	0,13	0,70	1,76	0,40	0,69
Age	0,21	0,13	0,13	0,08	1,59	0,12
Smoking	-0,53	0,15	-7,98	2,33	-3,43	0,001
Diabetes	-0,32	0,12	-10,71	4,19	-2,56	0,01
HTA	-0,53	0,14	-7,61	2,07	-3,68	0,0007
Periodontal disease	-0,26	0,13	-5,85	2,96	-1,97	0,05

A strong significant correlation was registered for R=0.64 and p<0.001 in the investigated relationship.
The patients in whom the analyzed risk factors were not registered were taken as a reference category.
The biggest influence on the primary stability of these type of dental implants has smoking (Beta=-0.53), followed by HTA (Beta=-0.53), diabetes (Beta=-0.32), periodontal disease (Beta=-0.26), the age of the patients (Beta=0.21), and the weakest influence is by the gender (men) (Beta=0.05).
Smokers have an average of 7.98 (B=-7.98) units lower primary implant stability compared to non-smokers, significant for p<0.01(p=0.001), with unchanged values of other parameters.
Patients who have HTA on average by 7.61 (B=-7.61) units have lower primary implant stability compared to patients who do not have HTA, significant for p<0.001(p=0.000), with unchanged values of other parameters.
Diabetic patients had an average of 10.71 (B=-10.71) units lower primary implant stability compared to non-diabetic patients, significant for p<0.05 (p=0.01), at unchanged values of the other parameters.
Patients who have periodontal disease by an average of 5.85 (B=-5.85) units have lower primary implant stability compared to patients without these conditions, non-significant for p>0.05 (p=0.05), with unchanged values of the other parameters.

With each one-year increase in age, the primary stability of implants (on average) increased by 0.13 (B=0.13) units, non-significant at p>0.05(p=0.12), with unchanged values on the other parameters.
Men have on average 0.70 (B=0.70) units higher primary stability of implants compared to women, insignificant for p>0.05(p=0.69) , with unchanged values of other parameters.
The results shown in table 3 refer to the investigated relationship between the primary stability of dental implants as a dependent variable and gender (men), age of patients, smoking, diabetes, HTA, osteoporosis and periodontal disease as independent variables for Straumann implants.
From a total of 50 patients, 15 (30.00 %) patients had no risk factors, 11 (22.00 %) were smokers, 6 (12.00 %) patients had diabetes, 10 (20.00 %) patients had HTA, 1 (2.00 %) had osteoporosis, and 7 (14.00 %) had some periodontal disease. (Table 3)

Table 3. Presence of risk factors

Risk factors	No	Cumulative	%	Cumulative %
Absence	15	15	30,00	30,00
Smoking	11	26	22,00	52,00
Diabetes	6	32	12,00	64,00
HTA	10	42	20,00	84,00
Osteoporosis	1	43	2,00	86,00
Periodontal disease	7	50	14,00	100,00
Missing	0	50	0,00	100,00

For R=0.47 and p>0.05, a medium strong insignificant correlation was registered in the examined relationship.
The patients in whom the analyzed risk factors were not registered were taken as a reference category.
The biggest influence on the primary stability of these dental implants has the age of the patients (Beta = -0.27), followed by diabetes (Beta = -0.25), gender (men) (Beta = 0.25), periodontal diseases (Beta = -0, 20), smoking (Beta = -0.14), HTA (Beta = 0.11), and the weakest influence is from osteoporosis (Beta = -0.07).
With each one-year increase in age, the primary stability of the implants (on average) decreased by 0.09 (B=-0.09) units, non-significant at p>0.05(p=0.09), with unchanged values on the other parameters.
Diabetic patients had an average of 2.76 (B=-2.76) units lower primary implant stability compared to non-diabetic patients, non-significant at p>0.05 (p=0.11), with unchanged values on the other parameters.
Men have an average of 1.78 (B=1.78) units higher primary implant stability compared to women, insignificant for p>0.05 (p=0.09), with unchanged values of other parameters.
Patients who have periodontal disease have on average 2.11 (B=-2.11) units lower primary implant stability compared to patients without periodontal disease, non-significant for p>0.05 (p=0.20), at unchanged values of the other parameters.
The smoker has an average of 1.20 (B=-1.20) units lower primary stability of the implants compared to the non-smoker, insignificant for p>0.05 (p=0.40), with unchanged values of other parameters.
Patients who have HTA on average by 0.98 (B=0.98) units have higher primary implant stability compared to patients who do not have HTA, non-significant for p>0.05 (p=0.52), with other values unchanged parameters.
The patient who had osteoporosis had an average of 1.86 (B=-1.86) units lower primary stability of the implants compared to the patient who did not have osteoporosis, insignificant for p>0.05 (p=0.62), with unchanged values of the rest parameters.

