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Rationale for Dental Implants

Ilser Turkyilmaz and Gokce Soganci

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1. Introduction

The loss of just one tooth will eventually have a global impact on the entire stomatognathic system. Bone loss, shifting of teeth, occlusal changes, decreased bite force and many more effects are felt throughout the entire system [1-3]. In attempt to prevent the progression of these effects, dentistry has continually searched for the ideal tooth replacement. With the advent of dental implants, clinicians can now restore patients higher levels of health and function than ever before [4-8].

The deleterious effects of tooth loss have been well know for centuries. As early as 600AD we have evidence of early Honduran civilizations attempting to implant seashells as replacements of a missing tooth and root complex [9]. As an alternative to replacing the entire tooth complex, the profession of dentistry has also created innovations targeted at replacing just the coronal aspect of the deficient site. An example of this would be the classic three unit fixed dental prosthesis to replace an extracted maxillary molar. This modality of treatment presents many attractive features. The time involved to restore only the coronal deficiency is minimal, often times being accomplished in as little as one hour. Commonly, this will involve alteration of existing, and sometimes virgin, teeth to support a tooth borne, fixed dental prostheses. The unfortunate side effect of this treatment lies in the eventual development of future complications on those abutment teeth. [10]. Whether it be recurrent decay, material failure, or a different ailment, at some point the prosthesis will start to breakdown and the next restoration will be more invasive, costly and time consuming to both the patient and the practitioner [11]. More importantly, entire system will still experience negative effects because the root was never replaced. Both hard and soft tissues underneath the pontic site are still subjected to the cycle of breakdown as if the tooth was never replaced. Even with known future flaws in this design, the speed and affordability of these restorations have kept them as a popular method to replace missing teeth.

The patient driven treatment plan classically places emphasis on speed of restoration and direct cost to the consumer. Until recently, implant dentistry has performed poorly in those two categories when compared to tooth borne restorations. Continued development in both macroscopic and microscopic elements in implant design have ushered in the era of speedier implant treatment. Traditional dental implant protocols were known to prescribe long time periods of healing. Patient and doctor demand have recently placed a high value to shortening the time period involved in implant dentistry. From dual stage, to single stage to immediate loading, the trend is consistent in shortening the treatment times to allow for immediate results [12-14]. Further, the increase in the number of companies in the industry, and improved methods of manufacturing have helped keep the cost of implant treatment attainable to the vast majority of patients. Contemporary implant dentistry has not only started to rival classic tooth borne care, but it is becoming the clear choice for tooth replacement. This has caused the number of implants being sold and surgically placed to grow exponentially [15]. With the advent of immediate placement and loading, this industry is poised to command the lion's share of the tooth replacement market as it will be satisfying all the demands of both the patients and practitioners with regard to speed, cost and healthy replacement of the all the missing components in the system.

Historically, there have been many valuable contributions from clinicians that helped implant dentistry evolve. Implant dentistry main consistent feature has been constant evolution in design, materials and protocols. The list of contributors is a different topic of discussion than what is targeted in this book. However Dr. Per-Ingvar Branemark is deserving of special attention.

In the 1950's Dr. Branemark was involved with in-vivo blood flow experiments on rabbits [16]. Initially, titanium chambers were being embedded in the ears of rabbits to record data for their investigations. When Dr. Branemark moved those chambers into the femurs of rabbits he later discovered he could not remove the chambers from the bone into which he had placed the chambers. He found the bone to have grown around the chambers and thus integrated to the titanium surface. Following this discovery, Dr. Branemark performed additional studies that verified the phenomenon of osseointegration [17]. His collaborative efforts verified pure titanium to be the material of choice. His efforts from that point on were largely targeted to the development of dental implants and improving the quality of life in the edentulous population or those suffering from maxillofacial defects [17,18].

