



## A Proposal of New Classification for Dental Implant Complications

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### ABSTRACT

**Aim:** 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.

**Materials and methods:** Dental literature was reviewed via PubMed focusing on articles published in English, which included data regarding dental implants, complications, and classification from January 2000 to January 2018. The author, who has experience with implant placement and restorations for 15 years, and ten of his colleagues, formed a list of implant complications that they have encountered in their practices.

**Results:** After 3,736 articles were found in the initial search, a total of 613 potentially relevant review articles were identified in the database. After the full-text analysis of 25 articles, only 6 review articles with complication classifications were utilized in this study. In addition, a clinically based classification named "Turkyilmaz's Classification of Implant Complications" including three categories was created. 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.

**Conclusion:** It has been suggested that categorical data regarding complications of dental implants are limited, and the new complication classification presented in this article may help clinicians identify and overcome commonly encountered implant complications.

**Clinical significance:** For clinicians, it is important to know possible complications regarding dental implants. In this article, a group of dentists created and suggested a new classification for implant complications, which may help clinicians identify commonly encountered complications and how to handle them in the clinic.

**Keywords:** Complication, Esthetics, Failure, Implant, Nerve injury, Success.

**How to cite this article:** Turkyilmaz I. A Proposal of New Classification for Dental Implant Complications. J Contemp Dent Pract 2018;19(8):1025-1033.

**Source of support:** Nil

**Conflict of interest:** None

### INTRODUCTION

Implant dentistry has come a long way since Per-Ingvar Branemark first presented the osseointegration of dental implants, and the use of dental implants has increased exponentially in the last three decades.<sup>1-3</sup> Initially, very few specialists were trained in surgical placement and implant-related restorations using very strict guidelines. As the treatment became more predictable over years, the benefits of therapy became evident.<sup>4,6</sup> Since then, the tremendous demand for dental implants has fueled a rapid expansion of the market. The field is rapidly evolving and expanding, both in surgical techniques and in types of restorations available. Implant restorations were mainly indicated for the rehabilitation of function in the 1980s and 1990s, but increasing consideration is being placed on esthetics in modern implant dentistry.<sup>7,8</sup>

The demand for implant therapy has fueled growth of the industry. Now many clinicians offer implants as a solution to partial and complete edentulism. The procedures are no longer limited to specialists.<sup>5</sup> Problems with implants have been rising as more clinicians who do not have advanced training and skills are involved in implant placement and implant-related restorations.<sup>5,9</sup> The literature now has some reports with long-term results.<sup>3,6</sup> It would be safe to say that implant treatments are associated with several complications<sup>10,11</sup> and that they need to be addressed. Unfortunately, little quantitative data

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regarding implant complications<sup>12-17</sup> are available as most clinicians tend to report their high success rates.

The purpose of this study is 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.

## MATERIALS AND METHODS

### Search Strategy

A systematic review of the English literature was performed using an electronic database (Medline, PubMed) from January 2000 to January 2018. 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 full-text 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.<sup>12-17</sup>

After a meticulous review of the literature, a new classification for implant complications was proposed to help clinicians determine the problems and overcome them if they are encountered. The author, who has experience with implant placement and restorations for 15 years, contacted ten of his colleagues from the USA and got

their input regarding implant complications to present this new classification.

## RESULTS

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.<sup>12-17</sup> Table 2 depicts the detailed information of those publications.