Table 4. Influence of risk factors

R= 0,47 ; F(7,42)=1,68 и p<0,14						
	Beta	Std.Err. of Beta	B	Std.Err. of B	t(44)	p-level
Intercept			66,58	2,689	24,77	0,000
Male	0,25	0,14	1,78	1,03	1,73	0,09
Age	-0,27	0,15	-0,09	0,05	-1,75	0,09
Smoking	-0,14	0,16	-1,20	1,41	-0,85	0,40
Diabetes	-0,25	0,15	-2,76	1,71	-1,61	0,11
HTA	0,11	0,17	0,98	1,50	0,66	0,52
Osteoporosis	-0,07	0,14	-1,86	3,71	-0,50	0,62
Periodontal disease	-0,20	0,16	-2,11	1,61	-1,31	0,20

This clinical study was performed in the private health dental clinic "Vita-Dent" in Tetovo, Republic of Macedonia. All subjects who are included in the study group are of legal age and have given their consent for the performed therapeutic activity.All dental implants are placed and all measurements taken are made by an oral surgery specialist. Therefore, we do not need to harmonize and standardize the received data. The research covers the period from 2014 to 2019. The presented data and results refer to 100 subjects included in the research group.

Primary implant stability at placement is a mechanical phenomenon that is related to local alveolar bone quality and quantity, implant type, and implant placement technique.The primary stability of a placed dental implant is related to the mechanical relationship and contact of the implant with the surrounding alveolar bone, while the bone regeneration and remodeling phenomena affecting the alveolar bone, in turn, determine the secondary or biological stability of the placed implant. Provided and adequate primary stability is positively correlated with secondary stability (Javed et al., 2013).

Elaborating on the primary stability of implants, Atsumi et al., (2007) made the classification of the following factors affecting primary stability:

1. Quantity and quality of the alveolar bone in which the implants are placed;
2. Surgical technique and procedure, the method and of course, including the skill and experience of the surgeon or clinician who places the implant;
3. The implant (ie its shape, geometry, length, diameter and surface characteristics).

Turkyilmaz et al. in their study from 2009 indicated that the factors affecting implant stability can be divided into two large groups:

1. patient-related factors (alveolar bone volume and quality, presence of general or local systemic factors);
2. parameters dependent on the implantation procedure itself, which in turn are divided into:
    I. type of implant;
    II. type of surgical procedure.

The method we had used in this research is the resonance frequency analysis. Meredith (1997) and Sennerby and Meredith (1998) first proposed the RFA method as a highly efficient qualitative method for assessing the stability of dental implants. Resonance frequency analysis (RFA) allows assessment of implant stability

by measuring the frequency of implant oscillation in the alveolar bone. This analytical procedure represents an objective and non-invasive method for measuring the stability of implants, although so far there is limited evidence in the literature for its complete reliability. Resonance frequency analysis is a non-invasive diagnostic technique that uses a piezoelectric transducer, which emits a sinusoidal signal within a certain frequency, which means it causes the dental implant to vibrate. What is measured with this instrument is the resistance of the implant to the action of vibration. The implant resistance to vibration is measured by the device and transformed into an ISQ (Implant Stability Quotient) value. The values of this quotient range from zero to 100, with a value of 100 indicating the maximum stability of the implant. What is most significant in the analysis of the data is that the higher the readings of the instrument, the better the stability of the implant.

Precisely because of that, but also because it is a non-invasive diagnostic method that measures the stability of implants, RFA is gaining considerable popularity in modern implantology. More importantly, it is a portable, hand-held device that uses magnetic frequencies between a transducer and a resonant frequency analyzer. The transducer is a metal obstacle, with a magnet on top of which the implant or abutment is attached with a force of 5 to 10 Ncm.

Epidemiologically, a risk factor is defined as an environmental exposure, an aspect of an individual's behavior or characteristics, which is related to a certain disease or phenomenon (such as, for example, the presence of dental plaque in the context of the development of peri-implant infection), as opposed a determinant is defined as a non-modifiable risk factor (such as an innate defect in neutrophil granulocyte function that impairs the host's immune response).

