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COMPLICATIONS AND FAILURES IN MODERN IMPLANTOLOGY

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ABSTRACT

Aim of the study:The aims of this study are to review the available literature related to implant complications and propose a new classification method for dental implant complications and describe different methods and treatment modalitiesto deal with dental implant failure.

Material and methods: Dental literature was reviewed via focusing on articles and published in English, which included data regarding dental implants and complications. Data from 106 patients with 186 dental implants were analyzed. The presence of sucessful healing (yes/no) at the time of incorporation of the final prosthesis was assessed. Mixed models were compiled for each target variable to enable estimation of the effects of patient-related andimplant-related conditions on the risk of early implant failure.

Results:Types of complications in these three groups (Mild, Moderate, and Severe) were listed, and some of them were illustrated. Also, recommendations for clinicians were made on how to avoid these problems and/or overcome them. Nine out of 186 implants (4.8%) placed in 106 participants failed before incorporation of the final prosthesis.The use of shorter implants (< 10mm) and the need for augmentation procedures were associated with a greater risk of early implant failure. For shorter implants, the risk was 5.8 times greater than that for longer implants ($p = 0.0230$). Use of augmentation procedures increased the risk by a factor of 5.5 ($p = 0.0174$).

Conclusions:Implants placed in the dental practice with a specialization in implantology heal successfully. The use of augmentation procedures and of implants shorter than 10mm seems to be associated with a greater risk of early implant failure.The ultimate success of implants is not only based on diagnosis, evaluation, treatment planning but also on having a knowledge regarding the complications of implants and their fruitful management. In short it is always better to remember: 'Prevention is better than cure' and 'a stitch in time saves nine.'

Key words: Implant, Complications,Failures,Osseointegration.

INTRODUCTION

The field of implantology is progressing very rapidly with a wide variety of applications in various interdisciplinarybranches. These include prosthodontics (for replacing missing tooth and maxillofacial prosthesis), orthodontics (for the purpose of growth studies1 and anchorage2),periodontics (for bone preservation and augmentation3) andoral surgery. Proper case selection and treatment planningare the keys to success of implants. The focus of implant research is shifting from descriptions of clinical success to the identification of factors associated with failure. A detailed knowledge regarding the complications and failures is a must. Prompt management of these complications holds the key to the success of the implants.

Although advanced methods of oral-health preservation are delaying tooth loss to later in life, the loss of teeth is still a major problem in aging societies worldwide. Tooth loss can affect chewing function and dental esthetics and, therefore, oral-health-related quality of life. Dentists often have to select conventional toothsupported, implant-supported, or combined tooth–implant-supported prosthetic treatments on the basis of clinical conditions and patients' requirements. Implantsupported dental prostheses are now widely used for the replacement of one or more missing teeth.

Moreover, the use of dental implants can often avoid the integration of unrestored adjacent teeth or the use of a removable prosthesis.

Implant systems characterized by micro-rough surfaces and internal abutment connections result in successful healing and long-term clinical performance. Nonetheless, it should be remembered that early failure (no or inadequate osseointegration, i.e., intimate bone-to-implant connection before functional loading) can also occur. Early failures account for approximately 2–6% (%) of implants placed, and the incidence can be even higher for implants placed in specific risk populations (for example (e.g.), patients receiving zygoma implants after tumor surgery or radiotherapy and/or chemotherapy).

Early loss of an implant is not, however, an acute rejection reaction; rather, it is a consequence of bacterial colonization of the implant surface, which results in the development of fibrous scar tissue between the implant surface and the surrounding bone. Factors identified as being associated with early implant loss are diverse, as is the definition of early loss (endpoints, e.g., abutment connection, occlusal loading, oneyear after placement, etc.)

Several studies have attributed the absence of healing to the implant site (maxilla or mandible, anterior or posterior), smoking, and comorbidities such as periodontitis and metabolic diseases. Poor healing is also linked with poor quality and low quantity of bone, which frequently results in the need for augmentation procedures, or in the selection of short implants. Preoperative antibiotics, in contrast, seem to be a protective factor for primary healing.

The purpose of this retrospective study was,therefore, to evaluate the early implant failure and possible risk factors for failure of dental implants placed in a dental practice of which one specialization is implantology and to review the dental literature regarding implant complications.Also, a new,clinically relevant, system of classification for implant complications was proposed as a guide for clinicians to identify the complications and overcome them.

Dental implant surgery has become routine treatment in dentistry and is generally considered to be a safe surgical procedure with a high success rate. However, complications should be taken into consideration because they can follow dental implant surgery as with any other surgical procedure. Many of the complications can be resolved without severe problems; however, in some cases, they can cause dental implant failure or even life-threatening circumstances. Avoiding complications begins with carefull treatment planning based on accurate preoperative anatomic evaluations and an understanding of all potential problems. This chapter contains surgical complications associated with dental implant surgery and management.

