Current Trends in Immediate Osseous Dental Implant Case Selection Criteria

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Abstract: As endosseous dental implant therapy rapidly becomes the prosthetic standard of care for a vast array of clinical applications, we are faced with the challenge of developing dynamic treatment planning protocols. This paper will discuss the clinical benefits of immediate implants and outline a synthesis of case selection criteria garnered from amongst current immediate implant trends. Our immediate findings are that although implants have become widely accepted despite controversial beginnings and the available literature consistently cites high levels of success (ranging from 94 to 100 percent on average), there is no universally agreed upon case selection criteria. Our principal conclusion is that the high success rate of endosseous implant therapy has yet to achieve wide public acceptance and utilization. Overcoming barriers to public utilization will greatly depend on our ability as dentists to appropriately select cases and deliver treatment in a timely and cost-effective manner. Further, developing case selection criteria for immediate dental implants will help to overcome these barriers by increasing treatment success rates and minimizing treatment cost and time.

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As dental professionals, we find ourselves immersed in an exciting era of revolutionary therapeutic change. As endosseous dental implant therapy rapidly becomes the prosthetic standard of care for a vast array of clinical applications, we are faced with the challenge of developing dynamic treatment planning protocols. However, despite the high success rate of endosseous implant therapy, it has yet to achieve wide public acceptance and utilization.1 Endosseous implant therapy in the mandible (parasympyseal mandible) has repeatedly been reported at a success rate of 95 percent or better, yet public utilization of endosseous implant therapy has not exceeded 5 percent (Figure 1).2 Several authors have suggested what those barriers to public utilization have been, but the most frequently cited reasons for underutilization of endosseous implant therapy are that treatment cost is perceived to be too high and treatment takes too long (Branemark’s original treatment protocols required one to two years to complete treatment).1 Additionally, researchers have proposed that the public places a low value on endosseous implant therapy.2

With the prevalence of edentulism approaching 50 percent in individuals over age sixty-five, dental professionals are actively seeking to increase public utilization of endosseous dental implants. An obvious area of focus has been to decrease the amount of time necessary to complete implant therapy. Three approaches to achieve this goal have dominated clinical research and practice: delayed/immediate implant loading, improving implant surface technology (promotion of quicker healing and better osseo-integration), and immediate placement of an endosseous implant after extraction of a natural tooth.1 This paper will focus on the last of these three approaches and will discuss current trends in immediate endosseous dental implant case selection criteria. For the purposes of this paper, the working definition for an immediate endosseous implant is extraction of a natural tooth followed by immediate placement (within the same surgical procedure) of an endosseous dental implant.

Immediate implants have become widely accepted despite controversial beginnings and the available literature consistently cites high levels of suc-
cess (ranging from 94-100 percent on average), yet there is no universally agreed-upon case selection criteria.1,3-6 The need to further develop case selection criteria for immediate dental implants is particularly noteworthy because when they are employed in a clinically appropriate situation, immediate implants provide clinically recognizable benefits. Broadly speaking, these benefits include reduction of morbidity, reduction of alveolar bone resorption, preservation of gingival tissues, preservation of the papilla in the esthetic zone, and reduction of treatment cost and time (the healing phase is shorter in general and there is a reduction in the number of procedures).1,2,5,7,8 To maximize the advantage of these benefits and to minimize implant failure, case selection must be based on sound clinical and research criteria. Hence, this paper will provide a synthesis of selection criteria, garnered from amongst the current trends.

Selection Criteria

In general, immediate dental implant selection criteria are contextually dependent on the unique circumstances that pertain to each individual patient and should reflect the following factors: achieving predictable osseointegration, anatomical considerations, maximizing esthetic results and soft tissue maintenance, restoring function, the surgical technique and experience of the dental surgeon, and the patient’s medical status, expectations, and level of compliance.1,9 Additionally, the criteria tend to reflect the fact that the vast majority of immediate implants are single-tooth implant restorations (predominantly incisors and premolars), which are site- and defect-specific (Figure 2).5,6 Immediate dental implants may be considered the treatment of choice for an endodontically infected tooth, root fracture, root resorption, periapical pathology, root perforation, and unfavorable crown-to-root-ratio (not due to periodontal loss).5 However, site selection remains very controversial.

