Chapter 1

Implant complications: scope of the problem

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Introduction

The introduction of endosseous dental implants as an option for restoring partially and fully edentulous patients has revolutionized dental treatment. High survival rates reported for single and multiple missing tooth replacements have validated the use of implant-supported restorations as a predictable method for oral rehabilitation [1–9]. In fact, owing to the improved function provided by implants, the Toronto Consensus Conference concluded that a two-implant-supported overdenture should be considered the standard of care (replacing the full denture) for mandibular edentulous patients [10].

Implants enable a single missing tooth to be replaced without restoring adjacent teeth. In addition, implants allow fixed restorations to be fabricated in patients who are fully or partially edentulous. Thus, the National Institutes of Health, Consensus Development Conference Statement in 1978 on Dental Implant: Benefits and Risk concluded that, "clinically, thousands of patients have been treated with dental implants for years and there is no question that many received long-term benefits." However, the report further stated that, "some implants fail in patients within six months; and some have resulted in extensive bone loss and produced irreversible defects and complications" [11]. Although this report is more than 35 years old, and refers to different types of implant systems than those that are currently being used, problems with implant complications have grown in number and complexity. This is reflected in the increased number of articles, journals, and continuing education conferences that have recently been devoted to the topic of implant complications [12–31].

Two literature reviews reported that when implant success was defined as an implant-retained restoration free of complications, only 61% of patients after 5 years with implant-supported fixed partial dentures (FPDs) [28] and 50% of patients after 10 years with combined tooth/implant FPDs [20, 29] reported no complications.

Moreover, the prevalence of complications increased dramatically in some categories. In the 10-year study, for example, in terms of technical complications, the incidence of connection-related complications (screw loosening or fracture) rose from 4.3% after 5 years to 26.4% after 10 years. Of the 9% of restorations that were cemented, loss of retention of the restorations occurred in 6.2% within 5 years and 24.9% within 10 years [20]. Obviously, implant complications increase with the length of time an implant-supported restoration is in place.

The second edition of dental implant complications continues with the same format as first edition, where the various complications are discussed with respect to their etiology, prevention, and treatment. Since the publication of the first edition, five chapters have been added, covering newly recognized complications. Moreover, every chapter has been updated to encompass new knowledge and techniques that have been recognized and evolved since the publication of the first edition. Following a similar "Etiology, Prevention, and Treatment" format, this chapter addresses the scope of the problem regarding implant complications.

Etiology

There are several reasons for the increased numbers of implant complications being experienced by clinicians

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in recent years. First, the total number of implants being placed has increased significantly over the past 10–15 years. The *2000 Survey of Current Issues in Dentistry*, published by the American Dental Association, noted that over a 4-year span (1995–1999) the average number of implants placed by all dentists increased annually from 37.7 to 56.2 [32]. A dental implant overview evaluating the implant market by the Millennium Research Group in 2006 reported that from 2002 to 2006 the number of professionally active general practitioners rose from 125 230 to 130 830. During the same period the percentage of general practitioners rose from 5.0% to 19.0% [33]. As the number of general practitioners was increasing, the actual number of general practitioners placing implants in 2006 was four times higher than the number placing implants in 2002. In the years 2003, 2004, 2005, and 2006 the growth in the number of implants placed by general practitioners was 82%, 46.0%, 24.4%, and 20.1%, respectively. The Millennium Research Group reported that, "Global sales of dental implant systems … are expected to maintain double digit growth over the next five years soaring to more than 4.5 billion dollars" [33]. In fact an independent survey reported that the number of dental implants sold in the United States alone will be over 2.7 million by 2017 [34]. Therefore, the increased numbers of implants and implant-related procedures being performed would have in itself resulted in a greater number of complications even if the percentage of adverse event occurrences remained the same [35].