Risk factors for the occurrence of periodontal disease are necessary to be evaluated especially when placing implants. This especially applies to the period after the placement of the implants, in the phase of maintaining of the achieved results and, of course, in the assessment of the success of the implant therapy. In low-risk persons, even simple prophylactic procedures are sufficient, and the success of aesthetic restoration or dental implant is high. This is not the case in people with moderate or severe periodontal diseases, in whom periodontal therapy should first be carried out and more frequent check-ups should be done to achieve and maintain adequate periodontal health. Patients should be made aware that unless satisfactory periodontal status is achieved, dental implants and their longevity may be compromised.

There is a strong similarity between chronic periodontitis and peri-implantitis. Both chronic periodontitis and peri-implantitis are caused by bacterial infection from microorganisms located in a biofilm and show similar clinical features such as inflammation of the soft tissues and the appearance of defects in the alveolar bone in which the teeth or dental implants are located. But what must be noted is that inflammation of the peri-implant tissue develops more easily than that of the periodontal tissue, probably because the attachment between the implant body and the gingiva is weaker than the connection of the gingiva to the natural teeth. Therefore, maintaining satisfactory oral hygiene around the implants is extremely important for their longevity. (Petrovski & Papakoca, 2020).

Risk factors associated with failure of implant therapy have become a frequently discussed topic in recent dental research. Systemic and local risk factors for early and late implant failure have been studied in numerous literature reviews.

Risk factors for failure of implant therapy in the context of primary and secondary stability of dental implants in our study were identified using the Multiple Regression test (R, Beta, B, p).

Apart from "Risk factors related to operators" and "Risk factors related to biomaterials" in the world's professional and scientific literature, a big attention is focused on the influence of risk factors, and especially on "risk factors related to patients". There are many medical conditions and medications where there is insufficient evidence to say that they are absolute contraindications to treatment. However, some conditions and medications require medical evaluation and may be considered "relative risk factors." Some of these conditions are: Parkinson's disease, osteoporosis, hyperparathyroidism, certain bone disorders, such as

Morbus Paget, certain autoimmune diseases, such as Lupus erythematodes, smoking, a combination of excessive smoking, a history of periodontal disease, especially aggressive periodontopathy , certain medications, such as, for example, oral bisphosphonates, corticosteroids, immunosuppressants, and anticoagulants (Arlin, 2016).

Advanced age as a risk factor is of considerable interest, because the number of elderly people is increasing. The majority of studies on this topic, however, have not associated advanced patient age with greater implant failure. The results of this treatment have indicated that healthy vital elderly patients who have received dental implants may have the same prognosis as younger patients (Ikebe, 2009; Ettinger, 2015).

One of the most significant risk factors for reducing implant stability is gender. Namely, in the large number of studies, it has been proven that the decrease in the primary and secondary stability of the implants, and therefore in the longevity of the implants, is generally more present in the male population, in contrast to the female population. It has also been proven that male individuals usually maintain oral hygiene less than female individuals. It is considered that the reason for the above is related to the less satisfactory oral hygiene in men (Negri et al., 2014).

When placing dental implants, special attention should be paid to people who have conditions that are considered to be relative contraindications, such as:

- Uncontrolled/controlled diabetes;
- Smoking;
- Osteoporosis;
- Alcoholics;

Persons receiving medication due to the possible induction of gingival enlargement by some medications.

Diabetes affects the metabolism of carbohydrates, fats and proteins in the body (which is manifested by characteristic complaints), and after a long time it also affects the structure and function of blood vessels, nerves and other vital organs and organ systems. The main oral problems that occur in diabetics are oral infections and xerostomia, diseases of the teeth and surrounding dental tissues, and long healing after any intervention in the oral medium. If you wait too long, some of these problems can lead to permanent consequences. As such, the effect of inadequately treated diabetes and failure of implant therapy is an important topic in the literature. Some authors have found that the presence of diabetes has little influence on implant failure (Oates & Huynh-Ba, 2012; Oztel et al., 2017), while others agree that poorly controlled diabetes mellitus is associated with inadequate osseointegration, increased risk of peri-implantitis and periodontopathy (Razmara & Kazemian, 2015). In a retrospective cohort study including 48 diabetic and 1092 nondiabetic patients, Moy et al. (2005) reported a statistically significant relative risk for diabetic patients of 2.75 (95 % CI 1.46, 5.18). A systematic review of a total of four articles by Klokkeveld et al. (2007) found no significant difference in implant survival rates in Type 2 diabetic patients (91.7%) versus non-diabetics (93 .2%). But the results of this research should be taken with a grain of salt because only one of the reviewed studies. In the context of diabetes, in their review, Valero et al. (2007) found a higher failure rate of implant therapy in diabetic patients compared to the general population, predominantly during the first year after functional loading.