2. Tooth loss and edentulism

Although the profession of dentistry is developing osteoinductive, osseoconductive and regenerative products. The native alveolar bone is still the ideal support apparatus for teeth and dental implants. The lack of osseous stimulation from the tooth complex results in bone loss. This loss is manifested in both density and volume. Once the tooth and periodontal ligament are no longer in place, the body initiates changes to remove the alveolar bony support it had once provided. Osteoclastic activity increases and the alveolar bone is eroded away. If

the loss of a tooth is followed by placement of a dental implant, the loss of hard and soft tissue in the patient will be greatly reduced. If this process is not intercepted in a timely manner there will be a number of negative consequences dealt to the patient. Severe resorption of the bony processes harms both the quality of life and the quality of dental restorations that are able to be offered to the patients. The patient that waits to replace their teeth will often be informed that extensive grafting is needed to support dental implants. This results in increased cost and complexity. Whereas patients that are proactive in the transition from the dentate to edentate phases afford the clinician a better scenario to design for optimum results. Procedures such as "All on 4" have been designed to take an unhealthy, failing dentition to a healthy and fully restored state in as little as one day [19-21].

3. Expansion of the market

Currently, global populations are living longer. At the time when Dr Branemark discovered osseointegration, the world's life expectancy was 52. Currently, the life expectancy worldwide is 69.2 years. As our populations continue to live longer, there will be an increased demand on the dental profession's ability to both maintain oral health and effectively treat the edentulous population. Although there is speculation that the edentulous rate is dropping, the increased number of people entering the elderly population counters that number to yield an increase in the number of patients entering edentulism [15]. In fact, the total number of edentulous arches will climb to 37.9 million by the year 2020. This translates into a rise in the number of patients requiring at least one full arch of tooth replacement. Current evidence suggests that the restoration of the edentulous mandible with a conventional denture is no longer the most appropriate first choice of prosthodontic treatment [22,23].

While this demographic evolution may place strain on the world's medical model, it serves as an ideal situation for the dental practitioner. Opportunistic clinicians are recognizing this trend and learning the skills to provide the great services that can be offered using dental implants.

Modern society has placed a high value on appearances. In the midst of an economic recession in 2009 the United States of America's population spent 10.5 billion dollars on cosmetic surgery. Patients exert a demand upon the dental practitioner to provide esthetics and function. The days of patients succumbing to edentulism and alteration of lifestyle are over. Through various forms of marketing, the modern population is aware of our ability to restore lost function and esthetics. The global market for dental implants is currently 3.4 billion dollars, with expected growth in the coming years.

Contemporary dental practices are in an ideal position to provide implant dentistry to patients. Through marketing and patient to patient interactions, the public is becoming aware of what implant dentistry can provide to the world. Improvements in surgical protocols and implant designs have enabled the clinician to immediately restore missing pieces of the stomatognathic system. However, it is up to the clinician to take the time and learn the techniques and protocols if they wish to capitalize on this market.

4. Surface technologies

Through the initial experiments of Dr. Branemark and coworkers in 1977 [17] and recent researchers [24-26], the dental profession adopted commercially pure grade 4 (high oxygen content) titanium as the material of choice for the implant body. Recently, the alloy form of Ti-6Al-4V has also been adopted into the dental implant industry to improve strength, corrosion resistance and density [27-29]. While the use of an alloy gives added strength to an implant, the lower grade titanium will give an increased osseointegration. Research by Johansson and coworkers showed only slight differences in removal torque values after periods of healing when placing implants of various grades in rabbits [30]. These authors concluded that the level of integration was sufficient in the alloy group and an argument can be made to use the alloys which give improved strength characteristics. Current dental research has allowed for further modifications to both microscopic and macroscopic aspects of dental implants that have improved success rates and healing times.

Surgical integration in combination with healing and loading dynamics are the main factors of whether or not an implant is integrated successfully. The general purpose of surface technologies is targeted to specific goals. Increasing bioacceptance, speeding up the healing of the surgical site and osseointegration of the implant. Previous improvements on the micron level have been helpful, but the control of tissue response at the nano technological level is the current goal of researchers [31-33]. The implant itself will fall into one or a combination of the three possible categories. Metal, ceramic, or polymer are the three broad chemical classifications of the materials.

