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CASE REPORT

Challenges and Complications in Endosseous Dental Implant: An Analysis with Case Illustrations

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ABSTRACT

The purpose of this article is to illustrate with case representation of complications that have been reported in conjunction with endosseous root-form implants. On review of previous volume on implant complication, the most common implant complications are peri-implantitis, hemorrhage, damage to vital structure, loss of implant, inability to rehabilitation, implant body and component fracture. Successful implant rehabilitation is followed by meticulous case preparation and surgical protocol. Case examination can summarize certain challenges that may compromise implant success. We had focused on clinical data over a period of 15 years, regarding management of challenges in implants and failure/complications in implant rehabilitation. The complications can be categorized into following two categories: (1) Surgical complications and (2) prosthetic complications.

Keywords: Complications, Bone quality and quantity, Implant anatomy.

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INTRODUCTION

Major advances have occurred over the last four decades in the clinical use of dental implants making it simpler and reliable chairside procedure. However, implants sometimes results in a spectrum of complications leading to implant failure. Most common complication is the peri-implantitis, which is chronic inflammation usually causes osteolysis around the implant.[1] Many investigators have evaluated clinical features of implant associated complication listed as follows: implant loss, sensory disturbance, soft-tissue complications, loss of implant onto tissue spaces, improper angulated implant, dehiscence of peri-implant bone, peri-implantitis, bone loss and implant fracture.[2-5] In this article, implant complications over 15 years have been discussed.The purpose of this article is to provide data regarding the challenges in implant and types of complications that have been reported in conjunction with endosseous root-form implants associated with implant protocol and follow-up. Implant complications can be broadly categorized as: (1) Surgical complications and (2) prosthetic complications.

Case preparation for implant rehabilitation begins with clinical examination with radiographs and meticulous planning. Case examination becomes a key for successful implant prosthesis, as it reveals and warns the implantologist about the challenges (Tables 1 and 2) that could be encountered.

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SURGICAL COMPLICATIONS

Many surgical complications have been identified in the implant literature, like hemorrhage,[1-4] neurosensory disturbance,[1-17] adjacent tooth devitalization/damage,[18-22] mandibular fractures,[1,13,23-29] life-threatening hemorrhage,[30-34] air emboli,[35] implant displacement into the mandibular canal,[36] submandibular space, maxillary sinus, fracture of implant, fracture of implant hex, dehiscence of implant, screwdriver aspiration,[37] descending necrotizing mediastinitis,[38] intraocular hemorrhage[39] and singultus (hiccups).[40] Surgical complication can be classified depending on time of incidence as (Table 3).

PROSTHETIC COMPLICATIONS

Prosthetic complications (Table 4) are related to implant component and prosthetic component. Factors related to complications include length, number and angulation of implant, opposing dentition, parafunctional habits and masticatory forces and their duration. As per back volumes' review, a large number of mechanical complications have been reported and they include overdenture loss of retention/adjustment (30%); resin veneer fracture of fixed partial dentures (22%); the need for overdenture relines (19%); overdenture clip/attachment fracture (17%); porcelain veneer fracture of fixed partial dentures (14%); overdenture fracture (12%); opposing prosthesis fracture (12%); acrylic resin base fracture (7%); prosthesis screw loosening (7%); abutment screw loosening (6%); prosthesis screw fractures (4%); metal framework fractures (3%); abutment screw fractures (2%) and implant fractures (1%).[41]

Table 1: Preoperative assessment and the challenge in implant protocol

Preoperative assessment	*Challenge in implant rehabilitation*
Soft-tissue assessment	
1. Reduced attached gingival	Unhealthy gingival collar formation
2. High frenum at site of implant placement	Loss of gingival collar around implant
3. Thick mucosa at the site of implant placement	Peri-implantitis due to deep gingival collar
4. Thin mucosa at the site of implant placement	Unhealthy gingival collar/ implant dehiscence
Hard-tissue assessment	
1. Inadequate buccolingual width	Fenestration of cortical plate
2. Inadequate vertical height	Compromises implant selection
3. Pneumatization of sinus	Sinus perforation/loss of implant into sinus
4. Superior positioning of IAN	Compromises implant placement
5. Cleft alveolus	Presence of bone defect
Occlusal assessment	
1. Insufficient interocclusal space	Relative contraindication for implant placement
2. Insufficient mesiodistal space	Compromised prosthesis
3. Para-functional habits	Contraindication for implant placement
4. Malocclusion	Relative contraindication for implant placement
Systemic assessment	
1. Heavy smokers	Compromised healing process
2. Diabetics, irradiated patients	
3. Bone diseases	
4. Patients treated with cortico-steroids/other drugs of importance	

Table 2: Intraoperative assessment and the challenge in implant protocol

Intraoperative assessment	*Challenge in implant rehabilitation*
1. Improper orientation	1. Inability to rehabilitate
2. Excessive torque and lack of primary stability	2. Loss of implant/escape into tissue spaces
3. Delivery of implant deep below the alveolar crest	3. Bone formation covering the cover screw
4. Exposure of implant at apex	4. Implant fenestration
5. Exposure of implant at collar	5. Implant dehiscence