MATERIAL AND METHODS

A systematic review of the English literature was performed using an electronic database (Medline, PubMed). The following key word combinations were used during the search: “dental implants,” “dental implants and complications,” and “dental implants and complications and classification.” The full-text analysis of the review studies of relevance was conducted after titles and abstracts were screened for possible inclusion (Table 1). Data for the meta-analysis were extracted and compared by the reviewer. From an original yield of 3,736 articles, 613 were review articles and 493 were abstracts. Of those, 25 were selected for fulltext analysis. After the full-text analysis, 19 publications were excluded, as they did not include classifications for dental implant

complications. Only six review articles with full text including complication classifications were used in this study.

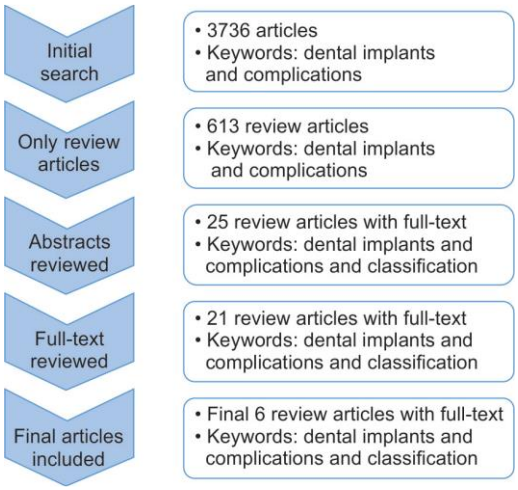


Table 1: The process of identifying the final six studies included from an initial yield of 3,736 articles

Also this retrospective study was performed with anonymized patient data from a dental practice. The owner of the practice was asked to provide data, for scientific purposes, from patients who had received one or more dental implants. All implant cases taking place between 2012 and 2017 (during which time a single implant system only was used) were anonymized on site.. The study protocol was evaluated and approved by the local ethics committee (no. S-248/2017). Only cases for which target variables were complete were included in the analyses.All implants placed at the dental practice from 2012 to 2017 were modern bone-level implants (blueSky; Bredent Medical, Senden, Germany). Surgery was performed by two dentists who offered the complete range of dental treatments, including prosthetic dentistry.

RISK FACTORS

Risk factors require an indispensible attention as they are often responsible for implant failures. The risk factors may be stated as:

Mechanical Factors

• Implant shape, surface
– Titanium implants with different shapes and surface preparations have similar success rates, but that smooth implants, compared to rough implants, appear to be less prone to peri-implantitis.
• Implant length and diameter
– Implants more than >4 mm in diameter showed better success rate than those with lesser diameters.5
– Shorter implants also showed more failure rates.

Anatomic and Osseous Factors

• Significant determinants for implant failure were poor bone quality (type 4), a resorbed jaw, and short implant length (7 mm).
• It has been found that neither jaw site (maxilla vs mandible) nor implant position (anterior vs posterior)
had any significant effect on implant survival.

Factors related to Occlusal Loading

• Parafunctional habits and excessive occlusal loadings are often a risk factor for implant failure.
• The opposing occlusion or dentition may also be a relevant determinant of implant success. Patients with implants opposing unilateral occlusal support showed the highest rate of implant failure (43.8%).

Systemic Risk Factors

• The most common systemic risk factors leading to implant failure are smoking, radiation treatment, diabetes (resulting in increased bone loss).
• Other common systemic conditions acting as risk factors for implant failure include chemotherapy, osteoporosis, hormone replacement therapy, scleroderma, Sjogren's syndrome, Parkinson's disease, multiple myeloma and HIV-positive individuals.

Microbial and Host Immune-inflammatory Factors

• Peri-implantitis, defined as infection and inflammation affecting implant supporting tissues, is leading causes of late implant failures.
• Organisms commonly involved are Porphyromonasgingivalis, Actinobacillusactinomycetemcomitans, Prevotellanigrescens, Staphylococcus aureus, Peptostreptococcus micros, Fusobacterium nucleatum, ssvincentii, F. nucleatum and ssnucleatum.

COMPLICATIONS

A complication is defined as a secondary condition that developed during or after implant surgery or prosthesis placement. It does not indicate that a substandard treatment was provided and also that an implant has failed. Prompt management of the complications is the key to implant success.

In 2008, Kelly Misch7 et al, had classified implant as:

• Treatment plan related (wrong angulation, improper implant location, lack of communication),
• Procedure related (lack of primary stability, mechanical complications, mandibular fracture, ingestion/ aspiration),
• Anatomy related (nerve injury, bleeding, cortical plate perforation, sinus perforation, devitalization of adjacent teeth) and others (iatrogenic, human error).
In 2010, Stuart J Froum,8 stated implant complications as:
• Associated with systemic disorders and medications
• Associated with implant planning
• Implant fractures
• Implant failures
• Peri-implantitis
• Esthetic complications due to implant malposition
• Related to immediate implant placement into extraction sites
• Related to immediately loaded dental implants
• Complications can also be described as those occurring during first stage surgery, second stage surgery, abutment connection, prosthetic procedure, control after prosthesis placement (Table 2).