Metals have enjoyed a long successful history in various areas of medical and dental implant practice. Biomechanical properties and suitability to sterilization are two advantages to this type of material. One must always remember that when the implant, abutment, or connecting screw are of dissimilar chemical composition, the risk of galvanic interactions exists [34-36]. Further, a galvanic reaction can yield corrosion, oxidation and even the production of pain in the host. This sort of complication is rarely reported, but the whenever we use dissimilar metals in our treatment plans we should be aware of this potential.

Ceramics can be seen as the entire implant or as a surface modification to the metal implant body. Common forms of coatings are hydroxyapatite, tricalcium phosphate or a form of bioglass [37-39]. The possibility of surface degradation, especially with hydroxyapatite, has been an area of contention with many pointing to this element when adverse implant to bone interactions occur.

Polymers were once thought to have advantageous qualities to be incorporated into implant design. Specifically, the shock absorbing capability was once thought to counteract the lack of periodontal ligaments with regards to occlusion. However, research and clinical reports have shown this material to be inferior to those previously discussed and is seldom incorporated today.

Surfaces are generally going to be further classified by the biodynamic response they illicit from the body [40]. No material is completely accepted by the body, but to optimize the

implant's performance emphasis is placed on minimizing biologic response while allowing adequate function. Bioinert, bioactive or biotolerant are the current terms used in this area of investigation [41,42]. All three of these descriptive adjectives imply biocompatibility to the host.

A biotolerant material is one that is not rejected by the host but, rather is surrounded by a fibrous layer. Bioinert materials are described as allowing close apposition of bone to the surface, lending itself to contact osteogenesis. Bioactive refers to allowing formation of new bone onto the surface but ion exchange with host tissue leading to formation of chemical bonds along the interface.

When the implant is inserted into the osteotomy site it will have an effect on the bone and blood clot that it is in intimate contact with. Osseoconductive and osseoinductive are common terms to describe the body's response to dental materials. Bioinert and bioactive materials are grouped into the osseoconductive category [41,42]. This refers to the ability to act as a scaffold, or allowing bone formation on their surface. Osseoinductive refers to a materials ability to induce bone formation de novo. An example of this is seen in recombinant human bone morphogenetic protein 2 [43,44].

A number of microscopic surface coating changes have been shown to provide improved healing to the implant surface. Generally, surface coatings are sprayed onto the implant. One must realize that surface coatings rely on adhesive qualities to remain on the implant during insertion. Bond strengths are currently reported to be in the range of 15-30 MPa. This low strength brings into question how practical a surface coating may be in the clinical environment. Speculation exists whether or not the coating is maintained during the placement of the implant into a osteotomy. However, many manufacturers are using this technology on their implants which suggests positive feedback from the clinical results.

Turned surfaces, sandblasted, plasma sprayed, acid etched, anodized, HA, zirconia, and more have been heavily advertised as additions to the pure titanium body. This list will continue to grow as implant companies position themselves to achieve faster healing times and thus allow for immediate loading. The common theme advertised from all the manufacturers is increasing bone to implant contact in both volume and speed. Examples of popular surfaces will be discussed. Currently there is over 80 companies producing over 250 different types of dental implants. Caution is recommended to the dentist with regards to this aspect of implant dentistry. As this field is rapidly changing. It is up to the clinician to use professional judgement on whether or not to adopt a new surface into their implant practice. Food and Drug Administration (FDA) clearance is often a good sign of whether or not a manufacturer's claim has undergone any actual scientific investigation.