Achieving Predictable Osseointegration: Primary Stability

Osseointegration is defined as “a direct structural and functional connection between ordered living bone and the surface of a load-carrying implant” and as “direct anchorage of an implant by the formation of bony tissue around the implant without the growth of fibrous tissue at the bone-implant interface” (Figure 3).10,11 Histological analysis of successful immediate dental implant therapy demonstrates that osseointegration is predictably attainable and efficacious and requires a minimum of 3-5 mm of intimate bone to implant contact.5,12 Bone quality and quantity and surgical technique are predominant clinical determinants that affect primary stability and will be discussed in further detail. The literature repeatedly points to primary stability as essentially the most important osseointegration determinant because it allows for vital bone maintenance, clot stabilization, and prevention of soft tissue collapse and epithelial down-growth.1,2,5,13,14 Hahn states that an inescapable conclusion is that mobility determines the interface (of implant to bone).13 Primary stability is achieved when the micro-movement (biomechanical determinant) of the implant-bone interface is below the threshold at which fibrous encapsulation occurs.14 Clinically, there is an absence of detectable move-
moment at the implant-bone interface along all planes of space.

When primary stability is unattainable, the procedure should be aborted. Failure to exercise prudence in this situation results in the following sequelae: fibrous tissue encapsulation of the implant, qualitative and quantitative loss of soft tissue and bone, and eventual implant failure. The dental surgeon must also consider that, during the first few weeks following the surgery, primary stability actually decreases slightly (due to the inherent surgical trauma). Slight underpreparation of the surgical site compensates for this loss. Since the micromovement threshold has yet to be empirically determined and there are currently no practical means to clinically measure micromovement, other factors must be weighed by the clinician. In other words, primary stability is dependent on several other selection criteria (see below), and the ideal immediate implant site should have a significant amount of supporting alveolar bone.

Achieving Predictable Osseointegration: Bone Quality and Quantity

Bone quality has been suggested as an important prognostic indicator of dental implant success and is of special importance when considering immediate implants. Lekholm and Zarb’s bone type classification is widely accepted and will serve as a guide for our discussion. Type I bone is homogenous, compact bone; Type II bone is a thick layer of compact bone surrounding a core of dense trabecular bone; Type III bone is a thin layer of cortical bone surrounding a core of dense trabecular bone of good strength; and Type IV bone represents a thin layer of cortical bone surrounding a core of low density bone. Placement of an immediate implant has the desirable effect of preserving alveolar bone width and height. When a tooth is extracted, predictable bone resorption ensues for six months. A typical defect of such resorption is a loss of crestal bone with a labial concavity. Delayed implant placement may result in compromised esthetics and function due to lingual placement of the implant. Hence, in certain circumstances, immediate implants will provide for more ideal prosthetic placement and will optimize esthetics, all via the preservation of bone (Figures 4 and 5). Extraction site classification systems have been devised. Each is unique in certain respects, and none are universally accepted. Instead of endorsing these systems, we have chosen to examine the most oft-cited and well-documented selection criteria as they relate to bone quality and quantity (as well as to avoid redundancy).

Specific clinical recommendations are as follows. The ideal extraction site for an immediate implant demonstrates little or no periodontal bone loss, adequate remaining supporting alveolar bone, adequate sub-apical bone, and dense crestal bone (types II and III bone are desirable and increase the likelihood of success). Such sites are most often found in the parasympyseal mandible (Figure 6). In general, bone quality and quantity are superior in the mandible; hence, immediate implant success is greater in the mandible as compared to the maxilla. Cornelini et al. cite studies with mandibular success rates of 95 percent and maxillary success rates of 92 percent. Careful case selection may preclude imme-
Immediate implants in the posterior region of the maxilla when bone quality and quantity are poor and/or deficient (obtaining primary stability is difficult). When type IV bone is encountered, an overall dental implant failure rate of 35 percent has been reported. For type IV bone in the maxilla implant, the failure rate has been reported to increase to 44 percent.