Table 3: Surgical complication in implantology

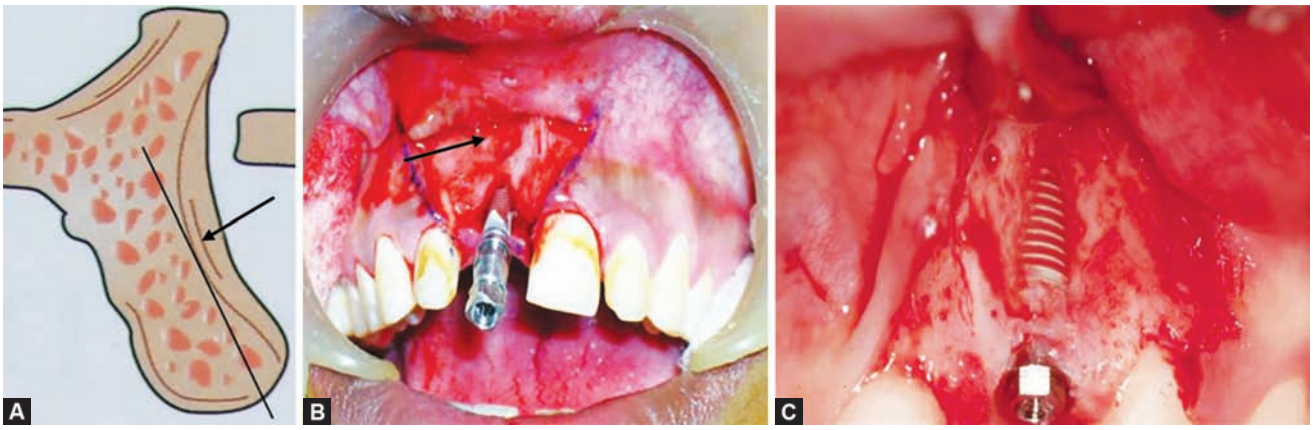
Intraoperative complications	*Postoperative complications*
1. Bleeding	1. Displacement of implant into sinus
2. Sinus perforation	2. Displacement of implant into tissue spaces
3. Damage to IAN	3. Fracture of bone
4. Wide osteotomy	4. Paresthesia
5. Improper angulation	5. Exposed implant
6. Labial/lingual plate perforation	6. Labial fenestration and dehiscence
7. Implant exposure	7. Loss of implant at stage 2
8. Inadequate primary stability	8. Peri-implantitis
9. Inability to prepare osteotomy	9. Loss of interocclusal space
10. Inability to deliver implant completely	10. Esthetic complications
11. Fracture of the drill	11. Phonetic complications
12. Improper calibration of torque	

CASE ILLUSTRATIONS

Complications related to Bone Quantity

Inadequate Labiolingual Width

As an age-related process bone undergoes certain changes like resorption. In maxilla, usually an inward pattern of bone loss (classification by Fallschussel classification, 1986) giving hourglass pattern of bone over labial cortex, oblique line depicting the path of implant placement, the arrow indicating the probable site of implant exposure (Fig. 1A). The serious encounter due to this pattern of bone loss are, exposure of implant during stage I (Fig. 1B) and labial fenestration[42,43] at stage II procedure, where the entire implant surface is exposed from implant apex to the crest of implant (Fig. 1C). Bone grafts and substitutes were used for success of implants. In some edentulous mandible anterior



Figs 1A to C: (A) Hour glass pattern, (B) implant exposure at apex and (C) implant fenestration at stage II of bone loss

Table 4: Prosthetic complication in implantology

Prosthetic complications related to implant component	*Prosthetic complications related to prosthesis*
1. Inability to rehabilitate due to improper implant planning	1. Crown decementation
2. Fracture of implant body	2. Metal framework fractures
3. Fracture of implant collar	3. Veneer fracture
4. Fracture of internal hex	
5. Abutment screw fracture	
6. Screw loosening	
7. Failure of cantilever	

region, a thin labiolingual width of bone is encounter. In reduced labiolingual width, implant placed can get exposed over a period of time or even before stage II due to loss of labial cortex. In the case illustrated, the clinical picture shows the thinning out of mucosa and discoloration of mucosa as the implant is lying just beneath the mucosa due to complete resorption of labial cortex (Fig. 2A). On surgical exposure, the site we noticed that the entire implant is exposed, and partial exposure of the second one (Fig. 2B).

Adequate Vertical Height of Maxillary Alveolar Bone

In poor bone quantity and quality as in maxillary molar region, possible complication is the migration of implants into the maxillary sinus. In a scenario like maxillary posterior region reduction of bone height available for implant placement is due to two reasons, ridge resorption and sinus pneumatization. Implant placement in maxillary posterior region is critical, due to minimal vertical bone height and the type of bone, i.e. D3 type of bone. Type D3 bone has a thin cortical bone and more of cancellous bone, that leads to reduced primary stability.[44] Sinus perforation is the common complication due to inadequate bone height in posterior maxilla. With reference to the above-noted clinical conditions, implant placement may lead to, loss of implant in to the maxillary sinus[45] (case 1, Fig. 3A; case 2, Figs 3B and C). The ideal way of management of such cases is by sinus lift and grafting procedures, thereby increasing the bone height for implant placement.

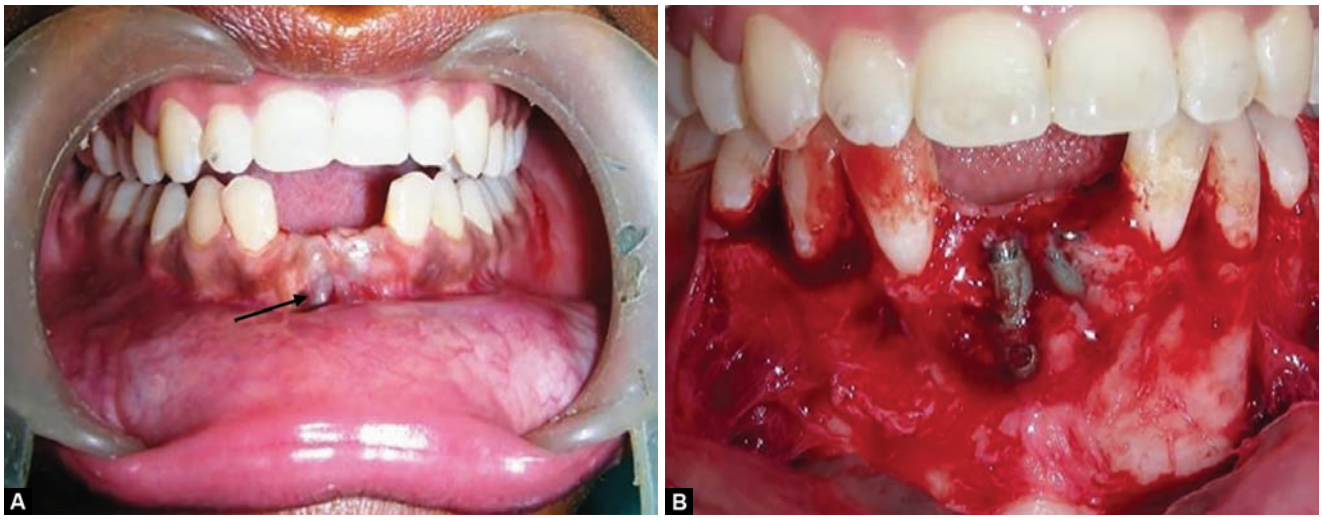
Adequate Vertical Height of Mandibular Alveolar Bone