Table 2: Implant complications

1st stage (during surgery)	2nd stage (abutment connection)	3rd stage (prosthetic phase)
1. Hemorrhage during drilling 2. Implant mobility after placement 3. Exposed implant threads 4. Lingual swelling 5. Postoperative pain around 6. Lower lip insensitivity 7. Exposed cover screw after few days 8. Abscess around cover screw	1. Sensitivity 2. Mobile implant (slight) and painful 3. Difficulty in insertion 4. Formation of granulation tissue around implant	1. Loosening of abutment screws 2. Fracture i. Abutment screw ii. Veneering material iii. Frame work 3. Bleeding on probing 4. Implant fracture 5. Bone loss around implant

Hemorrhage{bleeding}

The submental artery (2mm in average diameter) (Greenstein et al., 2008 as cited in Hofschneider et al., 1999) is a branch of the facial artery. The sublingual artery (2 mm in average diameter) arises from the lingual artery and is found coronal to the mylohyoid muscle (Greenstein et al., 2008 as cited in Martin et al., 1993). The arterial blood supply of the floor of the mouth is formed by an anastomosis of the sublingual and submental arteries. In the canine area, the vessels are located closer to the lingual plate and alveolar crest than they are in more posterior areas (Dubois et al., 2010).

Intraosseous hemorrhage is not a serious event, and control of the hemorrhage can be ensured by compressing the area with a directional indicator, an abutment, or the implant (Annibali et al., 2009). However, severe bleeding and the formation of massive hematomas in the floor of the mouth are the result of an arterial trauma.

A vascular wound may occur after detrimental surgical manipulations or tearing of the lingual periosteum, but in most cases, it is attributed to perforations of the lingual cortical plate. Mechanical pressure exerted by the expanding hematomas displaces the tongue and floor of the mouth both superiorly and posteriorly (Kalpidis&Setayesh, 2004). This occurrence may lead to extensive bleeding into the submandibular space, resulting in a life-threatening acute airway obstruction within the first few hours after surgery (Goodacre et al., 1999). The hemorrhage can easily spread in the loose tissues of the floor of the mouth(Fig. 1.), the sublingual area, and the space between the lingual muscles, which may require intubation or an emergency tracheostomy.

The surgeons also should consider other sources of potential hemorrhage and

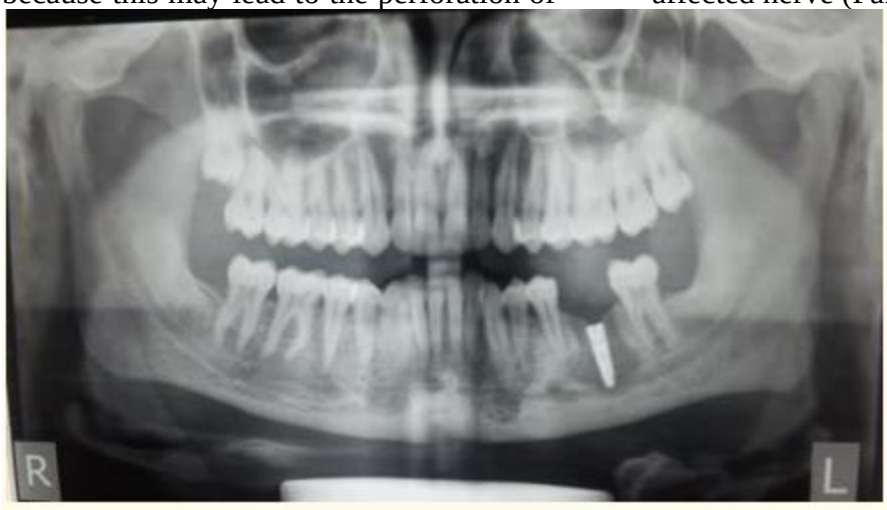
subsequent hematoma formation, including injuries to muscles or other soft tissues (Isaacson, 2004) (Fig. 2.). The escalating symptomatology of massive bleeding and progressive respiratory distress strongly resemble the clinical development of Ludwig's angina. Most important is the immediate bimanual compression at the suspected site of perforation and transport of the patient to the nearest hospital to secure the airway without delay (Dubois et al., 2010).

Hemorrhages can be controlled by gauze tamponage, application of hemostatic agents, cauterization, or digital compression. If a hemorrhage cannot be controlled by these methods, ligation of the bleeding vessel should be performed. An endovascular angiography is an alternative diagnostic tool that can overcome unsuccessful attempts to define and isolate the bleeding source. Incisions in the mucosa to relieve the hematoma should be avoided because they may promote further bleeding. The removal of an already inserted implant would also be ineffective.