Smoking is considered a relative risk factor because there have been numerous studies that have correlated smoking with increased rates of implant failure. There is also evidence that the risk may be dose-related and that smoking cessation may reduce the risk. The consumption of tobacco and other nicotine products can adversely affect the wound healing process, thus jeopardizing the success of bone grafting and implantation. A higher complication rate and implant failure rate were found in smokers with and without bone grafts during implant placement (Levin & Schwartz-Arad, 2005). Several previously published studies have pointed to the fact that cigarette consumption reduces the success rate of osseointegration and may be considered a risk factor for implant loss (Chen et al., 2013; Noda et al., 2015; Borba et al., 2017). In contrast, a study by Zupnik et al. (2011) found no association between implant failure and smoking. In one

study published by Vahemente et al. (2002) was noted that two risk factors are statistically associated with failure of implant therapy, such as tobacco use and period of implant loading. Regarding cigarette consumption, some studies (Noguerol et al., 2006; Bornstein et al., 2009) have found significantly greater treatment failure in smokers who consume more than twenty cigarettes per day than in nonsmokers. It has also been found that early failure and reduced primary of implants is associated with smoking and increased with cigarette consumption (Alsaadi et al., 2007). Van Steenberghe et al. (2002) found that approximately one from three implant failures occurred in smokers, and one in five patients with early implant failure smoked more than 10 cigarettes per day, whereas only 12.3% of patients were smokers without implant therapy failure. In contrast, Sverzut et al. (2008) did not observe a statistically significant association between smoking and early complications in implantology, concluding that smoking alone cannot be considered a risk factor for early implant loss.

Smoking and its relationship to various periodontal conditions have been the subject of great interest to a number of researchers. Smoking and peri-implant inflammation and risks are frequently discussed risk factors for implant failure and inflammation. In addition to these factors, various systemic diseases, genetic traits, the usual use of drugs or alcohol, smoking, the presence of periodontal diseases, radiation therapy, diabetes, osteoporosis, dental hard deposits and, of course, inadequate attention are also influencing the stability and longevity of the implants. towards your own oral health.

Osteoporosis is a condition characterized by a decrease in bone quality and bone quantity. Whether osteoporosis affects bone quality, bone quantity, or both remains a matter of controversy. It is important that treatment planning for implant therapy is based on a local assessment of the implant site (Tsolaki et al., 2009).

Very often systemically used drugs have an impact on bone metabolism, especially the treatment of osteoporosis, which is why in the past it was believed that they could negatively affect osseointegration. One study from 2016, however, found no convincing experimental evidence that the use of these drugs should be considered an absolute contraindication to implant therapy. However, the authors advise that these situations should be approached with caution and that further in vivo experimental studies are needed. Systemic drugs that were analyzed in this review paper are as follows: Cyclosporine, Glucocorticoids, Selective Serotonin Inhibitors, Nonsteroidal Anti-Inflammatory Drugs, Oral Bisphosphonates, and Chemotherapeutic Agents (Ouanounou et al., 2016). Numerous authors are of the opinion that the use of implants is contraindicated in patients with osteoporosis, and they conclude that impaired bone metabolism leads to a reduction in the healing process of the alveolar bone around the implants. However, other authors believe that the presence of osteoporosis is not a definite condition for contraindication to dental implant therapy. In these cases, the dentist should perform appropriate treatment planning, modify the morphology of the implant and use implants with a larger diameter and surface treatment. Thus, osteoporosis will no longer be a contraindication for implant placement, especially if an accurate analysis of alveolar bone quality is performed using computed tomography (Venkatakrishnan et al., 2017).