Mandibular fractures secondary to implant placement occur when implant is placed in type 4 or 5 (Atwood's atrophic mandible). In an inadequate vertical bone available, as an attempt of utilizing available vertical height of bone an implant with longer length may be selected. Case illustrated here in a mandible with reduced vertical height (Fig. 4A), a long implant that extended till the lower border has lead to fracture[47] of mandible and displacement of implant into submandibular space (Fig. 4B).

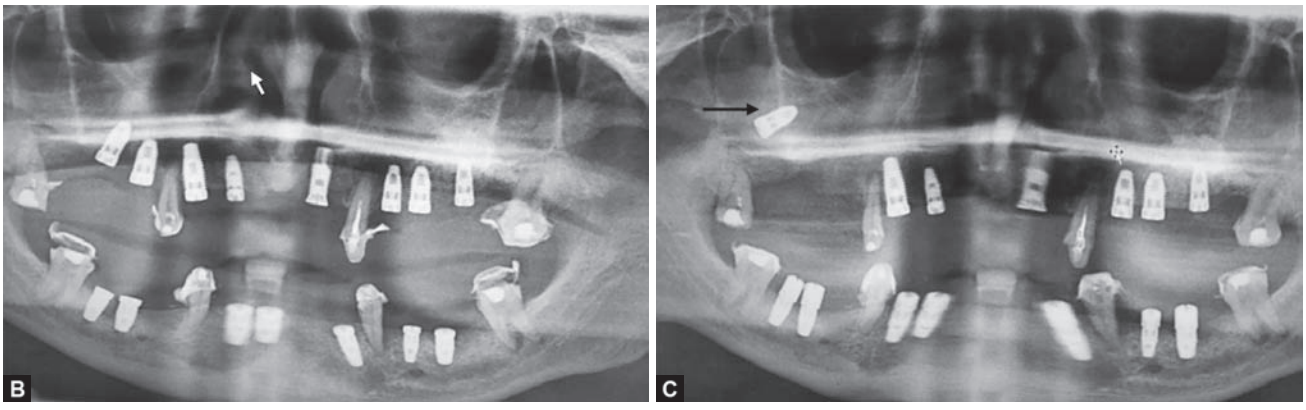
Inflammation

Peri-implantitis

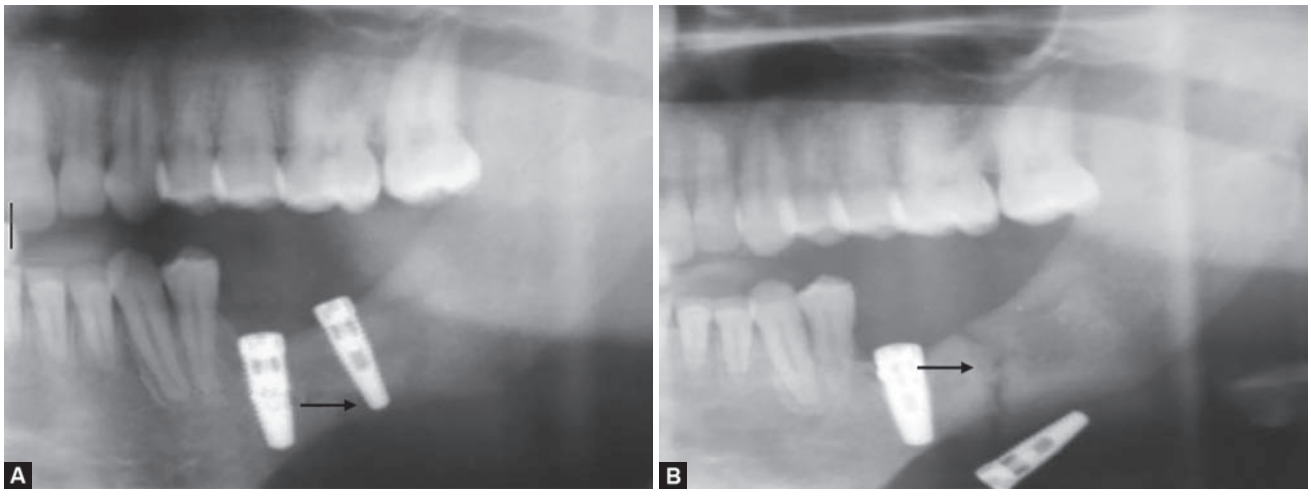
Peri-implantitis is defined as an inflammatory reaction with the loss of supporting bone in the tissues surrounding a functioning implant. According to the literature, peri-implant and its complications have been reported in three or more studies include fenestration/dehiscence, gingival inflammation/proliferation, and leads to gradual bone loss and finally implant failure.[1,8,14,43] After successful implant rehabilitation, peri-implantitis[46] is one of the most common late postoperative complication leading to the failure of implant-supported prosthesis. Peri-implantitis is seen in compromised systemic conditions and plaque accumulation due to improper local maintenance of implant by the patient.