The second reason is related to the fact that the increased number of implants being placed also reflects an increased number of dentists, varying in their clinical experience, placing and restoring implants. When first introduced to the profession, endosseous dental implants were primarily placed by oral surgeons and periodontists who had prior experience and training in bone and soft tissue surgery. However, as the number of dentists placing implants increased, more dentists, who did not routinely perform oral or periodontal surgery, began performing additional procedures as part of implant therapy. A recently published survey concluded that by 2015 more general dentists will be placing implants than all specialties combined [36]. Regrettably, in some cases this has resulted in an increased rate of implant-related complications. A recent article in the July 2014 issue of the *Journal of the American Dental Association* reporting on outcomes of implants and restorations placed in general dental practices reported the results of implant failures of 992 implants and patients from 87 practices. The results indicated a 7.0% failure rate when excessive bone loss was excluded from the analysis; "when excessive bone loss was included 18.7% (172/922) implants were classified as failures" [37]. This certainly is significantly higher than reported in the studies in which implants were placed and restored by specialists.

A third reason for the increased incidence of complications is related to the fact that until recently, there were few formal training courses in implant placement or restoration for dental students during their 4-year dental education [32]. Furthermore, the majority of that training was didactic in nature and did not include clinical experience with implant placement and restoration. From another perspective, many clinicians currently receive their implant training from continuing education courses offered by implant companies or private practitioners. These courses are less comprehensive than formal training programs and do not enable the participating dentist to become familiar with the breadth of complications that can occur.

The fourth reason for the increase in complications seen today is that dentists are placing implants in compromised sites using more aggressive protocols. Protocols today include implants placed at the same visit as tooth extraction, immediate provisionalization of the implant following placement, and in many cases the occlusal loading of an implant on the day of placement. Moreover, implants are being placed in compromised patients and/or in compromised sites where there is inadequate bone and soft tissue to fully emerge the implant [38]. Many of these sites require augmentation procedures before implant placement. Implants being placed in these augmented sites or with these aggressive protocols require more experience and skill than are required for routine implant placement. These added procedures, combined with the more aggressive implant protocols, provide more opportunities for complications to occur. An often quoted statement related to complex cases is: "The more complicated the case the more potential for complications." When these complications arise, many dentists placing and/or restoring implants have little or no experience on how to handle the problem. The value of experience was recently demonstrated by a pilot for US Airways. On January 15, 2009, US Airways flight 1549 took off from La Guardia Airport in New York City. After several minutes in flight a flock of birds collided with the engines and both engines shut down. The pilot, Chesley Sullenberger, could not return to La Guardia airport or fly to a nearby airport to land the plane, which had completely lost power. Instead, he safely landed the plane on the Hudson River, thus saving all 155 people aboard. When asked how he managed to do this, Mr. Sullenberger replied: "For 42 years, I had made small, regular deposits of education, training,

and experience and the experience balance was sufficient that on January 15th, I could make a sudden, large withdrawal" [39]. Regrettably, many dentists placing implants today lack the education, training, and experience to make that "withdrawal"; in other words, to know what to do if and when an implant complication occurs.