To prevent unintentional hemorrhages in cases involving the immediate placement of implants or recent tooth extractions, the practitioner should be careful not to use the extraction socket as a guide for angulation because this may lead to the perforation of the lingual cortex (Isaacson, 2004 as cited in Givol, 2000). Soft-tissue management during the procedure is essential, and clinicians should make every attempt to avoid subperiosteal tears (Isaacson, 2004).

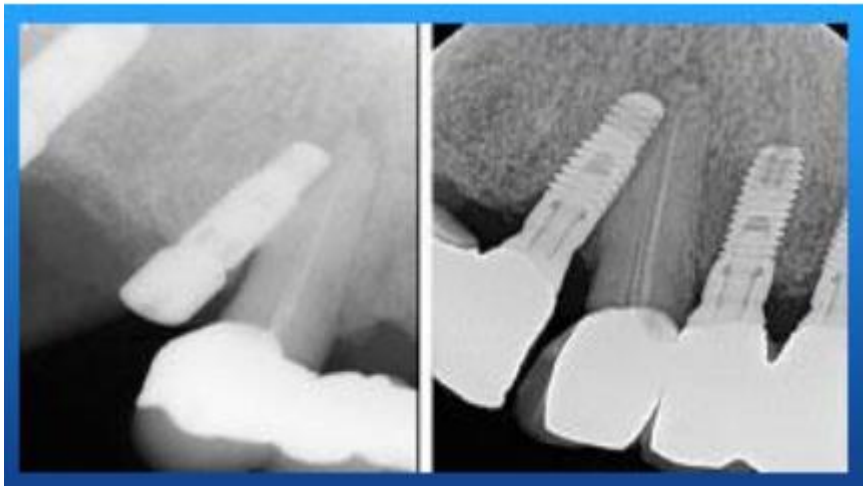
Neurosensory disturbances

A mean incidence of neurosensory disturbance incidence after implant surgery was 6.1% (Goodacre et al., 1999) to 7% (Goodacre et al., 2003), with a range between 0.6% and 39%. Nerve damage can have results ranging from mild paresthesia to complete anesthesia or even disabling dysesthesia.Possible causes of nerve injury include poor flap design, traumatic flap reflection, accidental intraneuralinjection, traction on the mental nerve in an elevated flap, penetration of the osteotomy preparation and compression of the implant body into the canal. Nerve injuries may be caused indirectly by postsurgical intra-alveolar edema or hematomas that produce a temporary pressure increase, especially inside the mandibular canal.Direct traumas are the most frequent causes of nerve injury, and they may occur through five mechanisms: compression, stretch, cut, overheating, and accidental puncture (Annibali et al., 2009). Finally, prolonged pressure from neuritis may lead to the permanent degeneration of the affected nerve (Park & Wang, 2005)



Injury to adjacent theet

Damage to teeth adjacent to the implant site may occur subsequent to the insertion of implants along an improper axis or after placement of excessively large implants. This problem arises more frequently with single implants (Annibali et al., 2009). Adjacent teeth should be evaluated before implant placement. Pulpal and periradicular conditions such as small periapical radiolucencies, root resorption and large restorations in/near the vital pulp are often misdiagnosed. Dilacerated roots and excessive tilting in the mesiodistal direction that invades the implant space often prevent ideal placement (Misch& Wang, 2008). The tilt of adjacent teeth should be assessed before drilling. The damage of an adjacent tooth by implant placement may cause the tooth to become non-vital, and the tooth may require subsequent endodontic treatment. This will not only result in damage to an adjacent tooth but also implant failure (Sussman, 1998). Use of a surgical guide, radiographic analysis and CT scan can help locate the implant placement, thereby avoiding damage to adjacent teeth. The angulation of adjacent teeth and dilacerations of roots must be radiographically assessed prior to implant placement. Ideally, 1.5 to 2 mm of bone should be present between an implant and the adjacent tooth. Furthermore, inspection of a radiograph with a guide pin at a depth of 5 mm will facilitate osteotomy angulation corrections (Greenstein et al., 2008). To prevent a latent infection of the implant from the potential endodontic lesion, endodontic treatment should be performed (Sussman, 1998).



Flap dehiscence and exposure of graft material or barrier membrane

The most common postoperative complication is wound dehiscence, which sometimes occurs during the first 10 days (Greenstein et al., 2008). Contributing factors of dehiscence and exposure of the graft material or barrier membrane include flap tension, continuous mechanical trauma or irritation associated with the loosening of the cover screw, incorrect incisions and formation of sequestration of bone debris (Park & Wang, 2005). Premature exposure of barrier membranes may also cause contamination of the graft and its eventual loss.

