

Dental Implants: Historical Perspective & Current Guidelines

EDO LAVI, DMD

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COURSE AUTHOR

Edo Lavi, DMD

COURSE OBJECTIVES

Upon completion of this course, the participant will have reviewed the origins and progress of dental implant methodology in history with an eye toward developing a better understanding of how these advanced aided the progression of techniques and the expansion of treatment indications. In addition, the participant will review current issues and guidelines including the growing preference for single tooth dental implants over fixed prosthodontic restorations; the advantages and disadvantages of immediate placement; and cemented restorations.

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Dental Implants: Historical Perspective & Current Guidelines

PART I: HISTORY OF DENTAL IMPLANTS

Tooth loss is a traumatic, even devastating, occurrence; and this has doubtless been true throughout human history. It is not surprising, then, that humans for millennia have sought to replace their lost dentition. The Etruscans are believed to have created bridgework fashioned from oxen bones some 2,500 years ago. Occupants of what is now Honduras, according to archeological findings, already developed a way to use tooth-shaped stones as dental implants about 1,000 years ago.

THE 1800s

In Europe, the earliest reference to an implant in modern literature appeared in a French work published in 1809. By the late 1800s, dentists on both sides of the Atlantic were experimenting with implants made of such things as extracted teeth (human and animal) and lead. As the first half of the 20th century unfolded, dental innovators continued to search for materials and designs that would survive for more than a brief period after implantation.

1940s – 1970s

One breakthrough came in 1941, when a Swedish doctor named Gustav Dahl placed a metal structure below the periosteum; vertical extensions protruded through the gingiva. Impressed by this work, two dentists from Providence, R.I., Aaron Gershkoff and Norman Goldberg, brought the technique for placing subperiosteal implants to the United States, an achievement that attracted attention from other American dental practitioners.

Another advance came with the work of Leonard I. Linkow of New York, who in 1964 introduced a self-tapping titanium implant. For cases in which bone was limited, Linkow later created a blade implant that eventually became the most widely used implant design in the 1970s.

In Switzerland, Dr. Andre Schroeder, chairman of the University of Berne, demonstrated the in-growth of bone into titanium plasma-sprayed hollow endosseous implants. At the same time, Professor Willi Schulte of the University of Tübingen in Germany reported success with immediate placement of vitreous carbon implants after dental extraction. Work with this design would eventually lead to the Frialit-2 implant.

THE BRÄNEMARK METHOD

The godfather of modern implants, however, was a Swedish physician and anatomical and experimental biologist named Per-Ingvar Brånemark. He was studying bone healing response and regeneration in the 1950s and in order to observe the functioning of bone marrow in vivo, he adapted an experimental chamber that had been used in England for insertion into rabbit ears. Unable to obtain tantalum (the

material used in the original design), he instead used titanium to make a chamber that could be inserted into rabbit legs to allow microscopic visualization of vital processes. After a months-long series of investigations, he sought to retrieve the chamber for reuse and found to his annoyance that it could not be removed from the rabbit bone.

Brånemark reportedly was not struck by the significance of this turn of events until some time after 1960, when he accepted a professorship in the Department of Anatomy at Gothenburg University. There, using an adaptation of the titanium chamber placed in the upper arms of human “volunteers,” he and his team investigated the workings and structure of human blood cells under a number of conditions. This work yielded a great deal of information about the nature of blood, and it showed the researchers that the titanium serving as lens casings appeared uniquely compatible with the human soft tissue and skin, provoking no adverse immunological reactions. At this point, Brånemark began to contemplate using titanium for medical applications.

In the years that followed, Brånemark and his team pursued this vision along a number of fronts. They designed titanium screws and inserted them into the jaws of beagle dogs, studying the conditions needed to achieve a solid bond between the bone and the metal. They studied the biomolecular processes that occur when titanium is placed in living tissue. As this understanding advanced, Brånemark believed it necessary to coin a new term to refer to the in-growth of the bone into the threads and crevices of titanium. He finally settled upon “osseointegration,” derived from the Latin words *os* (bone) and *integro* (to renew).