The fifth reason for the increased incidence of implant complications indirectly arises from the lectures and courses that dentists attend. These courses frequently cite the high implant success rates reported in the literature. Although it is true that the survival rates of endosseous implants have been documented to be high (in the 90th percentile), a number of factors must be understood about the studies on which these data are based. First, in almost all cases the authors and investigators involved in the study were experienced surgeons or restorative dentists who were very familiar with implant placement, implant restoration, and the implant system that was used. In addition, the patient inclusion and exclusion criteria for these studies were usually very strict, resulting in exclusion of patients and sites that presented with high risk. Moreover, implant technology is changing so rapidly that the specific design and surfaced implants that were used and reported on in those studies are in most cases not available from the same company today. Newer implant surfaces on currently available implants may show improved results (more rapid integration or greater implant to bone contact) but only now is the long-term data of these implants beginning to become available. Therefore, long-term data for many implants currently being used are limited as to the number and the length of time for which these "new" implants have been studied, with only 4 or 13 implant systems having survival documentation of 10 years or greater (Table 1.1) [40–52]. In an article reviewing different implant surfaces, the authors stated, "many clinically well documented oral implant systems have largely been abandoned for the potential benefit of new, untested devices" [53]. Another misconception arises when lecturers speak of implant "success," as opposed to implant survival. Traditionally, according to the literature, implant success was defined as an implant with no pain, no mobility, no radiolucent peri-implant areas, and minimum bone loss of less than 0.2 mm annually following the first year of loading [54]. Roos-Janasaker added to this definition by further defining a successful implant as one that loses no more than 1.0 mm of bone during the first year post placement [55]. Today the parameters for implant success also include the esthetic appearance of the final implant restoration. Many lecturers, sponsored by specific implant companies, will show their most successful esthetic cases that were accomplished using the sponsor's implant system. Few failures or complications are seen in these presentations. Few in the audience may realize that, as is done in well-controlled research studies, the selection of patients (and implant sites) was carefully screened when a successful case is being shown (see Chapters 11, 14, 15, 24, and 25). Rarely does the audience see a flawed response, and even less often, a complication. Thus, in clinical practice, when "things go wrong" and complications occur or when a clinician's results are not similar to what was shown in the lecture or symposium, the dentist, who was impressed by the "simplicity" and "reliability" of the implant system he or she purchased, is now at a loss as to what to do to rectify the unanticipated problem. Often times when a clinician, not experienced or knowledgeable about complications, attempts a "treatment" the problem is made worse and a solution more complex (Fig. 1.1).

Table 1.1 Implant survival data with different implant systems

Company	Surface	Published study	Patients (*n*)	Implants (*n*)	Follow-up	Implant survival
Nobel	TiUnite	Mozzati [40]	90	209	11 years	97.10%
Biomet 3i	Osseotite	Browaeys [41]	83	749	7 years	91%
	Nanotite	Östman [42]	42	139	1 year	99.40%
Straumann	SLA	Van Velzen [43]	250	506	10 years	99.70%
	SLActive	Markovic [44]	13	37	1 year	100%
	Tizr	Quiynen [45]	91	75	3 years	97.30%
Neoss	Multiple blasting	Zumstein [46]	50	183	12 months	98.20%
Biohorizons	LaserLok	Serra [47]	300	160	24 months	97.50%
Zimmer	RBM	Ormianer [48]	46	173	10 years	99%
Anklos	RBM	Romanos [49]	247	634	3 years	98.70%
Southern	RBM	Vandeweghe [50]	42	57	1–32 months	96.50%
Astra	TiOblast	Ravald [51]	66	184	12–15 years	95.50%
Bicon	HA coated	Urdaneta [52]	291	410	20 months	97.50%

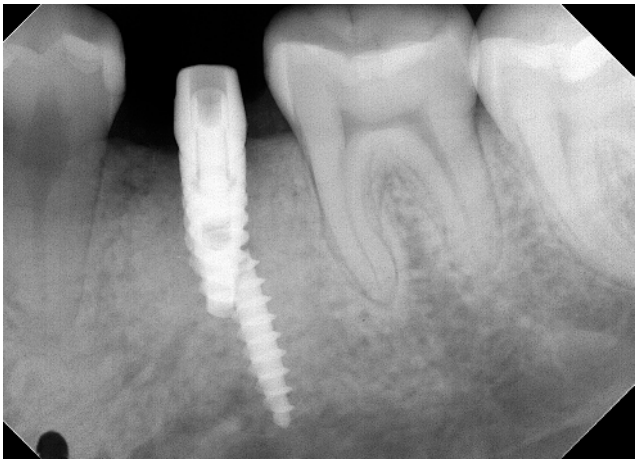


Fig. 1.1 After a narrow-diameter implant was placed and fractured, the dentist attempted to treat the complication by placing another, standard-sized implant, thus complicating the complication. Photographs provided by S.H. Froum and P. Mann. Reproduced with permission from S.H. Froum and P. Mann.