Figs 2A and B: (A) Clinical view and (B) surgical exposure—implant fenestration



Figs 3A to C: (A) Displacement of implant into maxillary sinus, (B) immediate postoperative and (C) postoperative



Figs 4A and B: (A) Immediate postoperative and (B) postoperative with fracture of mandible and displacement of implant

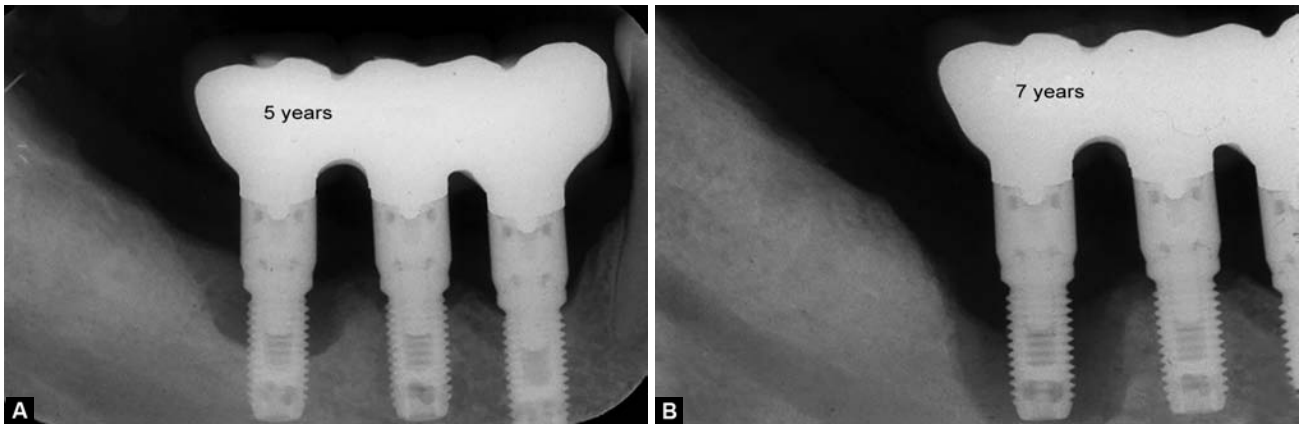
Peri-implantitis can also be seen in one of the multiple implants place, the reason being hypothetical as excessive masticatory forces and bone loss (Figs 5A and B).

A case of peri-implantitis (Fig. 6A) shows ideal features of peri-implantitis, like swollen, inflamed, redden gingiva with loss of stippling. On surgical exposure, a bone loss of 9 mm approximately was noted on graduated periodontal probe examination (Fig. 6B). The case was managed by debridement and bone grafting. After a period of 6 to 7 months, adequate amount of bone around the implant (Fig. 6C) showing a successful graft procedure.