By 1965, the Swedish team felt ready to apply its findings to human patients. Although they had originally planned to work with knee and hip joint surgeries, they instead selected as their first human subject a 34-year-old man who had been born with a deformed chin and jaw. Brånemark inserted four titanium fixtures into the man’s mandible, and several months later he used the fixtures as the foundation for a fixed set of false teeth. The fixtures survived, the patient’s life was transformed, and Brånemark resolved to develop more techniques for dealing with dental rehabilitation.

In 1976, the Brånemark method became fully covered by the Swedish national health insurance system, and Brånemark began training the first Swedish dental experts in his techniques in October 1977. Five more years would pass, however, before Brånemark’s findings were adopted by North American dentists. In April of 1986, the first annual meeting of the Academy of Osseointegration was held in Chicago.

EXPANSION OF TREATMENT INDICATIONS

During the past 20 years, the field of osseointegration has witnessed a number of significant developments in the United States. One of the most notable is the expansion of the treatment indications. Historically, dental restorations supported by osseointegrated implants evolved in this order:

- * The fully edentulous lower jaw
- * The fully edentulous upper jaw;
- * The short-span edentulous segment; and
- * The missing single tooth.

When Brånemark presented his findings at the 1982 Toronto conference, dental implants up to that point had only been utilized for fully edentulous jaws (upper or lower), and the treatment was only recommended for individuals in this category. Though placement of implants for a fully edentulous arch may appear more complex than replacing only one tooth, Brånemark selected for his early research subjects only individuals whom he classified as “dental cripples” in order to avoid the possibility of making any patient’s condition worse. These were people suffering from catastrophic dental failures, for whom traditional treatments were no longer an option. For such people, any success with dental implants would be an improvement.

Soon after the first Americans were trained in Brånemark’s method in Sweden, they began to adapt and apply these methods for other treatment indications, specifically single-tooth and short-span fixed partial dentures. In one sense, this was a logical thing to do. If Brånemark demonstrated that a full arch of teeth could be successfully restored on four or five implants, it seemed an obvious extrapolation that a three-unit bridge could be done on two implants.

Today, the fastest-growing treatment indication is the single-tooth replacement. While at one time, a dental implant was thought to be an aggressive treatment of last resort, today, replacing a missing single tooth with an implant-supported crown has a reasonable expectation of a 95% success rate. Compared to the preparation of healthy, vital natural abutment teeth, many dentists realize and embrace the idea that the single-tooth implant is actually a more conservative treatment for the patient in the long term.

ESTHETIC RESTORATIONS

A second important development has been the gradual shift in attention to the creation of esthetic restorations. In the mid-1980s, implant practitioners were focusing on functional rehabilitation of the fully edentulous patient. Esthetic results were secondary to the profound impact on patients’ life quality that resulted from having a truly fixed

restoration after functioning with denture adhesives for 30 years or more. But as dentists sought to offer osseointegrated dental implants on a more routine and elective basis, demand for esthetic results that were at least comparable to other forms of dentistry grew.

Implant dentistry in the 1990s experienced a transition from functional rehabilitation to esthetics, with esthetic results improving throughout the decade. One aspect of this transition has been the development of components specifically designed for the single-tooth restoration or segmental bridge.

What has also emerged is a more detailed understanding of the relationship between residual bone volume and papilla height, along with treatment planning to correct soft-tissue deficits either surgically or prosthetically. It has become apparent that changes in the soft-tissue contours in the post-tooth-loss resorptive process have the greatest impact upon the final restorative esthetic result. During the past two decades, the focus on bone and implants has been joined with an equal focus on ceramics and soft tissue.

SCREW RETENTION VS. CEMENTATION

Another significant change has come in the manner in which osseointegrated dental implant restorations are delivered. In the 1980s, dental implant restorations were not only primarily of a full-arch nature, but they were also screw-retained. During the 1990s, however, as more general dentists and dental laboratory technicians have entered the field, a rapid changeover to cemented restorations has occurred. These implant restorations more closely resemble their natural tooth counterparts and do not require the same intricacies in fabrication as a screw-retained restoration. Long-term provisional cements seek to retain the retrievability of cemented restorations. Today, virtually any restoration can be done in either a screw-retained or cemented fashion, provided this preference is accounted for in the treatment-planning process.