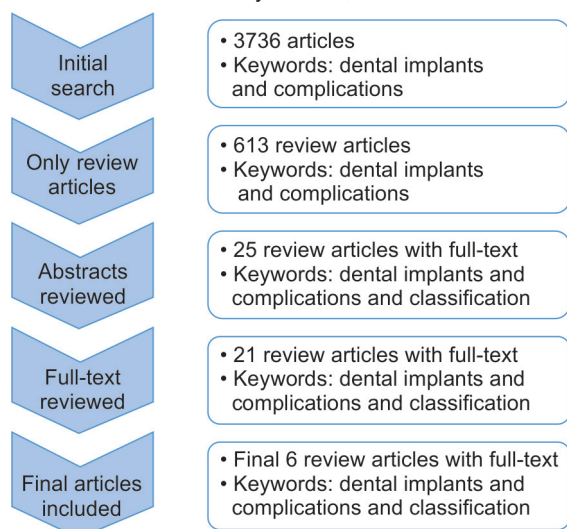
Park and Wang<sup>12</sup> described four different types of reversible implant complications: Intraoperative, immediate/early implant postoperative, late implant postoperative, and prosthetic (mechanical-biologic)-related. They have suggested that if these complications are not recognized at an early stage, ultimate failure with the implant/restoration is inevitable. Therefore, early recognition, the etiology of the problem, and prompt treatment are crucial for successful outcomes.

The article by Goodacre et al<sup>13</sup> searched the literature from 1981 to 2001 and reported the following six major categories of complications: Surgical complications, implant loss, bone loss, peri-implant soft tissue complications, mechanical complications, and esthetic/phonetic complications. They have found that overdenture loss of retention/adjustment is the most common and implant fracture the least common of mechanical complications.

The study by Chang et al<sup>14</sup> aimed to review the available evidence from 1991 to 2011 on the response of the peri-implant bone when subjected to excessive occlusal forces. They have basically focused on the loss of osseointegration, mineralized bone-implant contact (BIC), and bone density around oral implants using animal and human studies. Vahidi and Pinto-Sinai<sup>15</sup> have considered the failures and mechanical complications related to implant-supported overdentures and implant-supported removable partial dentures. They made few recommendations to avoid those problems and resolve them where they may have occurred.

The review by Sadid-Zadeh et al<sup>16</sup> focused on technical and mechanical complications regarding single implant restorations and partial fixed implant-supported prostheses. They presented six categories and subcategories as follows: Loosening of screws, fracture of screws, fracture of framework, fracture of abutment, chipping or fracture of veneering material, and decementation. They observed that the most common complication was screw loosening (5.6%) with single-implant restorations, and the fracture of the veneering material (12.4%) for partial fixed implant-supported prostheses.

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



**Table 2:** Descriptive data relative to the six studies included in this study

<i>Study (authors)</i>	<i>Source of search</i>	<i>Time period of search</i>	<i>No. of relevant studies</i>	<i>No. of included studies</i>	<i>Classification of complication</i>
Park and Wang <sup>12</sup>			N/A	N/A	<ul style="list-style-type: none"> <li>• Reversible complications               <ul style="list-style-type: none"> <li>– Intraoperative complications</li> <li>– Intraoperative surgical-related complications</li> <li>– Postoperative surgical-related complications</li> <li>– Prosthetic/mechanical-related complications during functional phase</li> <li>– Esthetic/soft tissue-related complications</li> <li>– Treatment of hemorrhage at implant osteotomy site</li> </ul> </li> <li>• Immediate/early implant postoperative complications</li> <li>• Late implant postoperative complications</li> <li>• Prosthetic (mechanical–biologic)-related complications</li> </ul>
Chang et al <sup>14</sup>	Medline (PubMed) Wiley Online Library	1991–2011	522	14	<ul style="list-style-type: none"> <li>• Loss of osseointegration               <ul style="list-style-type: none"> <li>– Animal studies</li> <li>– Human studies</li> </ul> </li> <li>• Mineralized BIC and bone density around oral implants               <ul style="list-style-type: none"> <li>– Animal studies</li> </ul> </li> </ul>
Goodacre et al <sup>13</sup>	Medline (PubMed)	1981–2001	N/A	218	<ul style="list-style-type: none"> <li>• Surgical complications</li> <li>• Implant loss</li> <li>• Bone loss</li> <li>• Peri-implant soft tissue complications</li> <li>• Mechanical complications</li> <li>• Esthetic/phonetic complications</li> </ul>
Vahidi and Pinto-Sinai <sup>15</sup>	Medline (PubMed)				<ul style="list-style-type: none"> <li>• Mechanical complications of implant-supported overdentures</li> <li>• Mechanical complications of implant-supported removable partial dentures</li> </ul>
Sadid-Zadeh et al <sup>16</sup>	Medline (PubMed)	1990–2004	N/A	N/A	<ul style="list-style-type: none"> <li>• Complications with partial fixed implant-supported prosthesis               <ul style="list-style-type: none"> <li>– Technical and mechanical complications</li> </ul> </li> <li>• Complications with single-implant restorations               <ul style="list-style-type: none"> <li>– Loosening of the abutment screw or the abutment</li> <li>– Fracture of the veneering ceramic or the crown</li> <li>– Other technical and mechanical complications</li> </ul> </li> </ul>
Al-Sabbagh and Bhavsar <sup>17</sup>	Medline (PubMed)	N/A	N/A	N/A	<ul style="list-style-type: none"> <li>• Internal factors for implant failure               <ul style="list-style-type: none"> <li>– Host-related factors (systemic and local)</li> </ul> </li> <li>• External factors for implant failure               <ul style="list-style-type: none"> <li>– Operative-related factors and implant-related factors</li> </ul> </li> </ul>