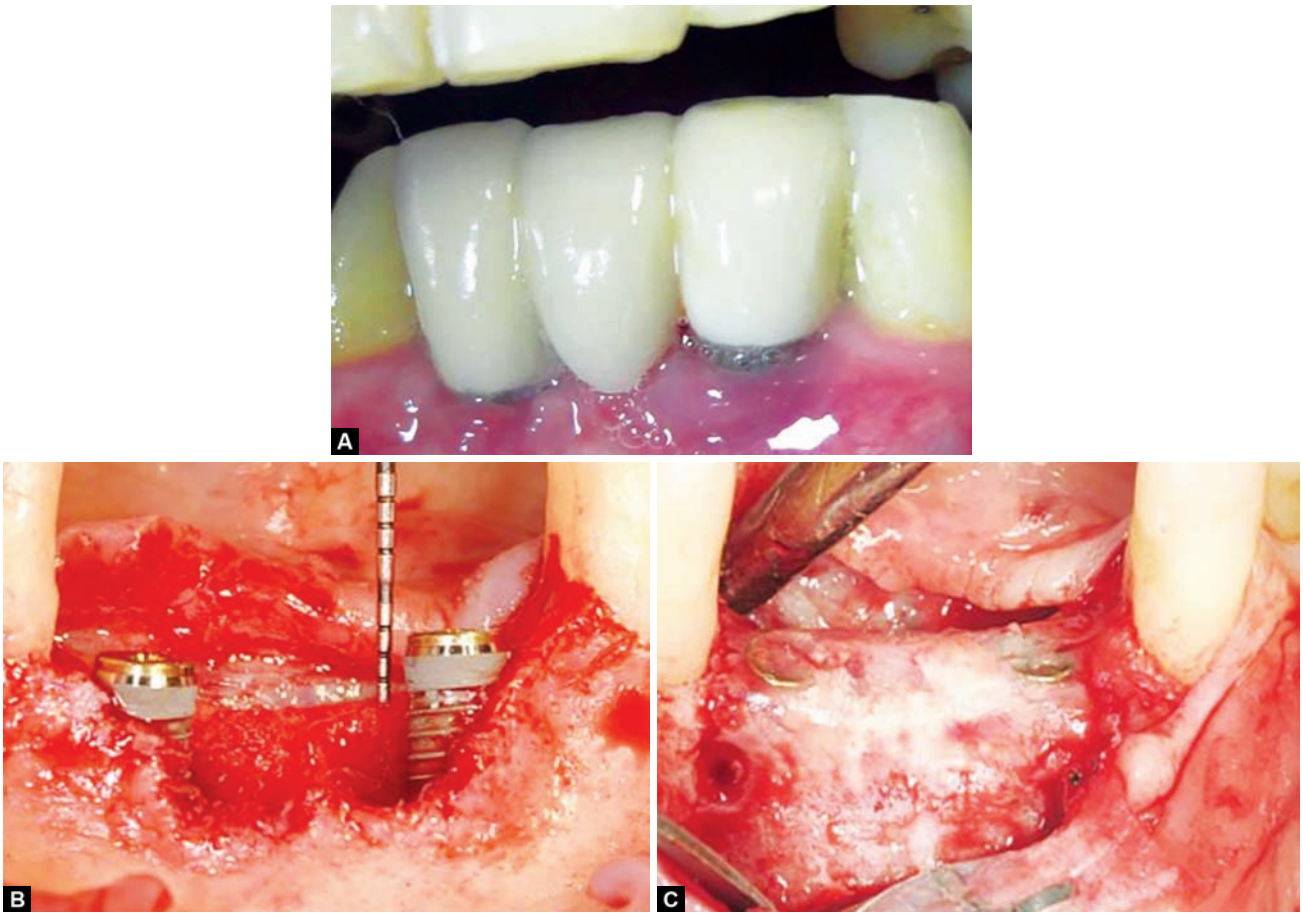
Fracture of Implant Components

Fracture of Implant Body

One of the basic criteria for prosthetic tooth rehabilitation is the crown-root ratio. As a rule of thumb crown-root ratio ideal 1:2, minimum 1:1 and optimum 2:3, altered ratio leads to failure of prosthesis. Implant fracture is noted with a lower incidence in edentulous jaws (0.2%) and more frequent occurrence in partially edentulous jaws (1.5%).[42] Crown root ratio found to be more which lead to implant body fracture (Fig. 7A).[11,18,42] Large crown length over a shorter



Figs 5A and B: (A) Five years postoperative and (B) seven years postoperative



Figs 6A to C: (A) Clinical appearance of gingiva, (B) surgical exposure and (C) after bone graft placement

implant acts as vertical cantilever, and leads to an imbalance in masticatory force distribution and failure of implant. The fracture implants had to be retrieved (Fig. 7B) and replaced.

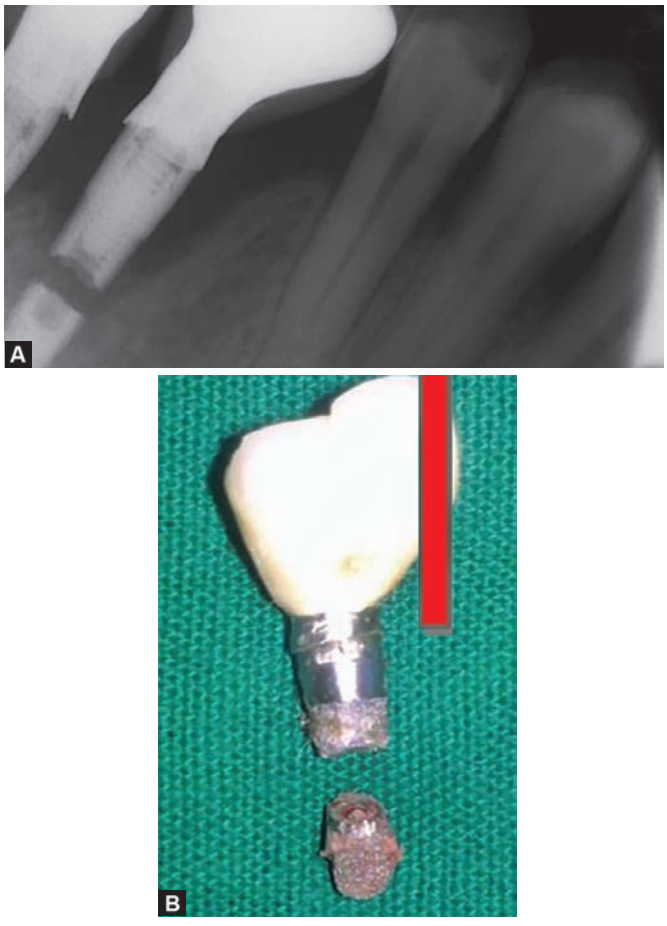
Fracture of Implant Component

First implant design was given by Per-Ingvar Brånemark; over a period of time, we see various modifications. The implant-abutment attachment component, i.e. implant platform is modified as internal from an external hex. The internal hex modification of the attachment seems to weaken the attachment component of implant. In the case radiograph illustrated, an implant with internal hex platform was used that has lead to fracture of the internal-hex component (Figs 8A and B) and implant failure.

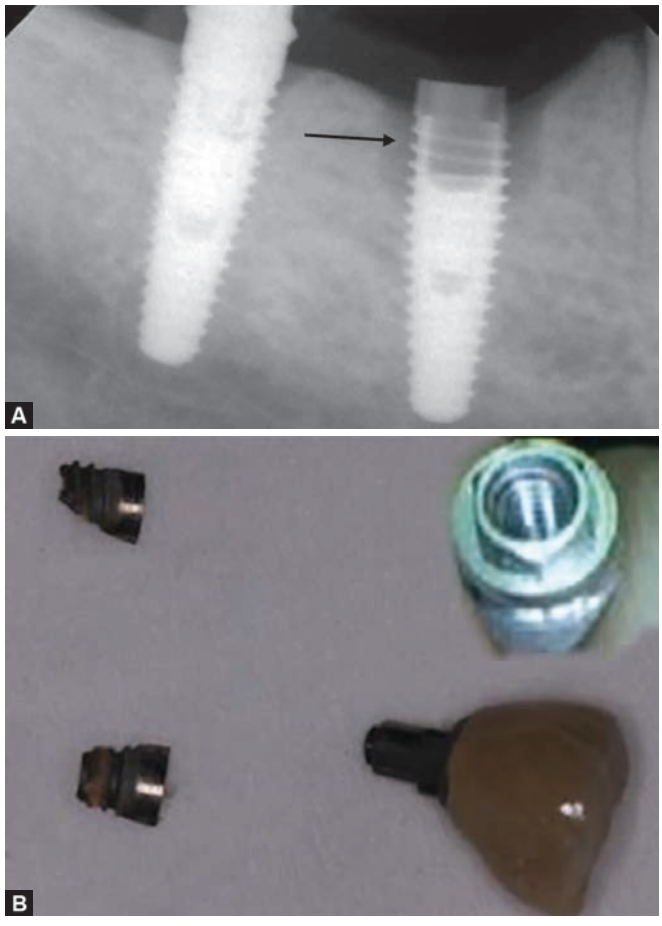
Angulation of Implant Placement-related

Improper Orientation

Successful functional oral rehabilitation depends of functional adaptation of the prosthesis to masticatory forces.