IMMEDIATE LOADING

A final development that is taking place is the immediate loading of immediate implants, particularly when treating the anterior mandible. A waiting period of 12 months or longer to allow total socket healing used to be accepted protocol for placing dental implants. More than 15 years of research and clinical practice were needed for the concept of immediate endosseous implantation into fresh extraction sites to be accepted.

Recent clinical and scientific reports now describe a one-stage surgical protocol in which dental implants are placed immediately in extraction sockets and immediately loaded, eliminating the usual period of

healing (nonfunction). This protocol eliminates both the 3-6 month waiting period after extraction, and the waiting period after the placement of implants.

PART II: CURRENT IMPLANT ISSUES

Now we will evaluate three of the developments described above:

- The growing preference for single tooth dental implants over fixed prosthodontic restorations utilizing teeth or implants for support and anchorage.
- Immediate implants and immediate loading.
- Cemented restorations.

DENTAL IMPLANTS

The issue of whether to retain questionable teeth or replace them with dental implants has been debated in the literature. In the past, dentists were often obliged to rely on debilitated natural teeth to support a crown restoration, fixed bridge, or removable partial denture. A debilitated tooth has a guarded long-term prognosis as a restorative abutment, since all or most of the coronal tooth structure is lost, its root has a thin cross-section or is "hemi-sected" or short, or the tooth has a compromised periodontal attachment.

Endodontics, periodontal therapy, and the placement of a post and core are generally needed to restore these teeth prior to the final restoration. These extensive procedures are not only costly but also time-consuming. Even when well done, the final root and post "complex" remains an unavoidable weak link under final restorations. When under routine functional load, let alone the stresses associated with being an abutment for a fixed or removable partial denture, such teeth are often subject to catastrophic failure. The use of dental implants, in contrast, allows the placement of the optimal number of abutments with adequate length and diameter to support the prosthesis as needed. Dental implants are also not subjected to caries and may be used successfully even in caries-prone individuals.

Teeth with questionable prognoses may continue to lose bone and soft tissue as their condition deteriorates. Tissue loss may adversely affect the adjacent teeth, compromise esthetics, and put the success of the restorations at risk. Furthermore, continuous bone loss around questionable teeth may also compromise the future placement of dental implants. When such teeth are finally diagnosed as hopeless and extracted, they leave a residual ridge that may not be adequate for implant placement. This may result in a compromise in implant length, diameter, location, or angulation, or may require additional augmentation procedures with various degrees of success that may jeopardize the prognosis

of implants. The use of dental implants to support prostheses, on the other hand, has been shown to preserve adjacent remaining alveolar bone.

A comparison of the survivability of debilitated teeth to the success rates for single-tooth implant-supported restorations, shows significant improvements in implant survivability over natural teeth. Aquilino and colleagues looked at the 10-year survival of abutment teeth adjacent to edentulous spaces. Abutment tooth survival for patients treated with fixed partial dentures was 92%, 81% for untreated spaces, and 56% for removable partial abutment teeth.

In a parallel study, Preist restored implants placed in bounded edentulous spaces and found the survival rate of the adjacent teeth to be 99.5%, with only 1% needing any treatment. The non-involvement of the adjacent teeth in the restoration seemed to have a most advantageous effect and would decrease the future liability of these teeth needing further care.

Dental professionals must therefore recognize the fact that in certain cases the preservation of debilitated natural teeth may offer patients a poorer prognosis than the early removal of such teeth and their pre-emptive replacement with a dental implant. Implants are nearly always the appropriate dental solution in the following cases:

- *Teeth that have unusually enlarged root canal spaces or roots with thin peripheral walls* since they are prone to root fracture when in function. This is of particular concern when these teeth are to be used for abutments for fixed or removable prosthetics to avoid the failure of the entire restoration and bone loss.
- *Teeth that have little remaining coronal tooth structure* unless there is significant bulk to the root. The greater the loss of coronal tooth structure and the shorter the root, the less resistance the post and core has to dislodgment, leading to the failure of the overlying crown or fixed partial denture.
- *Teeth with very poor crown-to-root ratios.*
- *Long-span fixed partial dentures.* The placement of multiple implants will provide superior support to the arch and the separation of individual teeth, than will endodontically treated teeth.
- *Teeth that have adequate bulk to restore but do not respond to endodontic re-treatment.* Prolonged or ineffective healing will destroy needed alveolar bone and complicate future implant or other restorative procedures.