To avoid wound dehiscence, tension-free closure using a buccal releasing incision is most important. Dentures should be relieved with a tissue conditioner. Mattress

combined with interrupted sutures are also useful. When the dehiscence is small and occurs within 24 to 48 hours, the clinician can immediately resuture the dehiscence

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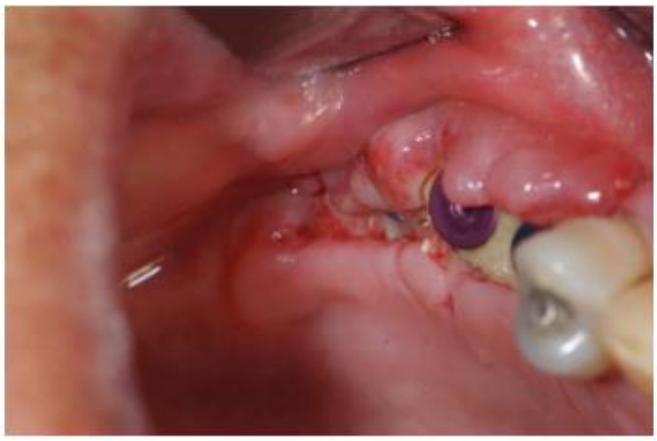
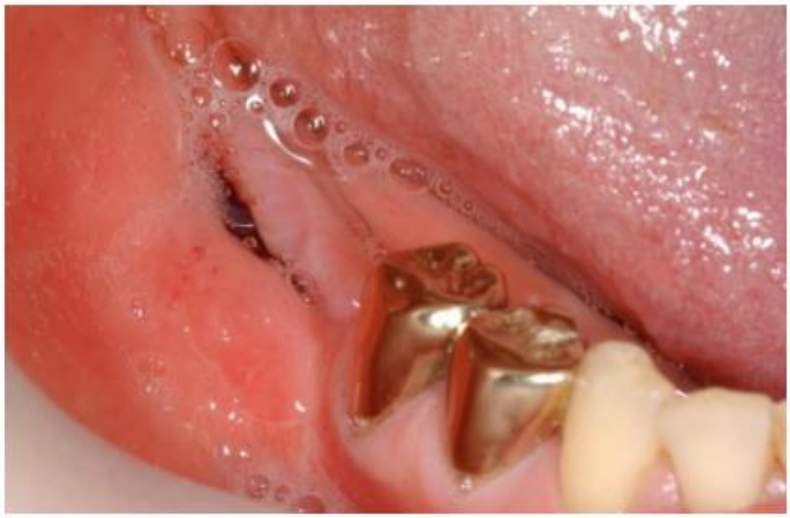


A dehiscence after guided bone regeneration and implant placement using a non-resorbable membrane.



A dehiscence after implant placement.

Bisphosphonate-related osteonecrosis

Bisphosphonates are drugs that inhibit bone resorption; they are widely used for the treatment of osteoporosis, multiple myeloma and skeletal complications of bone metastases.The American Association of Oral and Maxillofacial Surgeons(AAOMS) states that patients are considered to have bisphosphonate-related osteonecrosis of the jaw (BRONJ) if they have the following three characteristics: current or previous treatment with a bisphosphonate, exposed or necrotic bone in the maxillofacial reginthat has persisted for more than 8 weeks and no history of localized radiotherapy to the jaws (Advisory Task Force on Bisphosphonate-Related Ostenonecrosis of the Jaws, 2007). The risk of BRONJ associated with oral bisphosphonates appears to increase when the duration of therapy more than 3 years.

This time may be shortened in the presence of certain comorbidities. Type 2 diabetes mellitus (Abu-Idet al., 2008), prolonged steroid therapy (AdvisoryTask Force on BisphosphonateRelated Ostenonecrosis of the Jaws, 2007), and health-threatening habits such as smoking

(Wessel et al., 2008; Yarom et al., 2007) were suggested as predisposing conditions for the development of BRONJ.Ifsystemic conditions permit, discontinuation of oral bisphosphonates for a period of 3 months prior to and 3 months after elective invasive dental surgery may lower the risk of BRONJ. The risk reduction may vary depending on the duration of bisphosphonate exposure (Advisory Task Force on Bisphosphonate-Related Ostenonecrosis of the Jaws, 2007).

Currently, there are no reliable or widely available tests for the risk of BRONJ. Marx et al. recommend a blood test, specifically involving a serum C-terminal telopeptidetest (CTX) to assess a surrogate marker of bone turnover in patients taking oral bisphosphonates. Categorization of <100 pg/mL as high risk, 100 pg/mL to 150 pg/mL as moderate risk, and >150 pg/mL as minimal risk provides the clinician (Marx et al., 2007).