The study by Al-Sabbagh and Bhavsar<sup>17</sup> mainly evaluated the factors related to implant failure. Their classification of factors related to implant failure consisted of two major groups as “Internal” and “External.” The group of internal factors were associated with the host and had two subgroups of systemic and local factors. The group of external factors had two subgroups; operative-related factors and implant-related factors. They also suggested some guidelines to avoid implant failure.

### New Classification for Implant Complications

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



**Table 3:** 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*

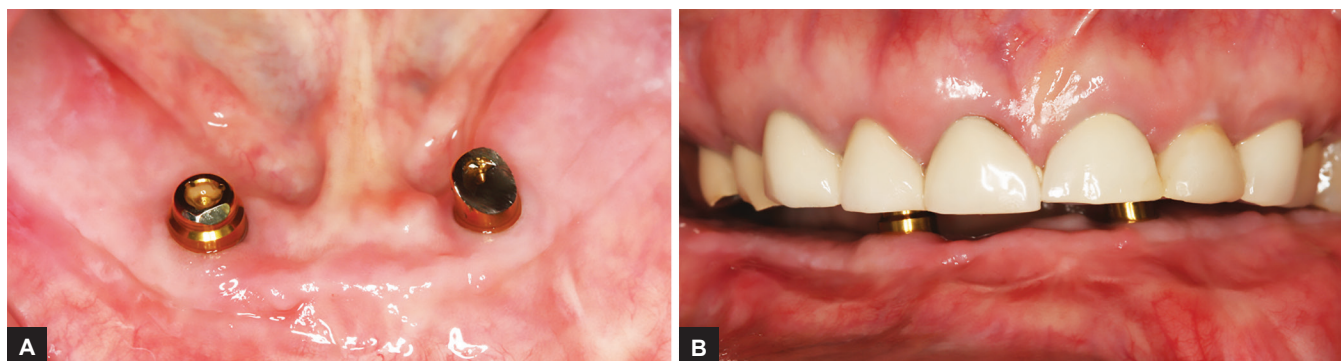
- Late (in months) cleaning of excess cement
- Nonreplaceable broken abutment/framework
- Nonrestorable mispositioned/misangulated implants, poor esthetics
- Removal of broken/failed implant
- Inferior alveolar nerve injury, jawbone fracture, and sublingual hematoma

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 (Table 3). A few cases of moderate (Figs 1 and 2) and severe (Figs 3 to 6) 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?"