Figs 7A and B: (A) Radiograph showing fractured implant and (B) implant retrieved



Figs 8A and B: (A) Radiograph showing altered radiopacity at the implant collar and (B) retrieved implant and fractured implant collar

Implant placement should be done, in consideration of orientation[47,48] of the tooth replaced by the implant, direction of masticatory force and also the orientation of adjacent tooth. The radiograph (Fig. 9) shows an improper angulation of implant orientation, such condition not only compromises the implant but also the adjacent tooth. Control of orientation is easily managed by a prefabricated surgical stent. Occasionally, incorrect positioning or lack of relative parallelism in the placing of the implants causes damage to an adjacent tooth.

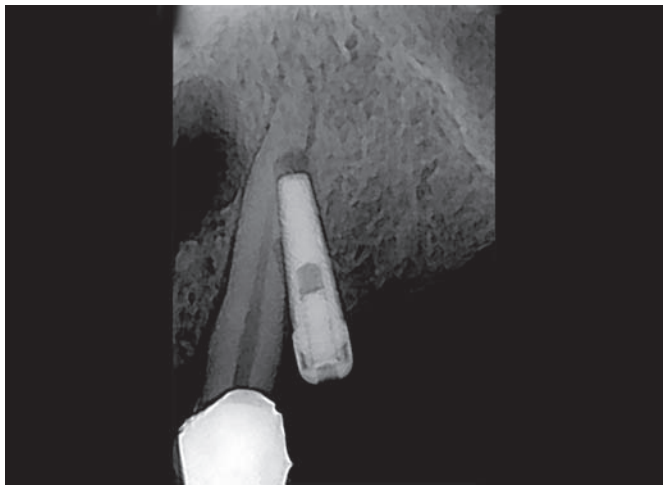


Fig. 9: Improperly oriented impinging the adjacent tooth root

DISCUSSION

Implant treatment is regarded as a safe technique with high rates of success. Nevertheless, it has complication in every surgical procedure. Complications that can occur and must be known in order to prevent and manage the same. A detailed case evaluation must be conducted systematically during the preoperatory stage based on clinical history, thorough investigations and, if necessary, consulting other specialists, dentists or physicians.

The challenges that occur in implantology are a consequence of an inadequate quality or/and quantity of bone, an erroneous surgical technique, improper prosthetic design, infections, lack of oral hygiene deleterious habits, patient cooperation and systemic diseases that are poorly controlled.

There are various classifications in the implant volumes[44] and publications,[46] here complications in implantology are classified as follows:

- Surgical complications and
- Prosthetic complications

As illustrated above, adequate bone quality and quantity plays a key role in implant success. Inadequate bone quantity being a major challenge, alveolar bone augmentation procedures plays a major role in implant dentistry. Among ridge augmentation procedures, augmentation with bonegraft, distraction and ridge split techniques are popularly used in implant practice. The bone graft used can either be an autologous or allogenic with autologous having more success. In preparing alveolar ridge for implant placement, the size of graft used is typically limited by the availability of space at the recipient site that allows for proper gingival coverage and water tight closure of surgical site. As a process of uptake and healing the bonegraft may lose some of its bulk, leaving insufficient ridge for implant placement. A slow resorbing bone like cortical bone serves better for both maintaining the graft as a scaffold and primary stability of implant. Bone augmentation with alloplastic material or combination of graft are frequently used to achieve adequate bone bulk. Membrane technique and molecular approach are the advances in augmentation techniques.[49]

Hemorrhage is a most common emergency situation. This can be avoided by a preoperative radiological examination that should include regular computerized tomography to appreciate the particular anatomy of each mandible. The onset of this complication is easily determined by clinical signs and symptoms. Hemorrhage is commonly encountered in sinus lift procedures, osteotomy closer to the inferior alveolar canal. The reason being claimed as high vascularity of the sinus lining, damage to the vascular anastomosis namely, the posterior superior alveolar artery and rarely damage to the infraorbital artery.[46]

Malposition or an overangulation of implant placement, leads to an obstacle for carrying out the prosthetic restoration, while it also would deteriorate long-term implant viability. One of the key for success is to study the axis of those teeth adjacent and/or the edentulous space to be rehabilitated with implants. The malposition of an implant may lead to damage or loss of radicular surface or the root apex and a subsequent postoperative pulpitis, or periodontitis, sometimes also involves the nonintegration of the implant because of the inflammation. Other causes for implant failure due to malpositioning are, proximity of implant to the tooth, shorter distance between tooth and implant, shorter time lapse between the endodontic procedure and the implant placement.[46,47] Osseous dehiscences and bone fenestrations can go unnoticed in those cases in immediate implant prosthesis, inadequate buccolingual width or a transmucosal flapless surgery[50] when compared to conventional implant placement. This risk can be prevented by a correct exploration of the alveolus and assessment of implant orientation before inserting the implant.