Dentistry needs to rethink its traditional approach to treatment planning for these teeth with a long-range perspective, which will impel them to incorporate the use of dental implants at a far earlier point in their day-to-day restorative treatment planning.

IMMEDIATE IMPLANTS

During the past 10 years, numerous clinical studies have shown that dental implants can be placed immediately in extraction sockets with success when sites are carefully selected. Dental implants have been placed at the time of extraction with a variety of techniques including without augmentation, with bone grafting, with bone grafting and a barrier membrane, and with and without primary closure. The techniques report survival rates of 94% to 100% over a varied healing period of three months to approximately seven years. Investigators have reported high success rates with all type of implants, including screw, cylinder, hydroxyapatite-coated, tapered, and single-stage.

The single-tooth implant restoration has been the most common immediate implant application, but immediate implants have also been successfully utilized in full-arch restorations. Single-rooted teeth, predominately incisors and premolars, have been the most frequent sites for immediate implants; but a study by Schwartz-Arad and colleagues evaluated molar immediate implants and found a success rate similar to healed molar sites in carefully selected cases.

Determining whether immediate implant placement is a reasonable clinical choice requires evaluation of the potential implant site. Initial implant stability is the most critical factor in implant osseointegration. Therefore an ideal site is one with significant alveolar bone around the socket enabling the implant to fill the socket space and little or no periodontal bone loss on the tooth that is to be extracted. In most studies, the investigators chose bony three to four walls, at least 3mm to 5mm of bone beyond the apex and a bony length of 10mm or greater for immediate implant placement. There is general consensus that bony defects with two and three walls missing or severe labial and circumferential defects are not suitable for immediate implant placement. Horizontal defects of less than 1.5mm do not need membranes to obtain histologic osseointegration.

The first step in immediate implant placement after case selection is an atraumatic extraction. Every attempt should be made to minimize trauma to the alveolus during the extraction. The use of a minisurgical blade to make the initial sulcular incision around the tooth will facilitate separating the soft tissues from the root and cutting the periodontal ligament. The periodontal ligaments can be further separated from the tooth with a periosteal elevator, which will help prevent fracture of the alveolus. Once the tooth has been loosened with the periosteal elevator, if there is adequate tooth

structure, the tooth can be carefully removed with extraction forceps. If there is not adequate tooth structure to grip with forceps or rongeurs, then the extraction may be attempted with the periosteal elevator alone or by sectioning the root so that the remaining root fragments can be extracted without placing pressure on the alveolus. The socket is then debrided with curettes or rotary instruments.

The resulting extraction socket is evaluated for osseous defects. If all four walls are intact and the circumferential defect is less than 1.5mm, an implant well may be placed without the need for bone grafting or augmentation. If three or more walls are present or if the circumferential defect is greater than 1.5mm, an implant may be placed; but bone grafting and protection of the socket with a membrane is recommended.

Next comes the preparation of the extraction area and the apical bone for the placement of the implant. The first step in the dental implant placement is the beginning of an osteotomy with a round bur or pilot drill. Once the osteotomy is complete to the desired depth with at least 3mm to 5mm of intimate implant to bone contact, an implant is placed. The implant must be stable within the osteotomy with no mobility. The implant ideally should be in contact with the extraction site, leaving no gap between the occlusal part of the implant and surrounding socket walls but not place undue pressure upon thin alveolar walls because this can result in microfractures and early crestal bone loss. Studies have shown that close adaptation of the implant to socket wall promotes greater osseointegration. In clinical studies, investigators have utilized a wide variety of techniques—including the use of a bone graft to fill the gap and/or the use of an occlusive membrane to prevent epithelial perforation into the space between the implant and the socket wall—to aid in the healing of this space.

In early studies, woven e-PTFE membrane exposure was a significant complication of membrane placement. Newer, more-stable resorbable membranes allow membrane exposure without complication. Certain barriers—porcine collagen and freeze-dried dermas, and laminar freeze dried bone—can be used in techniques that do not require primary closure.