4.1. Microscopic topography

Currently, most all manufacturers have made the shift from smooth implant surfaces to a rough surface [5,24,45,46]. Recently, even the smooth collar model that was promoted for increased hygiene has seen reduced promotion and use. This signals that most contemporary research points to rough surfaces functioning better in the role of promoting the mechanical

interlocking of the surrounding tissues. On the microscopic level of this element lies cell differentiation responses to different microscopic topographies. The appositional response of the extracellular matrices in the bone to implant environment have shown potential for providing improvement in implant performance [47,48]. Similar to the computer industry, the major advances in this area are found in nanotechnological engineering [32,33]. The word nano-lithography may be the next buzz word in advertisements from implant manufacturers. As a profession we will get there, but as technologically advanced as this sounds, the reality of current manufacturing is a surface is being textured by some sort of grit blasting process.

TiUnite is the current surface advertised by NobelBiocare. This adds an osseoconductive element to implants manufactured by NobelBiocare. It is a highly crystalline and phosphate enriched titanium oxide characterized by a micro structured surface with open pores in the low micrometer range. The surface is generated by spark anodization and consists of titanium oxide [49,50]. The following photos show an implant with TiUnite surface, and scanning electron microscopic (SEM) images of TiUnite surface during osseointegration (Figures 1-4).



Figure 1. NobelReplace Straight Groovy Implant with TiUnite surface.

Strauman currently promotes a surface by the name of SLActive [51-53]. This title denotes how the implant is conditioned for optimizations. Sandblasting with Large grit followed by Acid etching is how the manufacturer achieves the surface topography. To create the 'active' surface, the implant is conditioned with nitrogen and preserved in an isotonic saline solution.

Astratech dental implants are currently promoting a TiOblast and Osseospeed surface [54,55]. Essentially the surface of the implant is grit blasted with titanium dioxide particles to achieve

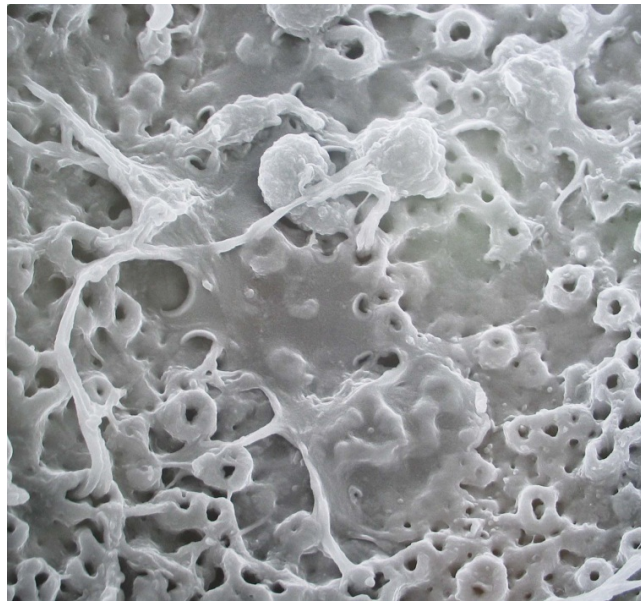


Figure 2. SEM view of TiUnite surface during osteoblasts are attaching on it.



Figure 3. SEM view of TiUnite surface when osteoblasts have filled pores on the implant surface.

an isotropic, moderately roughened surface. Later the implant is chemically conditioned with fluoride to gain slight topographical changes.

Zimmer contemporary surface is called MTX [56,57]. This acronym denotes 'micro-texturing' the implant surface. The implant is Grit blasted with hydroxyapatite particles and then conditioned a non-etching environment to remove residual blasting material.

3i, or implant innovations Inc, uses surface technology termed nano-tite [58,59]. After micro-texturing like the companies previously listed, the implant is then conditioned into a calcium phosphate solution.