Anyone placing or restoring implants must be prepared for the possibility of potential complications. These may be minor or major, reversible or irreversible in nature. Some of the problems that we are seeing with implant complications today include implant fracture (Fig. 1.2), implant failure (Fig. 1.3 a,b) malposed or nonrestorable implants (Fig. 1.4) (see Chapters 29 and 30), periimplantitis (Fig. 1.5 a, b), esthetic implant failures (Fig. 1.6), and implants causing permanent damage to vital structures or teeth (i.e., sensory damage, damage to adjacent teeth, sinus complications, and loss of bone and soft tissue when implants fail or require removal) (Figs. 1.7, 1.8, and 1.9). These adverse events are a growing concern to the dental community.

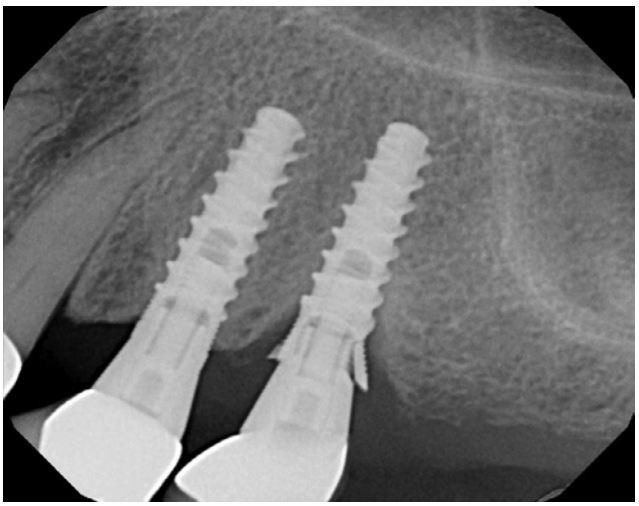
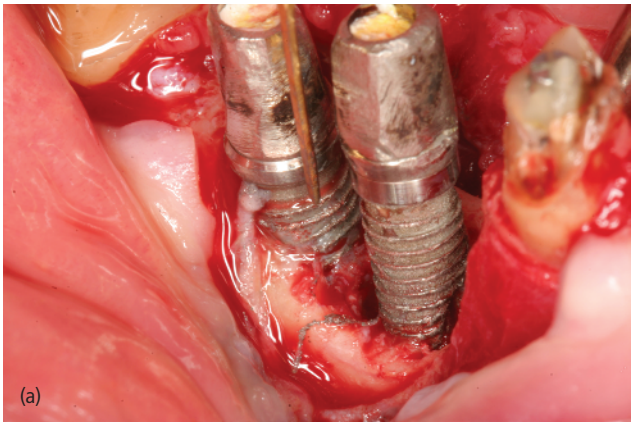


Fig. 1.2 Radiograph of a fractured implant (no. 13). Note the mesial and distal bone loss, which usually precedes or accompanies a fractured implant.



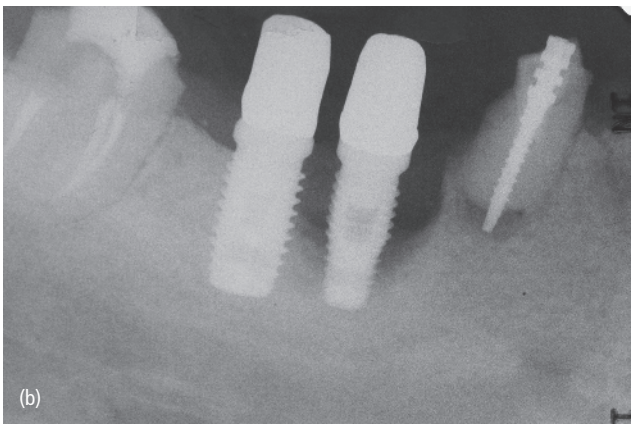


Fig. 1.3 (a) Clinical photograph of hopeless implant no. 29, bone loss around implant no. 30 and hopelessly involved tooth no. 28. (b) Radiograph of implants seen in (a).