Increased blood pressure (hypertension) is also a risk factor for disrupting the stability of the implants, and hence the longevity of the implant therapy. Primarily, elevated blood pressure during implant placement surgery increases the chance of intraoperative bleeding. In the context of dentists working under local anesthesia, precautions should be taken if such a surgical intervention is planned and the patient's blood pressure is elevated. This is especially important if the patient is taking anticoagulants, such as aspirin or warfarin. After the dental implant placement procedure, our attention needs to be directed to the period of post-operative recovery and healing of the dental implant. Inadequately managed high blood pressure limits the delivery of oxygen and nutrients to the veins and capillaries, thereby reducing the ability of surrounding blood-dependent cells to regenerate and repair cells. Drug-controlled blood pressure has very little effect on healing progress after placement of dental implants, but it does have the effect of avoiding indirect side effects of the healing process itself (Sánchez et al., 2013). In modern dental literature, it has been noted that

higher blood pressure is associated with increased bone loss. This may be because hypertension is associated with abnormal calcium metabolism, including increased urinary calcium excretion (Strazzullo et al., 1983). In our study we observed a significant effect of hypertension on osseointegrated implants. However, similar to what was observed in the literature, similar to our study, only a small proportion of hypertensive patients were not taking any type of antihypertensive medication. However, the hypertensive patients who did not take drugs, the survival rate of the implants, were comparable to the group of hypertensive patients who received antihypertensives. (Wu et al., 2016) Xerostomia is a side effect of the use of several antihypertensives. By changing other antihypertensives, xerostomia is rarely avoided as a side effect, and as a result of xerostomia, there is an increased prevalence of dental plaque and a burning and burning sensation in the oral cavity. As a result of the presence of xerostomia and the increased concentration of dental plaque, in people with hypertension who have dental implants placed, there is a greater possibility of developing inflammatory conditions around the implant, and thus there is an increased possibility of reducing its primary stability and through that the duration of the implant therapy itself also decreases. (Petrovski et al., 2015) The presence of gingival proliferation can also have an adverse effect on implant stability. It occurs when using some antihypertensive drugs (calcium blockers). The reason for the appearance of reduced stability in these cases is similar to the previously mentioned, that is, gingival enlargement leads to a reduced possibility of dental plaque removal and permanent bacterial colonization in the peri-implant tissues. (Petrovski, 2022)

What was discovered during our research is that smoking (Beta=-0.53), followed by hypertension (Beta=-0.53), diabetes (Beta=-0) has the greatest impact on the primary stability of MIS Seven dental implants. .32), periodontopathy (Beta=-0.26), the age of the patients (Beta=0.21), and the weakest influence is gender (that is, male gender) (Beta=0.05). Smoking (Beta=-0.44), followed by hypertension (Beta=-0.39), patient age (Beta=0.29), diabetes (Beta=-0, 24), periodontitis (Beta=-0.15), and the weakest influence is gender (male) (Beta=-0.003).The biggest influence on the primary stability of Straumann dental implants is the age of the patients (Beta=-0.27), followed by diabetes (Beta=-0.25), gender (men) (Beta=0.25), periodontitis (Beta=-0.20), smoking (Beta=-0.14), HTA (Beta=0.11), and the weakest influence is osteoporosis (Beta=-0.07). Such data differ from those commonly presented by Cobo-Vázquez et al. (2018), Hasan (2022) and Stanford (2010), but are similar to data presented by Mesa et al. (2008). We believe that this phenomenon is due to the small number of subjects in whom the presence of risk factors is determined.

According to Nergi et al. (2014), when patients were stratified by sex, there was a difference in primary stability observed in both male and female patients, although not statistically significant. According to Kop et al. (2013), none of the investigated factors such as age, sex, implant location, its design and length are statistically significant modifiers of the primary stability of implants and hence of the success of treatment with dental implants.

According to a study by Mesa, et al. (2008) women have a 1.54 times greater risk of loss of primary implant stability. This data contradicts our research, according to which men have a higher risk of implant loss as a result of loss of primary implant stability. According to Noguerol et al. (2006), only age and cigarette smoking were independently associated with early failure of implant therapy by decreasing values for primary stability of implants.

Similar to our study in one study from 2020, (HH, 2020) lower ISQ values (60.04 ± 0.4) were found in smokers than non-smokers (62.9 ± 0.6), (P = 0.0047) for primary stability of the implants, similarly to the secondary stability (64.0 ± 0.5) and (67.2 ± 0.6), (P = 0.0002). ISQ values, according to the same authors at the time of implantation did not differ between smokers and non-smokers, statistically significant differences were found 6 months after placement of implants (65.52 ± 5.05) and (67.61 ± 5.109) (P = 0.0226), respectively.