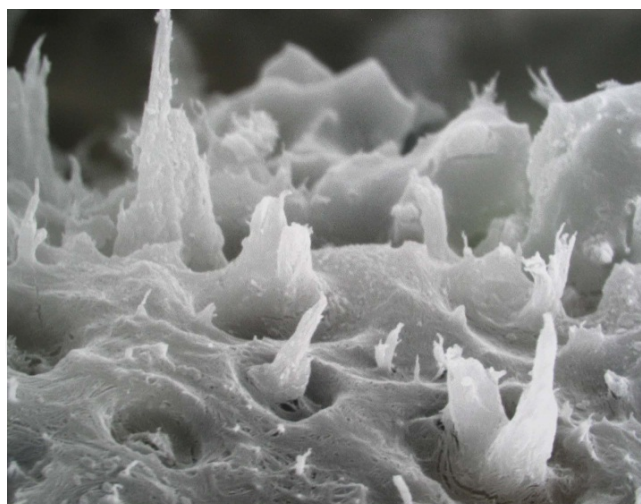


Figure 4. Another SEM view of TiUnite surface when osteoblasts have filled pores.

If all five of these surfaces from the five major manufacturers are compared, not much difference exists. Currently, a textured surface is created which is then followed by some element of conditioning thought to improve bioactivity.

An additional step to spraying on coatings or roughening the surface of implants is seen in the chemical treatment of the implant surface. The overriding goal in this treatment modality is to improve the wettability of the implant surface itself, or otherwise, to make the implant surface more hydrophilic [60]. Clinicians are advised that the contact angle of pre-existing surfaces was never poor and may be sufficient without additional modification. Early experiments have been promising in showing improvements in this area. However, it is not known to what extent this actually plays in implant success.

It is impossible to predict what the next big thing in implant dentistry will be. In fact, dentistry as a profession is changing so rapidly, it is a challenge for the practicing clinician to remain current with what the research world can produce. An over-riding principle must always be to be critical of what is advertised.

5. Macroscopic design

Dental implants have assumed a variety of shapes through the years. From frames to baskets and cylinders to tapered screw threaded forms, the macroscopic design has seen numerous functional advances. Currently the threaded implant body enjoys the majority share of the market. Experiments have shown that screw type implants maintain a higher bone to implant contact through years of function [9]. With this body shape dominating the market, a discussion in the elements of the screw shape is deserving.

There are four basic types of threads seen in a screw shape [9]. V-thread, buttress thread, reverse buttress thread and square threads. All of these designs will exert different forces on

the surrounding tissues when subjected to various load patterns. The thread pitch denotes the distance between adjacent threads. Thread depth will refer to the distance between the major and minor diameter of the implant. In addition to load distribution, the geometry of the thread will impact the surgical behavior of the implant during placement.

Implant bodies are commonly available as tapered or parallel. With regard to immediate load, clinicians are often looking for immediate stability. The tapered design imparts the ability to place an implant into an underprepared osteotomy site resulting in higher insertional torque values [61]. Controversy exists over what is the maximum torque that results in negative effects on the supporting tissues. Modern implants are being designed to withstand the high torquing forces on the implant body itself. However, some argue these high forces placed on the surrounding bone have the ability to cause compression necrosis. This is a current point of contention amongst various researchers. With regards to implant length, some manufacturers/researchers are promoting the use of shorter length implants [62,63]. However, caution is advised to the clinicians in this area, especially for implants shorter than 10mm.

When considering force distribution in the final prosthesis it is imperative to consider both biomechanics and limitations of biology [64]. By using longer and wider implants, the surface area of a load is increased. This in-turn lowers the force on the overall system ($F=M/A$). In contrast, if a wide platform implant is chosen for a given osteotomy site, one must be careful not to exceed the biologic parameters of the patient. For example, if a wide implant results in insufficient buccal bone, the gain in force distribution will be negated by the decrease of vascularity to the buccal bone in that site and potential implant complications.

The design of the implant to abutment connection is another aspect of treatment that the clinician must decide upon prior to treatment [65,66]. Whether to use external or internal hex, trilobe, conical, morse taper, platform switching are all decisions that must be made by the dentist (Figures 5,6). As in other areas of dentistry, there is a blend of art and science. Some clinicians use what works best in their hands or make decisions based on feel. Hopefully, as evidence based dentistry matures and actually starts to produce tangible recommendations, the decision making tree will become more research based.