The following observations and advice regarding implant complications, their etiology and sequelae as they relate to medicolegal issues are offered by Mr Art Curley, who is a senior trial attorney in the San Francisco-based healthcare defense firm of Bradley, Curley, Asiano, Barrabee & Gale PC:

> Dental implant related technology has evolved geometrically over the last 30 years to the point that the occurrence of complications and failures, once considered risks in the 1970s, may now be used as evidence of negligent care (legally: failure to meet the standard of care) for which the practitioner may be held liable.
>
> Recently a boarded specialist placed an implant in contact with the inferior alveolar nerve (IAN) resulting in significant chronic and untreatable pain. Plaintiff's attorney sent the client for 3D scan which confirmed the implant as being in the IAN canal. That image begged the question, if, post-op, an imaging system can show exactly where the implant is, why wasn't one either taken and used or at least offered to the patient prior to surgery to prevent nerve damage? The result was a verdict of $1,700,000. Two similar cases, involving iatrogenic nerve damage causing chronic pain and associated wage loss, resulted in settlements of $900,000 and $850,000.

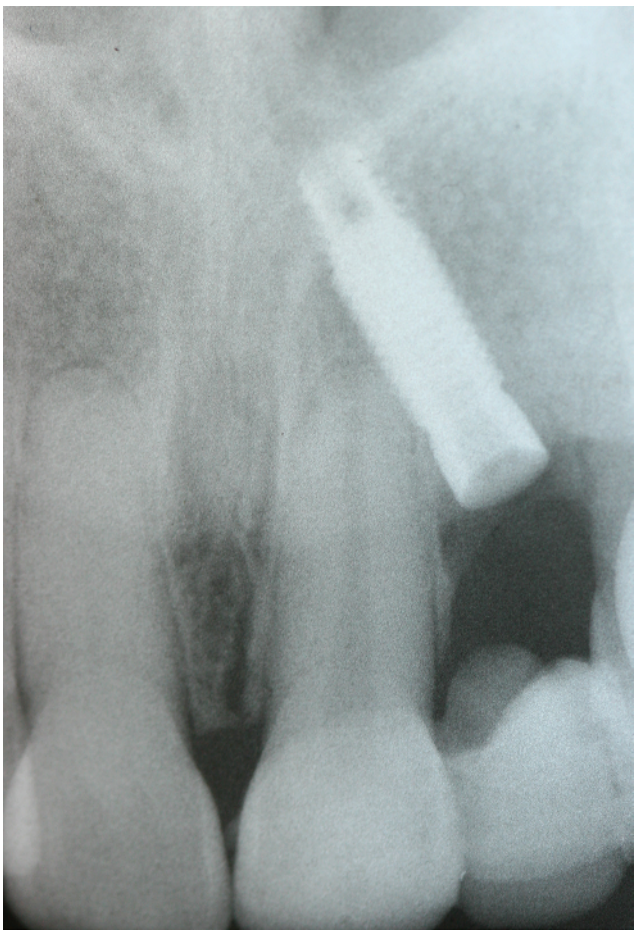


Fig. 1.4 Periapical radiograph of malposed maxillary left lateral incisor implant.