Historically, most clinical studies have used primary closure of the flaps over implants placed in extraction sites. There have been studies, however, using the inner portion of e-PTFE membrane, a synthetic resorbable membrane and a laminar freeze dried bone membrane as occlusive barriers without primary closure. The advantage of not having to obtain primary closure is the preservation of the gingival tissues. The advantage of a resorbable membrane is

that it does not have to be removed, and the collagen membranes and laminar freeze dried bone show excellent tissue compatibility. For single-stage implants, both resorbable and nonresorbable barriers have been used to cover the implant-to-socket-wall gap.

A temporary prosthesis, either removable or fixed, can be placed over the implants, but it should not put pressure on the implant or it will result in premature loading of the implant. Premature loading or vibration of dental implants has been shown to delay osseointegration and retard bone healing.

ADVANTAGES AND DISADVANTAGES OF IMMEDIATE PLACEMENT

The advantages of immediate implant placement are the reduction in time of therapy, the reduction in surgical episodes, and preservation of the bone and gingival tissues. The greatest rate of bone resorption occurs during the first six months following tooth extraction unless an implant is placed or a socket augmentation procedure performed. The implant may also help to support the gingival tissues and the interdental papillae, which are critical for implant esthetics.

The primary disadvantage of immediate implant placement is the fact that the clinician may not be able to place the implant at the time of extraction even though time has been scheduled. The patient must always be informed that although an immediate placement will be attempted, it is not guaranteed since there is always a possibility that factors such as ankylosis, bone fractures of facial plates, socket expansion during extraction, or extensive infection might make immediate placement impossible. These areas will require extraction socket healing and possible augmentation before an implant can be placed.

Placing an implant in an extraction site at the time of extraction—before primary closure of the tissue—also forces the periodontist to engage in some degree of guesswork regarding the growth of the soft tissue, which can prevent him from achieving the best esthetic results.

The advantage of immediately loading implants is that it allows for the immediate improvement in the patient's functional ability and self-confidence while dramatically reducing treatment time. The concept of immediate loading of dental implants can be very encouraging to patients who are very distraught over the loss of natural dentition and opposed to wearing removable prosthetic appliances.

The temporary prosthesis and the provisional crown that is placed on the implant prior to placement of the final crown can also help shape the gingival

tissues, a key factor in implant restorative esthetics. Thus, in the restoration of dental implants in the esthetic zone of the maxillary anterior teeth, it is recommended that a temporary crown be considered as part of the restorative treatment plan to help shape and form the peri-implant tissues prior to placement of the final crown. By wearing the provisional restoration during the healing period, the prosthodontist has the opportunity to evaluate the esthetics, phonetics, and functional loading during the normal osseointegration healing period, and make necessary modifications for the final restoration.

When it comes to immediately loading a single posterior tooth, however, especially a molar, the disadvantages may far outweigh the advantages of such treatment. This is because occlusal forces are 3-4 times greater in the posterior region than in the anterior area of the mouth. Immediately loading a single anterior tooth, which is subjected to small occlusal forces and has a great esthetic advantage, on the other hand, may be an indication for single tooth treatment. In a situation where a patient can tolerate wearing a removable denture, and has worn one for many years, immediate loading may not be as critical as for a patient who is being transitioned from natural teeth to dental implants.

Patients must be willing to accept the precautionary measures that are recommended for immediate loading, eg that they be on a soft diet during the three-month healing period to limit the functional forces during osseointegration.

Since there was very little good scientific data to support the early techniques of dental implants placed in function, immediate loading probably played a large role in producing mobility leading to early failures. The imprecise drilling methods used to prepare the osteotomy site for placement of implants resulted in implants lacking initial stability due to substantial voids adjacent to the implant. These implants were then immediately loaded. The premature loading of unstable implants caused the implants to loosen and become fibrous encapsulated.

Studies show that if the osteotomy site is precisely prepared, the undisturbed healing period, which was a tenet of Brånemark implants, can be unnecessary. The use of a series of standardized drills with copious irrigation creates an intimate receptor site. The implant then has excellent initial stability at the time of implant placement. There is a certain amount of micromotion that can be tolerated during the healing period. By having an implant with excellent primary stability splinted and stabilized with the adjacent implants, the amount of micromotion is limited and controlled to achieve osseointegration in a predictable fashion.