In the past, implants and type IV bone have been considered to be a poor combination. However, there is a lack of agreement on this issue. Bahat’s study of implants in the posterior maxilla indicates that the quality and quantity of bone appear to have little influence on success. Bahat reports a cumulative success rate of 94.4 percent in the posterior region of the maxilla and points to surgical technique as particularly important to success. Additional evidence has been reported suggesting that single dental implants (including immediate implants) perform well when placed in type IV bone, despite the suboptimal environment. The lack of agreement on this issue illustrates that site selection remains very controversial.

The number of remaining osseous walls is an important parameter in case selection criteria. Research consistently demonstrates that the presence of three to four remaining osseous walls is essential to immediate implant success and that implant failure rates significantly increase when this principle is violated. According to Douglass and Merin, a bony defect with two or three missing walls is not suitable for an immediate dental implant (Figure 7). When an immediate implant is placed in a site with three to four remaining osseous walls, the peri-implant defects will eventually show bone fill and will demonstrate a close bone-implant interface.

The prospective site should be carefully examined for circumferential crestal bony defects and labial bony defects. Should either be present and deemed severe, the site is not suitable for an immediate dental implant. However, such defects are not contraindicated if current osteogenic techniques (e.g.,

Figure 4 and 5. Preoperative and postoperative radiographs of immediate implant placement, demonstrating preservation of alveolar bone in the esthetic zone (Images courtesy of Dr. John Moriarty)
GTR barrier membranes, bone grafts, and combinations thereof are able to provide an adequate barrier to span the defect and promote bone fill (Figure 8).5

In the buccal-lingual dimension, an immediate implant site should possess a minimum bone measurement of 4 mm, and the individual plates should be thick enough to engage the implant without undue stress.6,7 The bony height of the socket (from the apex of the alveolus to the crest of bone) should demonstrate a minimum bone measurement of 7-10 mm.5,7 Bone levels beyond the apex (sub-apical) are likewise important, especially if more bone is needed to achieve adequate implant purchase (to facilitate the previously mentioned requirement of 3-5 mm of intimate bone to implant contact). According to some clinicians, 4-5 mm or 3-5 mm of sound bone beyond the apex is necessary to achieve this goal (Figure 9).5,14 However, failure to meet the above criteria is not necessarily a contraindication for immediate implants. These principles may be violated if other parameters are able to compensate for a given deficiency and the site is delicately prepared.

Anatomical Considerations: Extraction Site Morphology

Residual extraction site morphology is an important determinant of immediate implant success and can complicate implant positioning.12,14 The im-
Anatomical Considerations: Surrounding Anatomy

Responsible case selection also involves careful examination of surrounding anatomical structures. As with all implant protocols, one needs to take into consideration the proximity of structures such as the maxillary sinuses, the mental foramina, mandibular sublingual concavities, and the inferior alveolar neurovascular bundle. We reiterate that 3-5 mm of sound bone beyond the apex is desirable in order to better facilitate osseointegration. Furthermore, this “cushion” of bone is an important guideline to prevent impingement of the aforementioned anatomical structures. Any such impingement that would prevent primary stability or osseointegration or that would cause undue damage (parasthesia, etc.) should be considered a contraindication to dental implants, immediate or otherwise. However, violation of the 3-5 mm principle (of sound apical bone), provided that impingement is avoided, does not necessarily preclude success.

Maximizing Esthetic Results and Soft Tissue Maintenance

Selection of immediate implant therapy may be greatly influenced by esthetic considerations. Esthetic demands are placed on the dental surgeon by both the patient and the presenting clinical circumstances. All things being equal, an immediate implant may be the treatment of choice for an esthetically demanding patient. As previously discussed, there is bone resorption during the first six months post extraction, which may lead to an undesirable esthetic defect. According to Douglass and Merin, selecting an immediate implant protocol allows for early maintenance of gingival form and greatly facilitates peri-implant gingival tissue esthetics (due to maintenance of interdental papillae) (Figure 10). Additionally, Cavicchia and Bravi consider maintenance/development of functional and esthetic soft tissue to be an important phase of immediate dental implant therapy. The success of immediate implants in the esthetic zone can be enhanced further with the use of custom healing abutments (which serve to preserve crestal soft tissue and interdental papillae). However, traditional restorative criteria must still be applied, such as consideration of the posterior smile line.