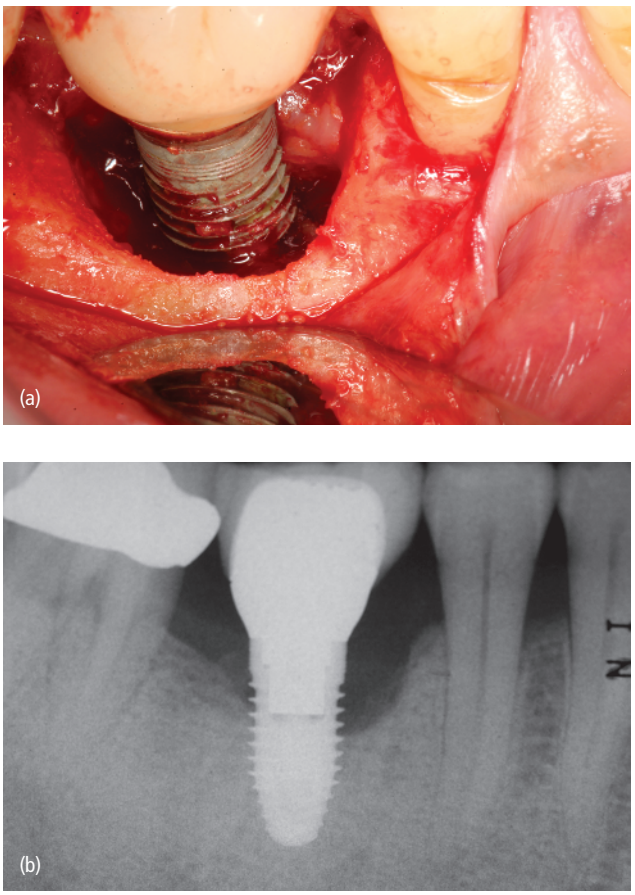


Fig. 1.5 (a) Clinical photograph of implant affected by peri-implantitis (note circumferential bone loss). (b) Periapical radiograph of implant in (a).

Mr. Curley offers the following advice and recommendations:

> The law considers the occurrence of complications as evidence in a claim of malpractice. Generally, there is a 3 point test as to whether a complication is evidence of a risk of treatment or evidence of a malpractice. A risk is a complication that cannot be avoided with the application of reasonable and prudent skill, care and technology. Skill is the physical conduct, such as the location placement of an implant. Care is the education, instruction and management of the patient before, during and after the treatment in question, such as clear post-operative instructions. Technology is the employment of tools, including testing equipment, imaging, and digital analysis and computation, such as the use of CBCT before and after surgery. Documentation as to the physical techniques employed, the instruction and consent process, and the offering of best imaging are critical in deterring and defending claims of malpractice.

Thus, a potential and undesirable result of these increased complications is that malpractice claims and therefore malpractice insurance premiums may eventually become so expensive for dentists utilizing implant restorations, so as to limit the use of implants as a restorative option (not unlike what occurred with obstetricians, many of whom stopped delivering babies). Lastly, with increased problems resulting from implant complications, third-party regulation may become more restrictive as to when and where implants may be used.

Fig. 1.6 Poor implant esthetics on the right implant-supported central incisor crown.

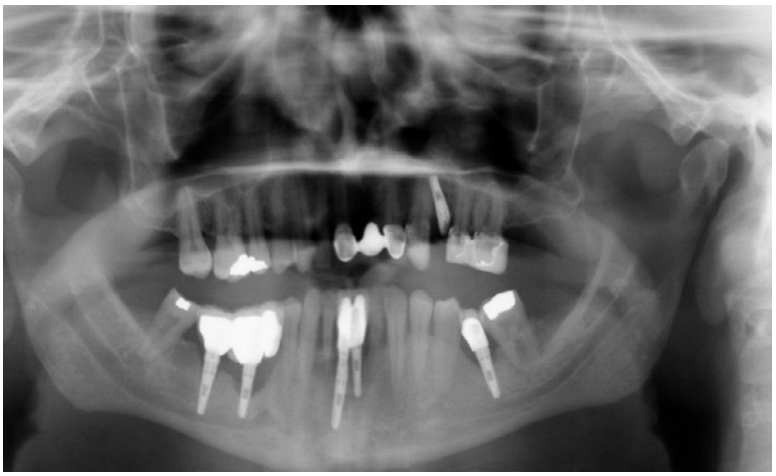


Fig. 1.7 Mandibular right distal implant impinging on the inferior alveolar nerve.