In a case of immediate loading, the prosthodontist should fabricate a provisional restoration prior to surgery so that he can place the implants in the ideal position for the prosthetic restoration. The abutments and prosthetic cylinders are connected to the implants. The prosthetic cylinders are then in turn connected to the provisional restoration intraorally using auto polymerizing acrylic resin following the conversion prosthesis technique. This technique allows for the placement of the implants in the proper position for each individual patient, followed by customization of the provisional restoration before surgical flap closure.

Cemented and screw-retained implant prostheses present distinct advantages and limitations. The major difference between the two strategies is that a screw-retained prosthesis can be removed and replaced by the clinician, while a cemented restoration is not intended to be retrieved. Each can be the best option, depending on the objectives of the prosthesis, the attributes of the implant system, and the philosophy of the practitioner.

A major benefit of a screw-retained prosthesis is retrievability. This includes removal of the prosthesis to retighten bridge or abutment screws, replace failed or fractured components, or to perform routine hygiene. This feature is particularly desirable in multiple-unit, full-arch, or cantilever prostheses, where some maintenance of restorative materials or structures, components, or implants would probably be necessary during the lifetime of the prosthesis. In addition, screw joint systems provide a great variety of transmucosal and prosthetic components, work well in patients with limited occlusal space, require no removal of subgingival cement, and cause no negative sequela when the cement is not removed. This is particularly important if the transmucosal-to-implant junction is greater than 3mm to 4mm subgingival.

The disadvantages of a screw-retained implant system are numerous. First, there is the problem of a lack of esthetics at the screw access channel, if the implant is not placed in the precise way that will cause the screw access hole to be optimally located. The screw access opening can also weaken the porcelain around the openings and at cusp tips, and establish unstable occlusal contacts. Second, if the metal is cut back to hide the non-esthetic metal, porcelain fracture around the screw access channel may occur. Third, screw-retained prostheses generally require both the abutment screws and bridge screws to be tightened using a torque driver to effect preload of the screws. This torquing appears to have lowered but not eliminated the incidence of screw loosening. Thus the screw joint has limited stability, particularly when used in single-tooth and partially edentulous situations. Fourth, screw-retained systems generally

leave a microgap beneath the gingival crest, resulting in chronic gingival inflammation. Finally, obtaining passivity of frameworks that are screw-retained is difficult due to dimensional discrepancies inherent in the fabrication process.

New designs of the abutment-implant connection seek to solve these disadvantages of the screw-retained implant by enhancing component coupling and increasing stack stability and rigidity. These systems utilize external splines or internal hexes and conical tapers for joining components, and they provide increased surface area contact between the implant and the abutment (a 2- to 5-fold increase). Internally fitted components provide resistance through the transfer of forces from the lateral surfaces of the abutment extension to the wall of the implant, reducing or eliminating the strain placed on the fastening screw, micromovement and loosening of the screw, deformation of the component stack, and separation of components. Finally, improvement to the abutment screws through design changes, refinement of materials, and surface coating now produce higher clamping forces to the joint and improved initial preloads.

CEMENTED RESTORATIONS

Cementation of implant restorations avoids many of the potential disadvantages of screw-retained implants. It eliminates unesthetic screw access holes and it can compensate for any minor dimensional discrepancies in the fit of restorations to abutments, which can contribute to lack of passivity, using cement and cement space.

The stability of the cemented implant, however, can also pose a liability. When cemented abutments are considered, it is imperative that the cement margin is shaped to maintain a relationship with the mucosa margin. With many manufactured abutments the cement margin is circular, which can lead to deeply located cement margins. Cement removal becomes difficult, if not impossible, and it can lead to soft tissue irritation. In general, the primary disadvantage of cementing implant-supported restorations is that it can be difficult to retrieve the restoration. If any repair of the restoration becomes necessary, the restoration may be destroyed during the removal procedure if the cement seal cannot be easily broken. Additionally, if an abutment screw loosens under a cemented multi-unit implant restoration, the restoration is usually un-cemented from abutments firmly seated to implants and firmly attached to the loosened abutment(s). Any force applied to a restoration on a loosened abutment has the potential to damage the internal threads of the implant.