Many articles have confirmed that implant surgery in patients receiving oral bisphosphonate therapy does not result in BRONJ.(Bell &Bell, 2008; Fugazzotto et al., 2007; Grant et al.,2008; Jeffcoat, 2006)Nevertheless, patients taking bisphosphonates who either had implants that failed to integrate or had integrated implants that subsequently failed have been reported (Goss &Backhous, 2007; Stark&Epker, 1995; Wang et al., 2007).AAOMS does not contraindicate dental implant placement in patients who have been taking bisphosphonates orally for less than three years prior to surgery, provided that they do not present other risk factors such as medications with corticosteroids or advanced age (e.g., older than seventy years). It has been reported that oral bisphosphonates had a lower risk because they took longer to develop bisphosphonate-induced osteonecrosis given their slower accumulation rates in bone (Ruggiero et al., 2004).

Moreover, a drug holiday is recommended 3 to 6 months in duration before dental implant placement in patients with a history of oral bisphosphonate use for longer than 3 years (Ruggiero et al., 2009).Finally, current guidelines contraindicate the placement of dental implants in cancer patients treated with intravenous bisphosphonates (Ruggiero et al., 2009; Khan et al., 2008).
Although bisphosphonates tend to accumulate in sites of active bone remodeling like the jaws, surgical trauma to the alveolar bone during implant surgery could further stimulate the postoperative accumulation of the drug in the implanted site. The localized interference of bisphosphonates on areas of bone turnover may reduce the peri-implant bone resistance to oral bacteria in the long term, thus increasing the risk of peri-implantitis. The potential role of infection on implant failure and BRONJ occurrence is still debated. However, at least one study has reported a reduced incidence of BRONJ in patients who were given prophylactic antibiotics(Montefuscoet al., 2008).

In addition, the use of perioperative antibiotics and a chlorhexidene mouth wash have been suggested. Great attention should be paid to the oral hygiene and plaque control of implant-prosthetic restorations (Bedogni et al., 2010).Patients treated with bisphosphonates who receive implants should be followed for long periods of time. All patients treated with oral bisphosphonates must be informed of the potential complications of implant failure and BRONJ development in both the short and long term before the placement of dental implants (Bedogni et al., 2010

Results

Study population

Two-hundred and six implants in 116 patients were placed at the dental practice during the years 2012–2017. Seven implants with a reduced diameter (2.8 mm) placed in three participants had to be excluded from analysis. This was because these implants had a different design (one-piece tissue-level implants with, e.g., a ball welded onto the implant), and a sub-group analysis of n = 7 seemed insufficient to achieve meaningful results. Seven other participants with 13 implants who had either not yet been fitted with their final prosthesis or did not wish to continue treatment at the practice (e.g., because of moving home) were also excluded from analysis.

Thus, 186 complete datasets (n = 106 participants) were analyzed (response ~ 90% for number of implants and participants analyzed). The mean (standard deviation, SD) age of the participants was 60.6 (12.7) years; 58.5% were female. Approximately one fifth of the participants were smokers. Participants suffered from amean number (SD) of 0.8 (0.9) diseases and took 1.4 (2.0) permanent medications. Approximately 10% suffered from diabetes and 26% had a history of periodontitis. The mean healing time for the implants before the final prosthesis was attached and loaded was 147.8 (81.9) days, 154.3 (79.9) and 137.8 (91.2) days in the maxilla and the mandible, respectively). Detailed information about the implants (length, diameter, site, etc.) is presented in Table 3.

Table 3 Results from bivariate analysis of implant outcome and dichotomized predictor variables(n = 186)

	Number of healedimplants (%)	Number of failedimplants (%)	p-value
Age (years)			
< 61	86 (93.5)	6 (6.5)	0.290
≥ 61	91 (95.7)	3 (3.1)	
Gender			
Female	103 (96.3)	4 (3.7)	0.416
Male	74 (93.7)	5 (6.3)	
Diseases			
< 1	80 (95.2)	4 (4.8)	0.965
≥ 1	97 (95.1)	5 (4.9)	
Medications			
< 1	78 (94.0)	5 (6.0)	0.499
≥ 1	99 (96.1)	4 (3.9)	
Smoking			
No	136 (95.8)	6 (4.2)	0.484
Yes	41 (93.2)	3 (6.8)	
Diabetes			
No	159 (95.2)	8 (4.8)	0.927
Yes	18 (94.7)	1 (5.3)	
Periodontitis history			
No	121 (95.3)	6 (4.7)	0.915
Yes	56 (94.9)	3 (5.1)	
Implant length (mm)			
< 10.0	14 (82.4)	3 (17.6)	0.010
≥ 10.0	163 (96.4)	6 (3.6)	
Implant diameter (mm)			
< 4.0	40 (95.2)	2 (4.8)	0.979
≥ 4.0	137 (95.1)	7 (4.9)	
Implant location			
Anterior	43 (100)	0 (0.0)	0.092
Posterior	134 (93.7)	9 (6.3)	
Jaw			
Maxilla	104 (92.9)	8 (7.1)	0.072
Mandible	73 (98.6)	1 (1.4)	
Healing method			
Open	39 (100)	0 (0.0)	.113
Closed	138 (93.9)	9 (6.1)	