The Surgical Technique

As with all dental implant protocols, surgical technique plays an important role, as well documented in the literature. Our discussion on this topic will therefore be limited to surgical aspects that are particularly germane to immediate implant protocol.
Atraumatic extraction technique is very important for the success of immediate implants and facilitates maintenance of the maximum amount of bone. For example, atraumatic extraction will allow for the preservation of buccal plate bone (preventing perforations/alveolar bone fracture), without which an immediate implant might be contraindicated. Atraumatic extraction may be prevented by ankylosis, which is a relative contraindication to immediate implant therapy. Gross iatrogenic expansion of the alveolus during extraction is likewise a relative contraindication.

There has been some debate over one-stage vs. two-stage surgery for immediate dental implants. Contemporary research trends indicate that two-stage surgery is unnecessary (a nonsubmerged surgical technique is successful), but patient-specific factors may temper the clinician’s judgment and point towards two-stage surgery (such as cigarette use, alcohol consumption, oral hygiene, periodontal status, presence of interim dentures, etc.). However, our review of the literature provided little evidence that a two-stage procedure significantly increases the success in these circumstances. When Heydenrijk et al. examined the micro-flora within the peri-implant area in one-stage and two-stage procedures, they found no significant difference. Their report also concludes that periodontal pathogens can be harbored within the peri-implant sulcus without significant signs of periodontal breakdown. When Kan et al. reviewed the literature, they concluded that the influence of oral hygiene on implant success remains controversial. Their review also indicates that peri-implant mucosal response should not be a criterion for implant success, as it has not necessarily been proven important to achieving or maintaining osseointegration. Regardless of the number of stages, as with placement into an edentulous area, the use of a surgical guidance stent has been associated with consistently better results in immediate placement.

The final point to be made regarding immediate implant surgical technique will serve to illustrate that appropriate case selection criteria are changing dynamically. As recently as 1999, Cavicchia and Bravi reported that immediate implants should not be loaded immediately (delayed loading is a necessity). The rationale for delayed loading only stems from the idea that immediate loading carries a great risk for fibrous encapsulation of the bony defect, lack of osseointegration, apical epithelial migration onto the implant surface, and lack of primary bone contact. However, this criterion is being challenged successfully at the UNC School of Dentistry, as successful immediate loading clinical trials are currently under way. Cooper et al. report 100 percent success (at six to eighteen months) after placement of fifty-four immediate implants with immediate loading (Figure 11). In this study, the criterion for loading was primary stability. The authors outline the following advantages to this implant protocol: maintenance of vertical dimension, elimination of relinements and interim denture therapy, and potential improvement of soft tissue healing. As additional data is published, the debate surrounding immediate implants that are immediately loaded will continue to evolve.

**Presence of Infection and Pathology**

As previously stated, immediate dental implants may be considered the treatment of choice for an endodontically infected tooth, root fracture, root resorption, periapical pathology, root perforation, and unfavorable crown-to-root-ratio (not due to periodontal loss), all of which may result in residual infection. Our survey of the literature indicates some disagreement about employing immediate implants in infected sites. Opinions vary from removing all residual infection prior to implant placement to the position that moderate infection (without active suppuration) is actually beneficial for immediate implant success. However, Cavicchia and Bravi state that immediate dental implant sites should be free of residual infection. However, Cavicchia
and Bravi do concede some level of success if there is no active suppuration and say that granulation tissue (associated with chronic infection) does not contraindicate immediate implant therapy. These authors also wisely point out that more studies are needed to determine the efficacy of immediate implants placed in sites of active infection. The most interesting argument comes from Gelb, who states that residual infection is not a contraindication. He argues that sites with residual infection (without active suppuration) have increased vascularity and cellular elements. Both vascular tissue and cellular elements are supportive of osseointegration, regeneration, and repair. Hence, the residual infection may provide a favorable environment. However, as with surgical criteria, clinicians must consider patient-specific factors such as cigarette use, alcohol consumption, oral hygiene, periodontal status, and the presence of an interim prosthesis.