4. Conclusions

Based on the data from this research it can be observed that most of the subjects have risk factors that can have effect on the reduction of the primary stability of the implants. The most significant risk factors affecting primary implant stability, and hence the longevity of implants, are tobacco consumption, systemic factors such as diabetes and hypertension, and the local negative impact of various forms of periodontal disease. Smokers have significantly lower primary implant stability compared to non-smokers. Also, diabetic patients on average have significantly lower primary implant stability compared to non-diabetic patients.

References

[1]. Adell, R., Eriksson, B., Lekholm, U., Brånemark, P. I., & Jemt, T. (1990). A long-term follow-up study of osseointegrated implants in the treatment of totally edentulous jaws. International Journal of Oral & Maxillofacial Implants, 5(4).

[2]. Alsaadi, G., Quirynen, M., Komárek, A., & Van Steenberghe, D. (2007). Impact of local and systemic factors on the incidence of oral implant failures, up to abutment connection. Journal of clinical periodontology, 34(7), 610-617.

[3]. Arlin, M. L. (2016). Risk factors in implant dentistry: Patient related risk factors. Oral Health, 26-36.

[4]. Atsumi, M., Park, S. H., & Wang, H. L. (2007). Methods used to assess implant stability: current status. International Journal of Oral & Maxillofacial Implants, 22(5).

[5]. Becker, A. R., Handick, K. E., Roberts, W. E., & Garetto, L. P. (1997). Osteoporosis risk factors in female dental patients. J Indiana Dent Assoc, 76, 15-19.

[6]. Borba, M., Deluiz, D., Lourenço, E. J. V., Oliveira, L., & Tannure, P. N. (2017). Risk factors for implant failure: a retrospective study in an educational institution using GEE analyses. Brazilian oral research, 31.

[7]. Bornstein, M. M., Halbritter, S., Harnisch, H., Weber, H. P., & Buser, D. (2009). A Retrospective Analysis of Patients Referred for Implant Placement to a Specialty Clinic: Indications, Surgical Procedures, and Early Failures. Implantologie, 17(1), 85-96.

[8]. Budu, V., Argatu, D., Butnaru, E., Grijincu, A., Herșcu, D., & Forna, N. C. (2022). PATIENT REQUIREMENTS FOR IMPLANT SELECTION. Romanian Journal of Medical and Dental Education, 11(1).

[9]. Buser, D., Weber, H. P., & Lang, N. P. (1990). Tissue integration of non-submerged implants. l-year results of a prospective study with 100 ITI hollow-cylinder and hollow-screw implants. Clinical oral implants research, 1(1), 33-40.

[10]. Chaudhry, S., Jaiswal, R., & Sachdeva, S. (2016). Dental considerations in cardiovascular patients: A practical perspective. Indian heart journal, 68(4), 572-575.

[11]. Chen, H., Liu, N., Xu, X., Qu, X., & Lu, E. (2013). Smoking, radiotherapy, diabetes and osteoporosis as risk factors for dental implant failure: a meta-analysis. PloS one, 8(8), e71955.

[12]. Cobo-Vázquez, C., Reininger, D., Molinero-Mourelle, P., González-Serrano, J., Guisado-Moya, B., & López-Quiles, J. (2018). Effect of the lack of primary stability in the survival of dental implants. Journal of clinical and experimental dentistry, 10(1), e14.

[13]. Esposito, M., Hirsch, J., Lekholm, U., & Thomsen, P. (1999). Differential diagnosis and treatment strategies for biologic complications and failing oral implants: a review of the literature. International journal of oral & maxillofacial implants, 14(4).

[14]. Ettinger, R. (2015), Treatment planning concepts for the ageing patient. Aust Dent J, 60: 71–85

[15]. French, D., Larjava, H., & Ofec, R. (2015). Retrospective cohort study of 4591 Straumann implants in private practice setting, with up to 10-year follow-up. Part 1: multivariate survival analysis. Clinical oral implants research, 26(11), 1345-1354.

[16]. Glauser, R., Lundgren, A., Gottlow, J., Sennerby, L., Portmann, M., Ruhstaller, P., & Hämmerle, C. H. (2003). Immediate occlusal loading of Brånemark TiUnite™ implants placed predominantly in soft bone: 1-year results of a prospective clinical study. Clinical implant dentistry and related research, 5, 47-56.

[17]. Hasan, A. (2022). An Investigation of Factors Affecting Aesthetic Outcome in Dental Implants in The Anterior Maxilla Region.

[18]. HH, G. (2020). E H. The clinical significance of implant stability quotient (ISQ) measurements: A literature review. Journal of oral biology and craniofacial research, 10(4), 629-638.