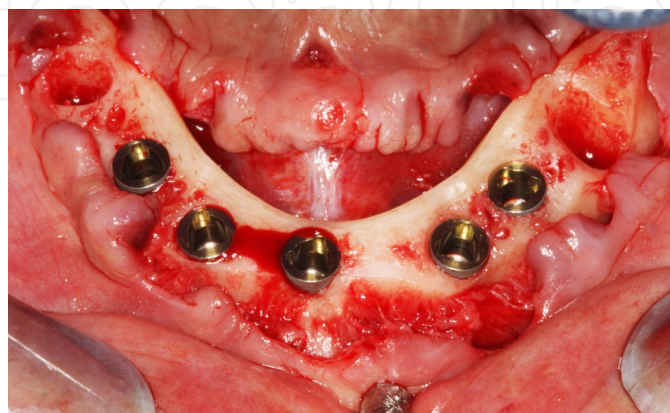


Figure 5. Immediate implant placement with NobelReplace implants with internal trilobe connection.



Figure 6. Cast with Branemark implant replicas with external hex connection.

In 1982, Dr. Gerald Niznick introduced the internal hex connection [67]. The purpose of this design was to create an implant to abutment connection that shifted the force from the implant screw to the platform connection. Prior to this innovation, screw fractures were a common complication [10]. Numerous studies have shown this to be a structural improvement with regards to reducing the stress placed upon the abutment screw [68,69]. Most clinicians prescribe implants with internal connections. Even with this said, the external hex remains a viable option and is still used by many dentists. After the decision of making your connection internal or external (Figures 7-9), the next choice is whether or not to use a platform shift.



Figure 7. Engaging and non-engaging UCLA abutments for NobelBiocare Replace implants with internal trilobe connection.

The term platform shift refers to a mismatched fit of the implant platform and that of the abutment. In the late 1980s the benefits of platform switching was unforeseen by the practitioners using this mismatched design. Wide diameter implants did not have a matching platform for the abutments so a regular platform was used. Upon follow up examination, the crestal bone levels were thought to be equal or better than platform matched connections [70,

71]. Current research suggests the medial movement of the implant / abutment junction is beneficial in reducing crestal bone loss. The marginal gap is thought to exert a sphere of influence on the biological reaction from the bone and soft tissues. A mismatched connection of .4 mm or greater appears to result in statistically significant less bone loss [72].



Figure 8. Engaging and non-engaging UCLA abutments for Zimmer implants with internal hex connection.



Figure 9. Engaging and non-engaging UCLA abutments for implants with external hex connection.

In implant dentistry, current paradigms for treatment success are based not only on true clinical outcomes such as implant survival, restoration survival, and patient satisfaction but also on surrogate clinical outcomes such as dentogingival esthetics and health of surrounding soft tissues [73]. This is especially important for implant therapy in maxillary and mandibular anterior regions, where esthetics play a predominant role in treatment success. A variety of abutments, and restorations differing in design and biomaterials have been introduced to achieve optimal mechanical, biological, and esthetic treatment outcomes. As an abutment material, traditionally titanium is selected due to its mechanical properties. However, the color of underlying titanium abutments negatively affected the appearance of peri-implant mucosa. To provide more predictable results regarding esthetic aspects, all-ceramic abutments made out of alumina and zirconia were introduced about 10 years ago. In vitro and in vivo studies [74,75] demonstrated superior fracture resistance of zirconia abutments with esthetic outcomes (Figures 10-13).



Figure 10. Implant is placed to restore maxillary left lateral tooth.



Figure 11. Zirconia abutment is screwed on the implant.



Figure 12. All-ceramic crown is cemented on zirconia abutment.