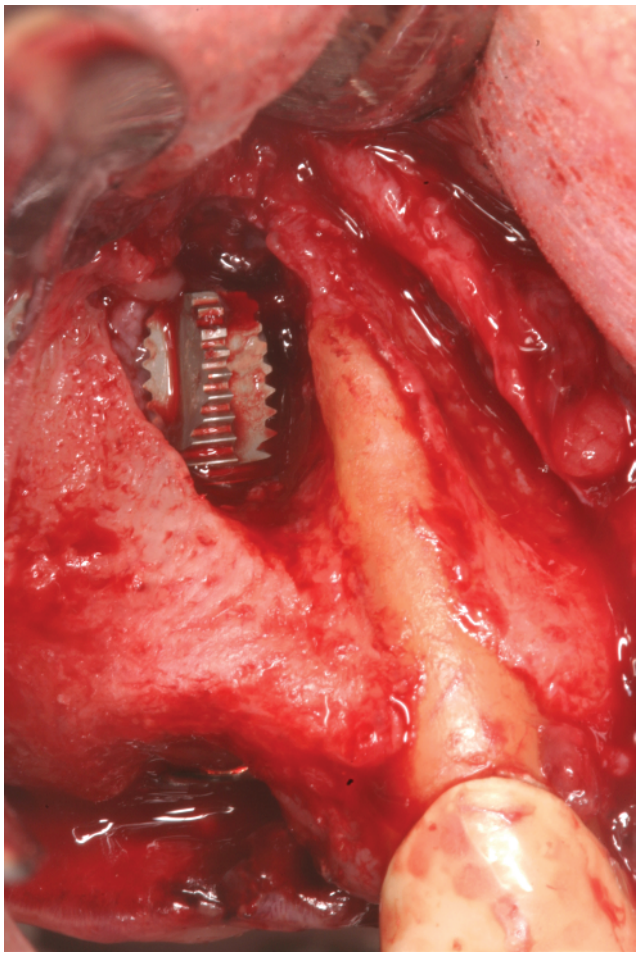
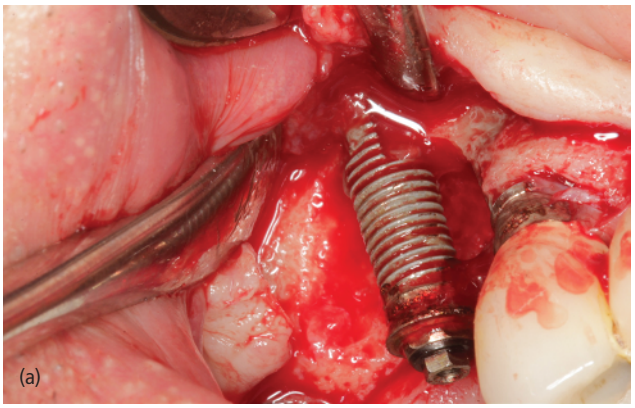


Fig. 1.8 Poorly positioned implant hitting the adjacent natural tooth.



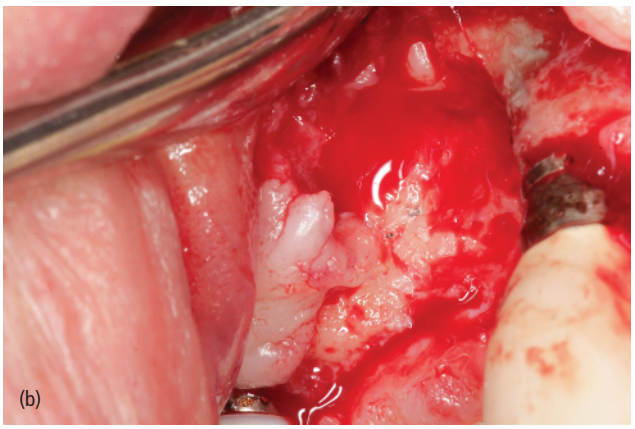


Fig. 1.9 (a) A failed implant prior to removal with 90% of bone loss caused by peri-implantitis. (b) The defect present following explantation of the implant.

Prevention and treatment

Most problems may be avoided if the implant companies promote, and clinicians adhere to, good clinical practice. This includes better and more comprehensive training for clinicians. Moreover, as the code of ethics prescribes (Section 2. Principle: Non-malfeasance, "do no harm"), "the dentist's primary obligations include keeping knowledge and skills current (and) knowing one's own limitations" [56]. In addition, both dentists and implant companies should adhere to responsible advertising to avoid unrealistic expectations by clinicians and

patients as to what implants can and cannot accomplish for specific problems. Better informed consent and communication among dentist, patient, and laboratory is essential to prevent unrealistic expectations for implant-supported restorations (see Chapter 24). In many cases an uncooperative or noncompliant patient may be the cause of a complication. Many patients refuse the presented plan or "insist" on treatment that exposes the practitioner and patient to greater risk. To prevent this, Mr. Curley advises dentists to consider the doctrine of "informed refusal."