[19]. Hickin, M. P., Shariff, J. A., Jennette, P. J., Finkelstein, J., & Papapanou, P. N. (2017). Incidence and determinants of dental implant failure: a review of electronic health records in a US dental school. Journal of Dental Education, 81(10), 1233-1242.
[20]. Ibbott, C. G., Kovach, R. J., & Carlson-Mann, L. D. (1993). Acute periodontal abscess associated with an immediate implant site in the maintenance phase: a case report. International Journal of Oral & Maxillofacial Implants, 8(6).
[21]. Ikebe, K., Wada, M., Kagawa, R., & Maeda, Y. (2009). Is old age a risk factor for dental implants?. Japanese Dental Science Review, 45(1), 59-64.
[22]. Javed, F., Ahmed, H. B., Crespi, R., & Romanos, G. E. (2013). Role of primary stability for successful osseointegration of dental implants: Factors of influence and evaluation. Interventional Medicine and Applied Science, 5(4), 162-167.
[23]. Klokkevold, P. R., & Han, T. J. (2007). How do smoking, diabetes, and periodontitis affect outcomes of implant treatment?. International Journal of Oral & Maxillofacial Implants, 22(7).
[24]. Kopp, S., Behrend, D., Kundt, G., Ottl, P., Frerich, B., & Warkentin, M. (2013). Dental implants and immediate loading: multivariate analysis of success factors. Revue de stomatologie, de chirurgie maxillo-faciale et de chirurgie orale, 114(3), 146-154.
[25]. Krebs, M., Schmenger, K., Neumann, K., Weigl, P., Moser, W., & Nentwig, G. H. (2015). Long-term evaluation of ANKYLOS® dental implants, part I: 20-year life table analysis of a longitudinal study of more than 12,500 implants. Clinical implant dentistry and related research, 17, e275-e286.
[26]. Kumar, G., & Narayan, B. (2013). Osseointegrated titanium implants: Requirements for ensuring a long-lasting, direct bone-to-implant anchorage in man. In Classic papers in orthopaedics (pp. 507-509). London: Springer London.
[27]. Levin, L., & Schwartz-Arad, D. (2005). The effect of cigarette smoking on dental implants and related surgery. Implant dentistry, 14(4), 357-363.
[28]. Meredith, N., Books, K., Fribergs, B., Jemt, T., & Sennerby, L. (1997). Resonance frequency measurements of implant stability in viva. A cross-sectional and longitudinal study of resonance frequency measurements on implants in the edentulous and partially dentate maxilla. Clinical oral implants research, 8(3), 226-233.
[29]. Mesa, F., Muñoz, R., Noguerol, B., Luna, J. D. D., Galindo, P., & O'Valle, F. (2008). Multivariate study of factors influencing primary dental implant stability. Clinical oral implants research, 19(2), 196-200.
[30]. Mohajerani, H., Roozbayani, R., Taherian, S., & Tabrizi, R. (2017). The risk factors in early failure of dental implants: a retrospective study. Journal of dentistry, 18(4), 298.
[31]. Moy, P. K., Medina, D., Shetty, V., & Aghaloo, T. L. (2005). Dental implant failure rates and associated risk factors. International Journal of Oral & Maxillofacial Implants, 20(4).
[32]. Negri, M., Galli, C., Smerieri, A., Macaluso, G. M., Manfredi, E., Ghiacci, G., ... & Lumetti, S. (2014). The effect of age, gender, and insertion site on marginal bone loss around endosseous implants: results from a 3-year trial with premium implant system. BioMed Research International, 2014.
[33]. Noda, K., Arakawa, H., Kimura-Ono, A., Yamazaki, S., Hara, E. S., Sonoyama, W., ... & Kuboki, T. (2015). A longitudinal retrospective study of the analysis of the risk factors of implant failure by the application of generalized estimating equations. Journal of prosthodontic research, 59(3), 178-184.
[34]. Noguerol, B., Muñoz, R., Mesa, F., de Dios Luna, J., & O'Valle, F. (2006). Early implant failure. Prognostic capacity of Periotest®: retrospective study of a large sample. Clinical oral implants research, 17(4), 459-464.
[35]. Oates, T. W., & Huynh-Ba, G. (2012, February). Diabetes effects on dental implant survival. In Forum implantologicum (Vol. 8, No. 2, p. 7). NIH Public Access.
[36]. Ouanounou, A., Hassanpour, S., & Glogauer, M. (2016). The influence of systemic medications on osseointegration of dental implants. J Can Dent Assoc, 82(g7), 1488-2159.
[37]. Oztel, M., Bilski, W. M., & Bilski, A. (2017). Risk Factors associated with Dental Implant Failure: A Study of 302 Implants placed in a Regional Center. The journal of contemporary dental practice, 18(8), 705-709.
[38]. Petrovski, M. (2022). Periodontal status of institutionalized elderly. MEDIS–International Journal of Medical Sciences and Research, 1(1), 15-20.
[39]. Petrovski, M., Minovska, A., Ivanovski, K., Forna, D. A., & Forna, C. N. (2015). Chemical induced xerostomia among Institutionalized eldery. Revista de Chimie, 66(10), 1614-1617..
[40]. Razmara, F., & Kazemian, M. (2015). Etiology, complications, key systemic and environmental risk factors in dental implant failure. Int J Contemp Dent Med Rev, 81, 1-6.
[41]. Sánchez, M. R., Pereira, C. C. S., Manrique, N. C., Silva, C. A., De Oliveira, J. A., Botacin, P. R., ... & Okamoto, R. (2013). Alveolar bone repair process in spontaneously hypertensive rats untreated and treated with losartan. Histomorphometric and immunohistochemical analysis. International Journal of Oral and Maxillofacial Surgery, 42(10), 1305.