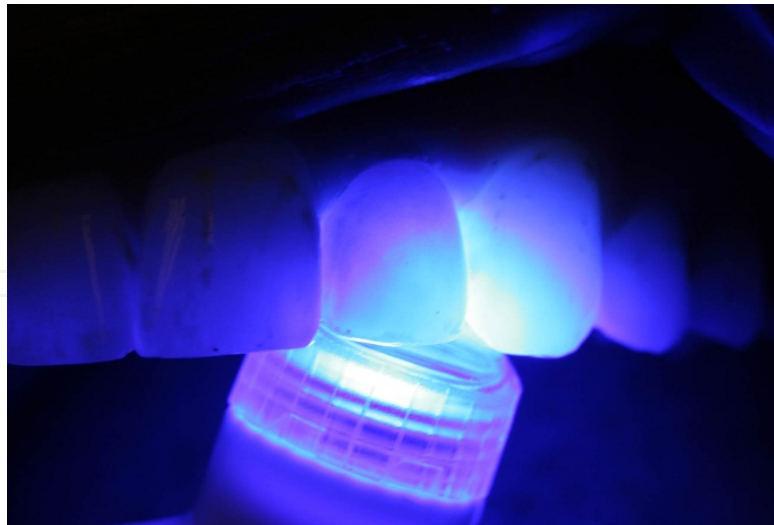


Figure 13. Translucency of natural teeth and all-ceramic restorations is similar, giving more esthetic outcomes.

6. Risk factors for implant candidates

Many attempts to use the phrase contraindications to dental implants have been made [76]. However those lists are often subject to controversy as the severity of a disease or patient condition exists on a sliding scale. For example, one diabetic patient may be at a higher risk than another [77,78]. Or one could ask, at what point does tobacco smoking effect implant survival? Case reports may exist for complications related to various patient conditions, but the doctor is reminded that those reports fall very low on the scale of strength of evidence the clinician can use and apply to their patient pool. Recently, the focus has fallen away from indications and contraindications and more emphasis is placed on risk factors. Risk factors are characteristics statistically associated with, although not necessarily causally related to, an increased risk of morbidity or mortality.

Multiple consensus review groups have recommended that risk factors be divided into two groups [76,79]. Systemic factors and local factors are the groups usually recommended and the latter is further subdivided into very high risk and significant risk. A noteworthy statement that resulted from these reports was in regard to the many attempts from other authors to create a list of relative and absolute contraindications to dental implant placement. This idea is discredited by this group because for many topics weak evidence exists in placing different conditions into an absolute contraindication. A case report of limited sample size is simply not enough evidence to create an absolute contraindication.

The chapter classified very high risk patients as those who could be attributed to having serious systemic disease, immunocompromised health status, drug abusers, and non-compliant patients [76]. A systemic disease can interfere with dental implant therapy at the level of local healing by altering tissue responses to implant placement and surgical treatments. Further, the medications that a patient may be taking for the systemic disease can interfere with normal

cellular functions and thereby affect healing and osseointegration. The American Society of Anesthesiology (ASA) has a well known publication to help classify a patient's risk to anesthesia leading into a surgical procedure [76]. Although many dental implants are not placed under general anesthesia, this classification system is an effective way to gauge the patients status for receiving any surgical treatment. For patients that fall into categories, dental treatment is not generally recommended until the patients health status improves and they are placed in a lower category. Significant risk patients were those who had prior irradiation, severe diabetes, bleeding disorders and/ or heavy smoking habits. Local factors are of particular concern with regard to implant survival. Some often highlighted factors are interdental / interimplant space, infected implant sites, soft tissue thickness, width of keratinized soft tissue, bone density, bone volume and implant stability.

In the era of immediate loading of dental implants, initial stability is of primary concern [46,80,81]. Reports have concluded through clinical research that initial stability is related to success with implant survival. There are a number of ways to measure the initial stability of an implant. The most common method of that is to measure the insertion torque of the implant during the final stage of placement using a torque wrench. Resonance frequency has recently been examined and verified to provide useful inpatient information [80] (Figures 14, 15). Specifically, values of multiple implants in the same patient are useful gauges on implant stability throughout the life of the implant. A correlation between preoperative CBCT scans and resonance frequency values at the time of placement has shown that primary implant stability may be able to be calculated preoperatively [81,82].