Dr. Daniel Y. Sullivan, a dental practitioner in Washington, D.C., and McLean, Virginia and Professor at the University of Pennsylvania School of Dentistry claims in [The International Journal of Oral & Maxillofacial Implants](#) (Vol 14, No 1, 1999) that the question of which modality is better depends

Self-Test

1. According to archeological findings, occupants of Honduras used which of the following as dental implants?
 - a. Animal teeth
 - b. Tooth shaped stones*
 - c. Metal rods
 - d. Gold teeth
2. Which of the following is the order in which treatment indications of dental restorations evolved?
 - a. Fully endentulous lower jaw, short-span endentulous segment, fully endentulous upper jaw, missing single tooth.
 - b. Missing single tooth, fully endentulous lower jaw, fully endentulous upper jaw, short span endentulous segment.
 - c. Fully endentulous lower jaw, fully endentulous upper jaw, short span endentulous segment, missing single tooth.*
 - d. Fully endentulous lower jaw, fully endentulous upper jaw, missing single tooth, short span endentulous segment.
3. TRUE or FALSE: Brånemark selected for his early research only individuals who needed single tooth implants.(F)
4. TRUE or FALSE: The preparation of healthy natural abutment teeth is a more conservative treatment than implants.(F)
5. Which of the following developments results from the growing emphasis on the creation of esthetic restorations?
 - a. The development of components specifically designed for the single tooth restoration.
 - b. Increased awareness of soft tissue contours in the post-tooth-loss resorptive process.*
 - c. The use of cemented restorations instead of screw-retained ones.
 - d. The preference for implants over the preparation of natural healthy abutment teeth.
6. Cemented restorations have which of the following advantages over screw-retained ones:
 - a. They are more easily retrieved.
 - b. They more closely resemble their natural tooth counterparts.*
 - c. They do not require the same intricacies in fabrication.
 - d. They are less likely to come loose.
7. TRUE or FALSE: Immediate loading of implants is particularly appropriate when treating the anterior mandible.(T)
8. Dental implants have been placed at the time of extraction with which of the following techniques?
 - a. With bone grafting
 - b. With bone grafting and a barrier membrane
 - c. Without augmentation
 - d. Without primary closure
 - e. All of the above
9. Immediate implantation reports:
 - a. A 53-60% success rate
 - b. A 75-80% success rate
 - c. A 20-25% success rate
 - d. A 94-100% success rate*
10. Immediate implants have been most commonly performed in which of the following sites?
 - a. Full arch restorations
 - b. Incisors*
 - c. Premolars
 - d. Molars
11. Which of the following is a contraindication for immediate implant placement?
 - a. Bony four walls
 - b. A minimum of 3mm-5mm of bone beyond the apex
 - c. Severe circumferential defects*
 - d. A bony length with a minimum of 10mm
12. Horizontal defects of what size do not need membranes for histologic osseointegration?
 - a. 3 mm
 - b. 5 mm
 - c. 2 mm
 - d. 1 mm*
13. TRUE or FALSE: The peritome is used to make the initial sulcular incision around the tooth. (F)
14. TRUE or FALSE: In an extraction prior to an implantation, a tooth should never be removed with extraction forceps. (F)
15. Which of the following have been used historically to fill the gap between the implant and surrounding socket walls in techniques that require primary closure?
 - a. A bone graft*
 - b. Porcine collagen
 - c. Freeze-dried dermas
 - d. Laminar freeze-dried bone
16. Which of the following barriers does not require primary closure?
 - a. Porcine collagen
 - b. Freeze-dried dermas
 - c. Laminar freeze dried bone
 - d. All of the above*
17. Which of the following are advantages of immediate implant placement?
 - a. It reduces surgical episodes.
 - b. It prevents bone resorption.
 - c. It may help support gingival tissues.
 - d. All of the above*
18. Which of the following are advantages of immediate loading?
 - a. It can help shape gingival tissues.
 - b. It reduces treatment time.
 - c. It allows for immediate cosmetic improvement.
 - d. All of the above*
19. Immediate loading is indicated in which of the following cases?
 - a. Implantation of a single maxillary anterior tooth.*
 - b. Implantation in a patient who is a smoker.
 - c. Implantation of a single posterior tooth.
 - d. All of the above
20. Premature loading of unstable implants can cause which of the following?
 - a. Loosening of the implants.
 - b. The fibrous encapsulation of the implants.
 - c. Collapsed bite.
 - d. a and b *
 - e. All of the above
21. Which of the following are advantages of screw-retained implant restorations?
 - a. They can be retrieved relatively easily.*
 - b. They eliminate the need for precise placement of the implant.
 - c. They are more esthetic.

d. They have the potential to compensate for minor dimensional discrepancies in the fit of restorations to abutments.