[42]. Sennerby, L., & Meredith, N. (1998). Resonance frequency analysis: measuring implant stability and osseointegration. Compendium of continuing education in dentistry (Jamesburg, NJ: 1995), 19(5), 493-8.
[43]. Stanford, C. (2010). Dental implant outcomes may vary in patients with a history of periodontal disease. Journal of evidence based dental practice, 10(1), 46-48.
[44]. Strazzullo, P., Nunziata, V., Cirillo, M., Giannattasio, R., Ferrara, L. A., Mattioli, P. L., & Mancini, M. (1983). Abnormalities of calcium metabolism in essential hypertension. Clinical Science (London, England: 1979), 65(2), 137-141.
[45]. Sverzut, A. T., Stabile, G. A. V., de Moraes, M., Mazzonetto, R., & Moreira, R. W. F. (2008). The influence of tobacco on early dental implant failure. Journal of Oral and Maxillofacial Surgery, 66(5), 1004-1009.
[46]. Tsolaki, I. N., Madianos, P. N., & Vrotsos, J. A. (2009). Outcomes of dental implants in osteoporotic patients. A literature review. Journal of Prosthodontics: Implant, Esthetic and Reconstructive Dentistry, 18(4), 309-323.
[47]. Turkyilmaz, I., Sennerby, L., McGlumphy, E. A., & Tözüm, T. F. (2009). Biomechanical aspects of primary implant stability: a human cadaver study. Clinical Implant Dentistry and Related Research, 11(2), 113-119.
[48]. Valero, A. M., García, J. C. F., Ballester, A. H., & Rueda, C. L. (2007). Effects of diabetes on the osseointegration of dental implants. Medicina oral, patología oral y cirugía bucal. Ed. inglesa, 12(1), 9.
[49]. Van Steenberghe, D., Jacobs, R., Desnyder, M., Maffei, G., & Quirynen, M. (2002). The relative impact of local and endogenous patient-related factors on implant failure up to the abutment stage. Clinical oral implants research, 13(6), 617-622.
[50]. Vehemente, V. A., Chuang, S. K., Daher, S., Muftu, A., & Dodson, T. B. (2002). Risk factors affecting dental implant survival. Journal of Oral Implantology, 28(2), 74-81.
[51]. Venkatakrishnan, C. J., Bhuminathan, S., Chandran, C. R., & Poovannan, S. (2017). Dental implants in patients with osteoporosis–a review. Biomedical and Pharmacology Journal, 10(3), 1415-1418.
[52]. Wu, X., Al-Abedalla, K., Eimar, H., Arekunnath Madathil, S., Abi-Nader, S., Daniel, N. G., ... & Tamimi, F. (2016). Antihypertensive medications and the survival rate of osseointegrated dental implants: a cohort study. Clinical implant dentistry and related research, 18(6), 1171-1182.
[53]. Zupnik, J., Kim, S. W., Ravens, D., Karimbux, N., & Guze, K. (2011). Factors associated with dental implant survival: a 4-year retrospective analysis. Journal of periodontology, 82(10), 1390-1395.