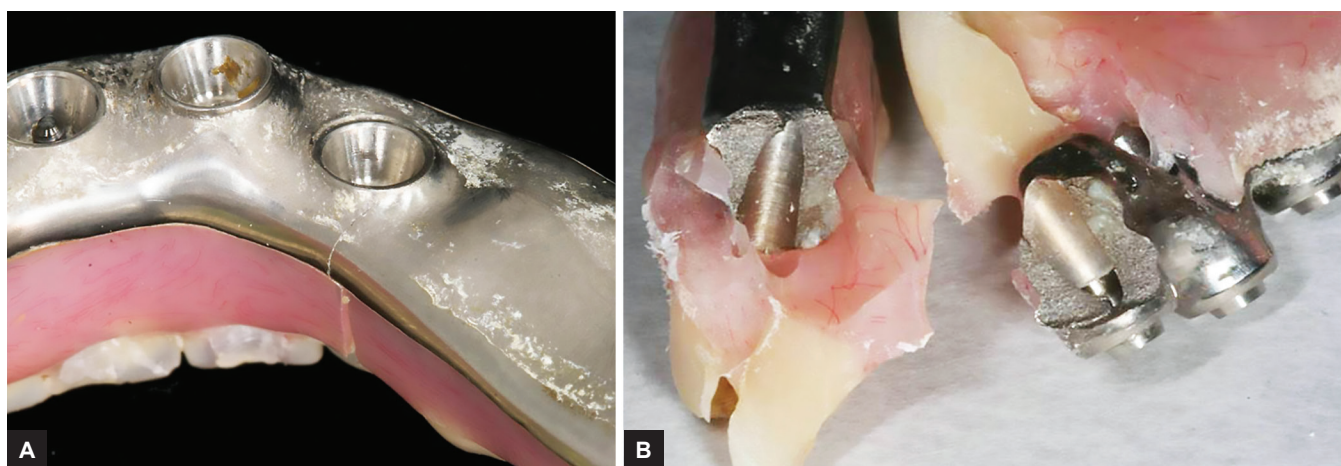
After the determination of a specific complication, a strategic plan with back-up options should be considered (Table 4) and then meticulously executed. It is crucial to inform the patient about the complication, explain to him/her the problem, and then what to do in order to fix it, before any remediation is attempted.

## DISCUSSION

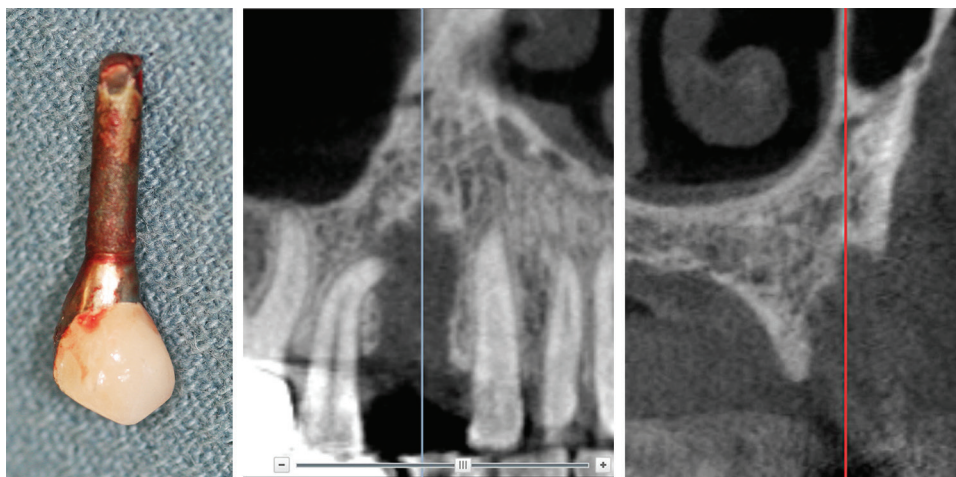
In this study, the dental literature regarding implant complications was reviewed and a new classification related