Figure 14. Osstell instrument used to determine implant stability.



Figure 15. Transducer of Osstell instrument attached to implant for measurement.

It is questioned if an adequate amount of interdental space needs to exist between an implant and an adjacent tooth [83,84]. Studies have shown that interdental spaces of less than 3mm were associated with increased bone loss around the implants. In this particular study, cases where this space was compromised seemed to especially result in bone loss around maxillary lateral incisors.

An infected tooth site is generally defined as one that exhibits signs or symptoms of pain, periapical radiolucency, fistula, suppuration, or a combination of these. The clinical scenario whereby an infected tooth is to be extracted and subsequently followed by implant placement in that site is commonplace in many practices. Whether or not placement of an implant in that site immediately is a key decision the dentist must face. Several clinical reports have been published on this topic, all with varying degrees of success [85,86]. However, studies like that of Villa have shown success in the placement of dental implants and immediate loading into previously infected sites. This idea is relatively new to dentistry, but the preliminary results do appear promising.

The subject of bone density and volume is of particular concern to the implant clinician. While bone density is often a topic of discussion, there exists little data on the relationship of bone density and implant success. With regard to bone volume, it is generally accepted that there are critical parameters in bone volume to support the success of a dental implant. An implant must be surrounded by bone that has adequate vascularity. If the surrounding bone does not have adequate thickness and therefore compromised vascularity, the implant has a higher chance of experiencing both soft and hard tissue attachment loss.

In addition to local and systemic biologic factors previously listed, a patient having a positive history to periodontitis and/or use of smoking tobacco should be noted and considered by the implant clinician. Drs. Heitz-Mayfield and Huynh-Ba performed a comprehensive review of the literature on this subject in 2009 [87]. They found numerous studies have targeted at success

rates in patients that fit this demographic of past periodontal disease and tobacco use. With regards to patients that had a history of treated periodontal disease they were able to identify patterns and make following useful conclusions;

- a. implant survival in patients with a history of treated periodontitis ranged from 59% to 100%,
- b. the majority of studies reported high implant survival rates >90% for implants with turned or moderately rough surfaces,
- c. all studies reported regular supportive periodontal therapy.

When discussing the issue of a positive history to tobacco smoking they found results that enabled them to make the following conclusions;

- a. Implant outcomes in 45 patients who were rehabilitated following an immediate loading protocol in the mandible were evaluated following 1 year of loading. The results showed there was no statistically significant difference in the smokers and non-smokers with regards to immediate loading protocol.
- b. The majority of studies showed implant survival rates in smokers of 80% to 96%.
- c. Overall there is limited data on the survival and success rates of implants in former smokers.
- d. There are studies that show an increased risk of peri-implantitis for patients that smoke.

The take away message from these reviews for the clinician should be; patients with a history of treated periodontitis and or smoking have an increased risk of implant failure and peri-implantitis. However, neither of these risk factors are absolute contraindications to implant therapy.

7. Conclusion

Implant dentistry has come a long way since the discovery of osseointegration of dental implants. In the last 40 years, the use of dental implants has dramatically increased. Initially, very few specialists were trained in surgical placement and subsequent restoration. As the treatment became more predictable, the benefits of therapy became evident. The tremendous demand for implants has fueled a rapid expansion of the market. Presently, general dentists and multiple specialists offer implant treatments. The field is evolving and expanding, from surgical techniques to types of restorations available.

In this chapter, general information regarding the need for dental implants, implant types and designs, and possible risk factors for patients who are looking for implant treatments have been provided. In the following chapters, more detailed information about several topics will be covered.

Author details

Ilser Turkyilmaz^{1*} and Gokce Soganci²

*Address all correspondence to: ilserturkyilmaz@yahoo.com

1 Department of Comprehensive Dentistry, University of Texas Health Science Center at San Antonio, Texas, USA

2 Department of Prosthodontics, Oral and Dental Health Center, Ankara, Turkey

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