According to Mr. Curley, that rule of law holds that a patient must be told in lay language the risks of not following the referral, recommendation, or advice of a doctor, including the risks associated with selecting a less than ideal treatment, test or procedure.[1] Risk management dictates that giving such warnings and obtaining "informed refusal" should be documented to be effective and a claims deterrent. Note that most dental malpractice insurance carriers and some dental societies have developed "informed refusal" forms for their members (see Chapter 28).

Other "preventive" measures to reduce complications would include clinicians attending courses and reading publications that include information on treatment planning and case selection designed to minimize risk.

With respect to some complications, their incidence of occurrence has not been well documented. For example, the prevalence of peri-implantitis was unknown until recently because most papers reviewed in the State of the Science on Implant Dentistry "did not include this parameter" [57]. Therefore, many patients and clinicians were not aware of this risk. However, recent studies show that this risk should be of concern and patients must be made aware of this before accepting the implant option. In two cross-sectional studies reported by Lindhe and Meyle, the incidence of peri-implantitis in the two groups of patients was 28% and ≥56% of the subjects and in 12% and 43% of implant sites, respectively [23]. A recent systematic review on the prevalence of peri-implantitis concluded that the prevalence "seems to be the order of 10% of implants and 20% of patients during 5–10 years after implantation" [58]. Knowledge regarding the etiology, prevention, and treatment becomes extremely important (see Chapter 9). The importance of a complication (e.g., sinus perforation) to the survival of the implant is an issue that is far from equivocal. Although several authors found no correlation between sinus membrane perforation (SMP) and implant survival [59, 60], others show a direct link between SMP and complications, including a lower implant survival rate [61, 62]. In all cases treatment of the perforation becomes paramount (see Chapter 19). Therefore, any clinician performing a sinus augmentation should be familiar with the etiology and treatment of this complication.

The "treatment" of the problem of an increasing incidence of complication occurrence is ironically in the "prevention" of these problems from occurring. Better case selection, knowledge of systemic problems that can result in complications, and better treatment planning are all essential to reduce the risk of complications (see Chapters 2 and 4). Use of available technology and diagnostic tools, such as computer tomographic scans, cone beam scans, surgical guides, computer treatment planning, and aids to assess primary implant stability (i.e., Periotest, Osstell), along with piezoelectric surgical machines, can aid the clinician in obtaining more predictable planning, placement, and restoration of implant-supported restoration (see Chapter 5).

Familiarity with medications commonly used in implant therapy is essential to any dentist in avoiding complications at the time of implant placement, augmentation procedures, as well as post surgically (see Chapter 3).

Finally, knowledge, learning, and experience are paramount to reducing the number of and severity of complications that will inevitably occur. Unfortunately, the statement "the trouble with using experience as a guide is that the final exam often comes first and then the lesson" [63] is often quoted and all too true. However, by reading about the various complications in the ensuing chapters of this book, hopefully, the clinician placing and restoring implants can vicariously, and less painfully, receive some valuable experience.

Moreover, the different authors will present this information from various aspects of their clinical experience. This should result in more comprehensive understanding of a problem and its treatment.

[1] CACI 535 A [*insert type of medical practitioner*] must explain the risks of refusing a procedure in language that the patient can understand and give the patient as much information as [he/she] needs to make an informed decision, including any risk that a reasonable person would consider important in deciding not to have a [*insert medical procedure*]. The patient must be told about any risk of death or serious injury or significant potential complications that may occur if the procedure is refused. A [*insert type of medical practitioner*] is not required to explain minor risks that are not likely to occur.

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