	Bone augmentation		
No	144 (97.3)	4 (2.7)	0.007
Yes	33 (86.8)	5 (13.2)	
	Torque reached (Ncm)		
< 30	59 (95.2)	3 (4.8)	1.000
≥ 30	118 (95.2)	6 (4.8)	

P-values are based on the chi-squared test. Significant p-values are marked in bold. P-values for trends (p < 0.100) are marked in italics

Estimation of risk factors for early implant loss

The effects of augmentation procedures (p = 0.0174) and implant length (p = 0.023) on implant healing were reproduced when adjusted for the different number of implants per participant (Table 4). Univariate, mixedmodel analysis revealed a 5.5-fold greater risk of failure of osseointegration (95% CI 1.4–21.7) for implants placed in an augmented implant site. A 5.8-fold greater risk was identified for short (< 10 mm) implants (95% CI 1.3–26.4).

Table 4 Results from univariate, mixed-model analysis with the dependent variable osseointegration (yes/no), participants as random factor, and the respective predictor as fixed factor (n = 186)

Variable	Odds ratio	95% CI Lower limit	Upper limit	pvalue
Older age	0.5	0.1	2.0	0.3029
Female	0.6	0.1	2.3	0.4232
More diseases	1.0	0.3	4.0	0.9648
More medications	0.6	0.2	2.5	0.5040
Smoker	1.7	0.4	7.1	0.4898
Diabetes	1.1	0.1	9.7	0.9278
Periodontitis history	1.1	0.3	4.6	0.9154
Shorter implant	5.8	1.3	26.4	0.0230
Narrower implant diameter	1.0	0.2	5.0	0.9790
Posterior implant*	6.1	0.3	111.3	0.2192
Maxilla	5.6	0.7	47.6	0.1113
Healing method (open)*	0.2	0.0	3.4	0.2535
Bone augmentation	5.5	1.4	21.7	0.0174
Lower torque	1.0	0.3	4.2	1.000

Significant p-values are marked in bold; *Because of non-convergence of the mixed model, a Firth-corrected logistic regression model was used instead to obtain estimates of odds ratios

After the initial search yielded 3,736 articles, a total of 613 potentially relevant review articles were identified in the database (Medline, PubMed), of which 25 were considered for full-text analysis. After the full-text analysis, only 6 review articles with complication classifications were used in this study. It has been considered that the classifications presented in the above articles are valuable, and it is important for clinicians to know why and how frequently those complications may occur. However, there is a need for a new clinically relevant classification that may guide clinicians in determining the problems that present and how to resolve them. In this report, the author who has been placing and restoring implants for 15 years proposed a new classification for implant complications by using his and his 10 colleagues' clinical experiences. This clinically based classification is called "Turkyilmaz's Classification of Implant Complications (TCIC)" with three groups: Mild, Moderate, and Severe. Types of

complications in these three groups were listed.

A few cases of moderate and severe complications were illustrated. In addition, suggestions are made of how to avoid these problems and/or overcome them. The clinician needs to ask himself/herself the following questions to determine the problem and how to resolve it: "What am I seeing now?", "Why/How did this happen?", "What should I do now?" After the determination of a specific complication, a strategic plan with back-up options should be considered
(Table 5) and then meticulously executed. It is crucial to inform the patient about the complication, explain to him/her the problem, and then what to do in order to fix it, before any remediation is attempted.

Table 5: The most frequently encountered problems in the clinic
in each category in TCIC
TCIC mild
• Occlusal adjustment, immediate cleaning of excess cement
• Replacement of screw access hole filling, re-cementation of
restoration
• Chairside repair of fixed and/or removable restoration
• Replacement of retentive plastic males on locators
• Re-tighten abutment (locator) and abutment/retaining screw
TCIC moderate
• Early (in days/weeks) cleaning of excess cement
• Removal/replacement of abutment/retaining screw
• Replacement of restoration due to poor fit and/or esthetics
• Replacement of broken abutment/framework/restorative material
• Restoration of mispositioned/misangulated implants
TCIC severe
• Late (in months) cleaning of excess cement
• Nonreplaceable broken abutment/framework
• Nonrestorablemispositioned/misangulated implants, poor
esthetics
• Removal of broken/failed implant
• Inferior alveolar nerve injury, jawbone fracture, and sublingual
hematoma

DISCUSSION

In this study, the dental literature regarding implant complications was reviewed and a new classification related to implant complications was suggested. The literature review showed a few articles including specific classifications. The classification presented in this article was mainly developed from clinical experiences, which many clinicians may face, while most of the previous studies included categories from a certain angle or a specific type of complication and factors that might have caused it.