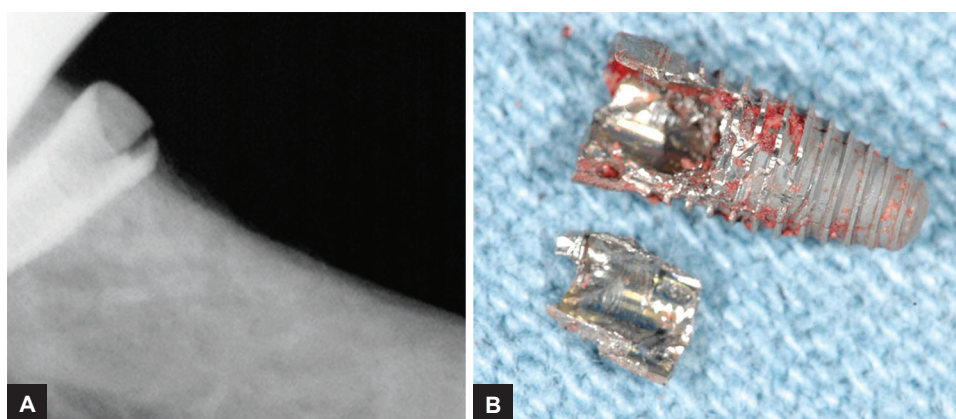
**Figs 1A and B:** Worn locators due to inadequate interarch space



**Figs 2A and B:** View of the screw-retained fixed mandibular hybrid prosthesis with a vertical fracture line posterior to the left canine tooth due to excessive cantilever length



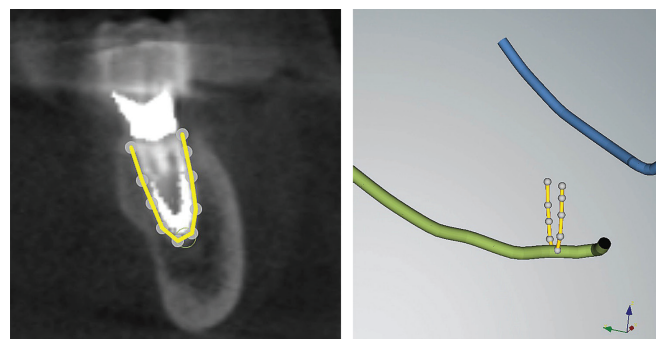
**Fig. 3:** Failed implant with a crown and cone beam computed tomography images of the bone loss after the implant removal



**Figs 4A and B:** View of a broken implant platform during the placement due to inadequate socket preparation/dense bone



**Fig. 5:** Major esthetic problem with implant-supported splinted crowns (maxillary lateral is cantilever) due to poor treatment planning and soft tissue management



**Fig. 6:** Cone beam computed tomography and three-dimensional implant planning images of the IAN damage causing paresthesia on the right side of the lower lip

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 study by Park and Wang<sup>12</sup> primarily focused on reversible implant complications, such as intraoperative, immediate/early implant postoperative, late implant postoperative, and prosthetic-related. They have reported that early realization of etiologic factors and instant treatment are vital to avoid failures.<sup>12</sup> Chang et al<sup>14</sup> used animal and human studies to investigate loss of



**Table 4:** The list of actions to overcome problems in each category in TCIC

<i>TCIC mild</i>
• Does not require surgical intervention
• May not require removal/replacement of restoration
<i>TCIC moderate</i>
• May require surgical intervention
• May require removal of restoration/abutment/framework
• Requires replacement of restoration
<i>TCIC severe</i>
• Requires surgical intervention
• Requires replacement of restoration/abutment/framework
• Requires implant replacement/removal
• Requires critical surgical intervention (i.e., IAN injury, sublingual hematoma)

osseointegration, mineralized BIC, and bone density around implants. The failures and mechanical complications related to implant-supported overdentures and implant-supported removable partial dentures were reviewed by Vahidi and Pinto-Sinai.<sup>15</sup> Sadid-Zadeh et al<sup>16</sup> focused on technical or mechanical complications regarding single-implant restorations and partial fixed implant-supported prostheses, and presented six different categories of complications. They also reported that most common complication was the screw loosening (5.6%) with single-implant restorations, and the fracture of the veneering material (12.4%) for partial fixed implant-supported prostheses. Al-Sabbagh and Bhavsar<sup>17</sup> basically searched the “Internal” and “External” factors related to implant failure. The internal factors were considered as systemic and local while external ones as operative-related and implant-related. Goodacre et al<sup>13</sup> suggested six categories of complications as surgical complications, implant loss, bone loss, peri-implant soft tissue complications, mechanical complications, and esthetic/phonetic complications. They reported that the most common three implant complications were loosening of the overdenture retentive mechanism (33%), implant loss in irradiated maxillae (25%), and hemorrhage-related complications (24%).