22. Which of the following is/are true?

- a. It is preferable to shape cement margins of abutments so that they are deeply located.
- b. If an abutment screw loosens under a cemented multiunit implant restoration, the restoration usually remains cemented to the abutments.
- c. A restoration may be destroyed during the removal of a restoration if the cement seal cannot be easily broken.
- d. Any force applied to a restoration on a loosened abutment can damage the internal threads of the implant.
- e. All of the above*

23. Which of the following is/are disadvantages of relying on debilitated natural teeth to support a crown restoration or removable partial denture?

- a. The procedures required to restore these teeth are costly and time-consuming.
- b. The stress involved in being an abutment for a partial denture can fatally weaken these teeth.
- c. These teeth may continue to lose bone and soft tissue.
- d. Abutment teeth have only a 15% chance of survival over ten years.
- e. a, b and c*

24. In the study conducted by Preist of restored implants placed in bounded edentulous spaces, the survival rate of the adjoining teeth was which of the following?

- a. 55%
- b. 65.5%
- c. 75.5%
- d. 95.5%*

25. Which of the following cases are indications for implants?

- a. The teeth have too much remaining coronal tooth structure.
- b. The roots of the teeth have significant bulk.
- c. The teeth have very poor crown to root ratios.*
- d. All of the above

26. TRUE or FALSE: If teeth have adequate bulk to restore but do not respond to endodontic re-treatment, implants are recommended. (T)

27. Which of the following is false?

- a. Teeth with thin peripheral walls are prone to root fracture when in function.
- b. Continuous bone loss around restored natural teeth may compromise future placement of dental implants.
- c. It is always advisable to keep a natural tooth regardless of the patients treatment plan.*
- d. Dental implants are not subjected to caries.

28. Which of the following are true statements about dental implants?

- a. Continued bone and soft tissue loss is likely at the site of dental implants.
- b. Dental implants allow the placement of the optimal number of abutments.
- c. Dental implants are not subject to caries.
- d. The non-involvement of boundary teeth in an implant restoration decreases the future liability of these teeth needing care.
- e. b and c*

29. Which of the following is/are true?

- a. Implants are the most esthetic restorative option for every patient.
- b. The concept of dental implants first developed in the late 1980s.
- c. Dental implants allow for predictable placement of the free gingival margin.
- d. None of the above*

30. According to Dr. Sullivan, which of the following is true?

- a. Single tooth implant restorations are best treated with screw retention.
- b. Large, full arch implant reconstructions are best cemented.
- c. Patients with severely limited interocclusal space are best treated with screw retention.*
- d. Short-span fixed partial dentures cannot be permanently cemented.

1. (A) (B) (C) (D)
2. (A) (B) (C) (D)
3. (A) (B) (C) (D)
4. (A) (B) (C) (D)
5. (A) (B) (C) (D)
6. (A) (B) (C) (D)
7. (A) (B) (C) (D)
8. (A) (B) (C) (D)
9. (A) (B) (C) (D)
10. (A) (B) (C) (D)
11. (A) (B) (C) (D)
12. (A) (B)
13. (A) (B) (C) (D)
14. (A) (B) (C) (D)
15. (A) (B) (C) (D)
16. (A) (B) (C) (D)
17. (A) (B) (C) (D)
18. (A) (B) (C) (D)
19. (A) (B) (C) (D)
20. (A) (B)
21. (A) (B) (C) (D)
22. (A) (B)
23. (A) (B) (C) (D)
24. (A) (B) (C) (D)
25. (A) (B) (C) (D)
26. (A) (B) (C) (D)
27. (A) (B)
28. (A) (B) (C) (D)
29. (A) (B) (C) (D)
30. (A) (B) (C) (D)

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