**Implant Component Selection for Immediate Implants**

Regardless of the implant protocol used, clinicians must carefully consider which implant system to select. However, the attributes that allow for a given implant system to be successful when employed as an immediate implant are not unique to this surgical protocol. That is to say, the attributes that make an implant system good for use as an immediate implant are the same attributes sought by most other implant surgical protocols. Therefore, rather than comprehensively belabor the characteristics of a good implant system, we will narrow our scope to those characteristics specifically highlighted in our literature review.

Screw type implants have superior primary stability and long-term osseointegration as compared to press-fit/machined surface implants. Given these facts, press-fit/machined surface implants are a poor choice for immediate implants. Implants with enhanced surfaces (increased roughness) are also superior because they facilitate better osseointegration (Figure 12). Specifically, immediate implants must maximize bone formation rate and clot retention (which affects osseoconduction). The literature also suggests the use of wide-diameter implants for immediate implants. Implants with a width less than 4 mm have been associated with implant failure.

An emerging implant system is the immediate placement of anatomically shaped dental implants. The RE Implant System (Hagen, Germany) produces a computer-milled anatomic dental implant that closely approximates the root morphology of the extracted tooth. Clinically speaking, the tooth is extracted atraumatically and an impression of the extraction site is obtained (captures socket morphology). The computer then uses the information gathered by the impression to mill a chairside anatomical implant. According to Coatoam and Mariotti the suggested advantages of anatomically shaped implants are as follows: prevention of alveolar bone resorption, improvement in health of the soft tissues, prevention of epithelial down-growth, elimination of barrier membranes, and reduction in postoperative

![Figure 12. EM images of enhanced implant surfaces: sand-blasted large grit acid etch (ITA SLA) on the left and titanium oxide blasted surface (ASTRA TiO Blast) on the right (Images courtesy of Dr. Lyndon Cooper)](images/figure12.png)
infection. However, milled anatomic dental implants must overcome some serious disadvantages if they are to move to the forefront of immediate implant therapy. Milled implants unfortunately replicate undesirable anatomy, such as the mesial concavity of the maxillary first premolar. The impression technique adds to the trauma of the surgical procedure. Immediate implants are typically placed within twenty minutes of tooth extraction, whereas the milled anatomic implant takes up to two hours to fabricate and place. This is not a time-efficient procedure for the clinician and is an impediment to optimal treatment. Finally, the cost for this type of procedure is considerably higher. This technology is interesting, but it must overcome these disadvantages and more clinical research is needed to support the claims made by its proponents.

Concluding Remarks

As dental professionals, we find ourselves immersed in an exciting time of revolutionary therapeutic change as endosseous dental implant therapy rapidly becomes the prosthetic standard of care. Everyday clinicians are faced with a vast array of clinical presentations and with the challenge of developing dynamic treatment planning protocols for dental implants. Yet the high success rate of endosseous implant therapy has yet to achieve wide public acceptance and utilization. Overcoming barriers to public utilization will depend greatly on our ability as dentists to appropriately select cases and deliver treatment in a timely and cost-effective manner. Further, developing case selection criteria for immediate dental implants will help to overcome these barriers by increasing treatment success rates and minimizing treatment cost and time.

Our discussion of the clinical benefits of immediate implants and our synthesis of selection criteria, garnered from amongst current immediate implant trends, should not be considered exhaustive. We must remember that these selection criteria are still being developed and are contextually dependent on the unique circumstances that surround each individual patient. Finally, an important point to reiterate is that immediate dental implant case selection must be based on sound clinical practice and research. Only then can we maximize the advantages afforded by immediate implants and minimize treatment failure.

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REFERENCES