Mandibular fracture, during implant placement, is associated with atrophic mandibles. The central area of the mandible has a greater risk for this complication because its poor vascularity.[51] The bone in this area is usually sclerotic and undergoes severe resorption as a consequence of a large period of edentulous and also as a result of the pressure exerted by the prosthesis, which makes the same incapable of tolerating force transmitted during implant protocol.[46]

Neurosensory impairment may occur at any time during implant surgery, i.e. flap elevation and retraction, during osteotomy preparation, bone augmentation, implant placement, suturing or any soft-tissue swelling after surgery incidence of (0-44%).[52] One of the most severe local complications is the damage of the osseous roof of the mandibular canal, which is caused by incorrect surgical procedure, incorrect reading of the X-ray or tomography.[46]

The choice of a screw-retained *vs* a cement-retained crown is a complex and comprehensive decision involving many points of consideration. Cement-retained implant-borne restorations has several advantages, including the elimination of unesthetic screw access holes and greater resistance to porcelain fracture. Soft-tissue surrounding screw-retained implant crowns were found to be healthier than soft-tissue surrounding cemented restorations. Custom abutments can now be designed with supragingival margins that allow for easy and complete cement removal. In implantology, reduced stress to the bone and implant is a desired feature. This is obtained through a passive fit of the prosthesis on the implant abutments to attain for a screw-retained implant restoration with more than one implant.[53]

Fracture of prosthetic retaining screws is more common than implant fracture and it is normally due to metal fatigue following an overload of materials.[46] An implant fracture seems to be an infrequent complication that could be ascribed to different reasons: defects in the implant design or materials used in their construction, a nonpassive union between the implant and the prosthesis or by mechanical overload, specially cantilevers in fixed prostheses, occlusal overload or/and parafunctional habits.[48]

CONCLUSION

All the above-listed complications are outcomes of improper execution of procedures. The vast majority of complications in implant surgery can be prevented by correct selection of case and treating, compromised and challenging cases in an appropriate way to achieve successful implant rehabilitation. Knowledge of the risks, trying to avoid them with the necessary information helps in designing a specific plan for every patient. Detailed case evaluation and treatment planning are desirable for a successful implant-supported prosthesis.

REFERENCES

1. Ayangco L, Sheridan PJ. Development and treatment of retrograde peri-implantitis involving a site with a history of failed endodontic and apicoectomy procedures: a series of reports. Int J Oral Maxillofac Implants 2001;16:412-417.
2. Berglundh T, Persson L, Klinge B. A systematic review of the incidence of biological and technical complications in implant dentistry reported in prospective longitudinal studies of at least 5 years. J Clin Periodontol 2002;29:197-212.
3. Goodacre CJ, Kan JY, Rungcharassaeng K. Clinical complications of osseointegrated implants. J Prosthet Dent 1999;81:537-552.
4. Johns RB, Jemt T, Heath MR, Hutton JE, McKenna S, McNamara DC, et al. A multicenter study of overdentures supported by Branemark implants. Int J Oral Maxillofac Implants 1992;7:513-522.
5. van Steenberghe D, Lekholm U, Bolender C, Folmer T, Henry P, Herrmann I, et al. Applicability of osseointegrated oral implants in the rehabilitation of partial edentulism: a prospective multicenter study on 558 fixtures. Int J Oral Maxillofac Implants 1990;5:272-281.
6. Jemt T, Laney WR, Harris D, Henry PJ, Krogh PH Jr, Polizzi G, et al. Osseointegrated implants for single tooth replacement: a 1 year report from a multicenter prospective study. Int J Oral Maxillofac Implants 1991;6:29-36.
7. Wismeyer D, van Waas MA, Vermeeren JI. Overdentures supported by ITI implants: a 6.5-year evaluation of patient satisfaction and prosthetic aftercare. Int J Oral Maxillofac Implants 1995;10:744-749.
8. Henry PJ, Tolman DE, Bolender C. The applicability of osseointegrated implants in the treatment of partially edentulous patients: three-year results of a prospective multicenter study. Quintessence Int 1993;24:123-129.
9. Lekholm U, van Steenberghe D, Herrmann I, Bolender C, Folmer T, Gunne J, et al. Osseointegrated implants in the treatment of partially edentulous jaws: a prospective 5-year multicenter study. Int J Oral Maxillofac Implants 1994;9:627-635.
10. Astrand P, Borg K, Gunne J, Olsson M. Combination of natural teeth and osseointegrated implants as prosthesis abutments: a 2-year longitudinal study. Int J Oral Maxillofac Implants 1991;6:305-312.
11. Higuchi KW, Folmer T, Kultje C. Implant survival rates in partially edentulous patients: a 3-year prospective multicenter study. J Oral Maxillofac Surg 1995;53:264-268.
12. Avivi-Arber L, Zarb GA. Clinical effectiveness of implant-supported single-tooth replacement: the Toronto study. Int J Oral Maxillofac Implants 1996;11:311-321.
13. Albrektsson T. A multicenter report on osseointegrated oral implants. J Prosthet Dent 1988;60:75-84.
14. Ellies LG, Hawker PB. The prevalence of altered sensation associated with implant surgery. Int J Oral Maxillofac Implants 1993;8:674-679.
15. Lazzara K, Siddiqui AA, Binon P, Feldman SA, Weiner R, Phillips R, et al. Retrospective multicenter analysis of 3i endosseous dental implants placed over a five-year period. Clin Oral Implants Res 1996;7:73-83.
16. Allen PF, McMillan AS, Smith DC. Complications and maintenance requirements of implant-supported prostheses provided in a UK dental hospital. Br Dent J 1997;182:298-302.
17. Walton JN. Altered sensation associated with implants in the anterior mandible: a prospective study. J Prosthet Dent 2000; 83:443-449.
18. Jemt T, Lekholm U, Adell R. Osseointegrated implants in the treatment of partially edentulous patients: a preliminary study on 876 consecutively placed fixtures. Int J Oral Maxillofac Implants 1989;4:211-217.
19. Jemt T, Pettersson P. A 3-year follow-up study on single implant treatment. J Dent 1993;21:203-208.
20. Rubenstein JE, Taylor TD. Apical nerve transection resulting from implant placement: a 10-year follow-up report. J Prosthet Dent 1997;78:537-541.
21. Kim SG. Implant-related damage to an adjacent tooth: a case report. Implant Dent 2000;9:278-280.
22. Margelos JT, Verdelis KG. Irreversible pulpal damage of teeth adjacent to recently placed osseointegrated implants. J Endod 1995;21:479-482.
23. Rothman SL, Schwarz MS, Chafetz NI. High-resolution computerized tomography and nuclear bone scanning in the diagnosis of postoperative stress fractures of the mandible: a clinical report. Int J Oral Maxillofac Implants 1995;10:765-768.
24. Mason ME, Triplett RC, van Sickels JE, Parel SM. Mandibular fractures through endosseous cylinder implants: report of cases and review. J Oral Maxillofac Surg 1990;48:311-317.
25. Tolman DE, Keller EE. Management of mandibular fractures in patients with endosseous implants. Int J Oral Maxillofac Implants 1991;6:427-436.
26. Shonberg DC, Stith HD, Jameson LM, Chai JY. Mandibular fracture through an endosseous implant. Int J Oral Maxillofac Implants 1992;7:40-44.
27. Neyt L, De Clercq C, Abeloos J, Mommaerts M. Mandibular fractures following insertion of denial implants. Acta Stomatol Belg 1993;90:251-258.
28. Kan JY, Lozada JL, Boyne PJ, Goodacre CJ, Rungcharassaeng K. Mandibular fracture after endosseous implant placement in conjunction with inferior alveolar nerve transposition: a patient treatment report. Int J Oral Maxillofac Implants 1997;12: 655-659.
29. Raghoebar GM, Stellingsma K, Batenburg RH, Vissink A. Etiology and management of mandibular fractures associated with endosteal implants in the atrophic mandible. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2000;89:553-559.
30. Laboda G. Life-threatening hemorrhage after placement of an endosseous implant: report of case. J Am Dent Assoc 1990;121: 599-600.
31. Mason ME, Triplett RG, Alfonso WF. Life-threatening hemorrhage from placement of a dental implant. J Oral Maxillofac Surg 1990;48:201-244.
32. Ten Bruggenkate CM, Krekeler G, Kraaijenhagen HA, Foitzik C, Oosterbeek HS. Hemorrhage of the floor of the mouth resulting from lingual perforation during implant placement: a clinical report. Int J Oral Maxillofac Implants 1993;8:329-334.
33. Mordenfeld A, Andersson L, Bergstrom B. Hemorrhage in the floor of the mouth during implant placement in the edentulous mandible: a case report. Int J Oral Maxillofac Implants 1997; 12:558-561.
34. Givol N, Chaushu G, Halamish-Shani T, Taicher S. Emergency tracheostomy following life-threatening hemorrhage in the floor of the mouth during immediate implant placement in the mandibular canine region. J Periodontol 2000;71: 1893-1895.
35. Dwyer MS. Re: Near fatal venous nitrogen/air embolism occurrence while inserting cylindrical endosseous oral implants. J Periodontol 1992;63(1):63.