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.<sup>18-20</sup> The clinician’s personal preference may influence the choice of retention system,<sup>18-20</sup> and generally, the clinicians with more experience and training tend to use screw-retained restorations. Due to fewer biologic

complications, peri-implant bone loss, and maintenance requirements, screw-retained implant-supported restorations are recommended by some studies.<sup>18-20</sup> 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.<sup>21-26</sup> Complete removal of excess cement from subgingival margins of abutment-supported restorations is unpredictable.<sup>21</sup> The connection between remaining cement and peri-implant inflammation and bleeding was reported by Wilson.<sup>24</sup> In his study using a dental endoscope, excess cement was associated with signs 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.<sup>24</sup> Two other studies<sup>25,26</sup> showed that complications involving residual excess cement ranged from acute severe bone resorption to implant loss.

The restoration of the edentulous arch requires a certain amount of vertical space between the opposing arches to ensure adequate restorative material thickness, space for the retentive elements, esthetics, freeway space, and cleansability.<sup>27-29</sup> The interarch space of 12 to 14 mm from implant platform to the incisal edge is needed for an implant-retained overdenture.<sup>29</sup> Inadequate interarch space can be a substantial hurdle for successful treatment, as it usually restricts the prosthetic armamentarium to short attachments and prevents the use of bars.<sup>27-29</sup> In addition to limited interarch space, excessive interarch space may cause esthetic and biomechanical problems.<sup>30-32</sup> Because the crown-implant ratio is compromised, marginal bone loss is more likely; hence, the long-term success of the implant is negatively affected.<sup>30-32</sup> Therefore, it is crucial to carefully evaluate interarch space before the commencement of any treatment.

Implant restorations in the anterior region are often not only the most challenging but also the most rewarding procedures in dentistry.<sup>33-36</sup> It is a cardinal rule to have a meticulous analysis of the smile, envelope of motion, and functional load as well as thorough evaluation of bone and surrounding soft tissues. In order to achieve a predictable success, the type of restoration and the space required for that restoration need to be determined before implant surgery.<sup>33</sup> Otherwise, the functional or esthetic qualities of the implant restoration will be compromised. Dental literature has several studies reporting the relationship between insufficient treatment planning and restorative complications of implant dentistry.<sup>27-31</sup>

In addition to adequate interarch space, the location and angulation of the implant are also critical factors for esthetically pleasing outcomes.<sup>27,37,38</sup> Poor treatment planning with undesired position and angulation of implants

will make the restorative procedures more challenging and costly, as extra materials and armamentarium, such as custom/angled abutment screws need to be utilized to overcome certain obstacles.<sup>27,37,38</sup>

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.<sup>39-43</sup> These implant-associated IAN injuries may occur during preparation or insertion of a dental implant. They may be directly related to the depth of preparation or implant length or width. Kaya and Sarikcioglu<sup>43</sup> suggested three types (neurapraxia, axonotmesis, and neurotmesis) of nerve injuries based on the severity of tissue injury, prognosis, and time for recovery. Neurapraxia is the mildest type, while neurotmesis is the most severe.<sup>43</sup> 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.<sup>41,43</sup>

Management of the problem will depend on the cause of the IAN injury;<sup>39</sup> 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.<sup>39</sup> The implant can be removed 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.<sup>39,43</sup> If the condition fails to improve within 2 months, referral to a neurosurgeon is recommended. However, early referral and management are recommended before distant degeneration of the nerve occurs.<sup>39,43</sup>

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 seen rarely but it is a serious complication and may cause a life-threatening situation for the patient.<sup>44-48</sup> 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.<sup>44-48</sup> 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.<sup>44,45</sup> In most cases, resolution of hemorrhage required a surgical intervention 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.<sup>44,45</sup>

## 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.

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