The new classification presented in this article includes three major categories and some problems may be seen in multiple categories, as the timing of discovery of the problem is associated with the extent of damage, which significantly affects the actions needed to be taken. To date, no consensus has been established on which retention system (cement- or screw-retained) is best to avoid soft tissue problems and peri-implant bone loss. Due to fewer biologic complications, peri-implant bone loss, and maintenance requirements, screw-retained implant-supported restorations are recommended by some studies.Cleaning of excess cement may be a mild, moderate, but also a severe complication. The damage, typically peri-

implant gingival inflammation, bone loss, and possible implant failure may vary.

Complete removal of excess cement from subgingival margins of abutment-supported restorationsis unpredictable. In his study using a dental endoscope, excess cement was associated withsigns of peri-implant disease in 81% of the participants and removal of excess cement resulted in resolution of the peri-implant disease in 74% of the participants. Two other studies showed that complications involving residual excess cement ranged from acute severe bone
resorption to implant loss.

As clinicians gained experience in implant dentistry, they encountered several complications associated with the surgical procedure. One of the most serious complications faced by the clinician and the patient is injury to the inferior alveolar nerve (IAN) after implant placement in the mandible. These implant-associated IAN injuries may occur during preparation or insertion of a dental implant. axonotmesis, and neurotmesis) of nerve injuries based
They may be directly related to the depth of preparation or implant length or width. There is three types (neurapraxia, on the severity of tissue injury, prognosis, and time for recovery. Neurapraxia is the mildest type, while neurotmesisis the most severe.Both the doctor and the patient will have an unpleasant experience related to sensory disturbances from the injury. Peripheral sensory nerve injuries are more likely to be persistent when there is an increased duration between injury and reviewing of the patient; therefore, early diagnosis is the key for successful treatment.

Management of the problem will depend on the cause of the IAN injury; therefore, radiographs are needed to confirm. If the implant is impinging on the nerve, it should be removed or unscrewed a few threads to relieve the pressure on the nerve. The implant can be remove with a trephine drill if it is already osseointegrated. If the implant does not seem to be impinging on the nerve, then nerve injury may have occurred during drilling. A course of steroids can be prescribed to control inflammatory reactions in the injured nerve. An alternative would be a large dose of nonsteroidal anti-inflammatory drugs (i.e., 800 mg ibuprofen) 3 times daily for 3 weeks. If the condition fails to improve within 2 months, referral to a neurosurgeon is recommended. However, early referral and management are recommended before distantdegeneration of the nerve occurs.

It is also important to note that a sublingual hematoma arising from injury to the lingual/sublingual artery while placing implants in the anterior mandible may be seenrarely but it is a serious complication and may cause a lifethreating situation for the patient. In general, anterior mandibular implant placement is considered as a routine, simple, and safe procedure. However, massive internal bleeding in the highly vascularized region of the floor of the mouth may result from an arterial injury induced during implant socket preparation, usually through a perforation of the lingual cortical plate.

Hemorrhage may begin immediately or with some delay after the vascular injury. The elevation of the tongue and floor of the mouth to obstruct the airway due to the expansion of lingual, sublingual, submandibular, and submental hematomas is very likely. In this situation, acute airway management, including intubation or even emergent tracheostomy, may be needed to prevent a complete occlusion. In most cases, resolution of hemorrhage required a surgical lintervention for ligation of the bleeding vessels and hematoma evacuation. The clinician should have proper knowledge, skills, and armamentarium to reduce the probability of this serious complication, and meticulous attention should be given during the instrumentation

and implant placement in the anterior mandible.

CONCLUSION

In this article, the literature regarding dental implant complications was reviewed and a new clinically relevant classification for implant complications was presented to guide clinicians in identifying and resolving complications.

Within the limitations of this study, early failure rates of dental implants placed in the dental practice are similar to those seen in previous studies, however, rates are also comparable to failure rates reported from university studies, eventhough somewhat toward the upper margin. The use of augmentation procedures and implants shorter than 10mm seem to be associated with early implant failure. Health-service research with larger samples is encouraged to verify these associations. The outcome of this study can help practitioners to estimate the probable success of their dental implants and to assess the suitability of surgical implant procedures. For sites with reduced bone quantity, the use of shorter implants might be an alternative to augmentative approaches; however, patients should be informed about the lower early success rates of both strategies.

REFERENCES

1. Turkyilmaz I. A Proposal of New Classification for Dental Implant Complications. J Contemp Dent Pract 2018;19(8):1025-1033.
2. The Journal of Contemporary Dental Practice, August 2018;19(8):1025-1033
3. Rodrigo Fuentealba, DDSa, Jorge Jofré, DDS, PhDb,Esthetic Failure in ImplantDentistry 2019
4. Vaidya S, Khalikar A, Dange SP, DesaiR. Complications and their Management in Implantology. Int JProsthodontRestor Dent 2019;2(4):150-155.
5. Johannes Krisam, Larissa Ott, Stephanie Schmitz, Anna-Luisa Klotz, Aida Seyidaliyeva, Factors affecting the early failure of implants placed in a dental practice with aspecialization in implantology – a retrospective study 2019