36. Theisen FC, Shultz RE, Elledge DA. Displacement of a root form implant into the mandibular canal. Oral Surg Oral Med Oral Pathol 1990;70:24-28.
37. Bergermann M, Donald PJ, Wengen DF. Screwdriver aspiration: a complication of dental implant placement. Int J Oral Maxillofac Surg 1992;21:339-341.
38. Li KK, Varvares MA, Meara JG. Descending necrotizing mediastinitis: acomplication of dental implant surgery. Head Neck 1996;18:192-196.
39. Krepler K, Wedrich A, Schranz R. Intraocular hemorrhage associated with dental implant surgery. Am J Ophthal 1996; 122:745-746.
40. Strull GE, Dym H. Singultus: a distressing postsurgical complication. J Oral Maxillofac Surg 1995;53:711-713.
41. Goodacre CJ, Benal G. Clinical complications with implants and implant prostheses. J Prosthet Dent 2003;90:121-132.
42. Adell R, Lekholm U, Rockler B, Branemark PI. A 15-year study of osseointegrated implants in the treatment of the edentulous jaw. Int J Oral Surg 1981;10:387-416.
43. Jemt T. Failures and complications in 391 consecutively inserted fixed prostheses supported by Branemark implants in edentulous jaws: a study of treatment from the time of prosthesis placement to the first annual check-up. Int J Oral Maxillofac Implants 1991;6:270-276.
44. Misch CE. Contemporary Implant Dentistry. 3rd ed. St. Louis: CV Mosby; 2008 Feb 4. p. 1120.
45. Implant text risk factors in implant dentistry: simplified clinical analysis for predictable treatment. 2nd ed. Franck Renouard, DDS.
46. Implant Dentistry—The Most Promising Discipline of Dentistry. Implant Complications Mª Angeles Sánchez Garcés, Jaume Escoda-Francolí and Cosme Gay-Escoda University of Barcelona, Faculty of Dentistry, Spain.
47. Mendonca G, Mendonca DB, Fernandes Neto AJ, Neves FD. Use of distraction osteogenesis for repositioning of an osseointegrated implant: a case report. Int J Oral Maxillofac Implants 2008;23(3):551-555.
48. Georgiev T, Nogalchev K. Local complications occuring during dental implantation. J Int Med Assoc Bulgaria 2010;16(4):35-37.
49. Elie E. Daou Stud attachments for the mandibular implant retained overdentures: Prosthetic complications. A literature review. Removable Prosthodontics Department, School of Dentistry, Lebanese University, Beirut, Lebanon The Saudi Dental Journal (2013). Available at: http://dx.doi.org/10.1016/j.sdentj.2012.12.003
50. Steigmann M. Aesthetic flap design for correction of buccal fenestration defects, practical procedures and aesthetic dentistry: PPAD 2008;20(8):487-493.
51. Chrcanovic BR, Custodio AL. Mandibular fractures associated with endosteal implants, oral and maxillofacial surgery 2009;13 (4):231-238.
52. Misch CE, Resnik R. Mandibular nerve neurosensory impairment after dental implant surgery: management and protocol. Implant Dentistry 2010;19(5):378-386.
53. Wittneben JG, Millen C, Bragger U. Clinical performance of screw-versus cement-retained fixed implant-supported reconstructions—a systematic review. Int J Oral Maxillofac Implants 2014;29(Suppl):84-98.