No one can argue with the success of dental implants, often giving the clinician predictable options for restoring missing or replacing failing teeth. The literature and clinical research has demonstrated successful evidence-based data on surgical procedures, biological factors, and prosthetic principles, which continue to influence and evolve implant dentistry. The goal of this article is to present current concepts of an aesthetic single tooth implant with emphasis on current literature and research data.

U.S. Market for Dental Implants and Patient Demographics
Currently 500,000 osseointegrated implants are being placed every year. In 2002, the U.S. implant market was valued at more than $150 million with a significant growth rate of 12%.1 A survey of U.S. dentists showed the number of insertions increased by 80% in the past decade. The demand for implant treatment is rising as the increasingly health conscious baby-boomer generation moves into retirement. Sixty-million Americans are missing one or more teeth and have not had any treatment. By the year 2007, half of today’s Americans will be over the age of 50. In fact, Americans over the age of 45 will comprise the majority of tomorrow’s patients.

Historical Perspective
In the 1980s the emphasis was on functional implants and hence the principle of osseointegration. The protocol developed by Professor Per-Ingvar Brånemark was primarily geared toward fully edentulous patients suffering from dental conditions for which traditional treatments were no longer an option. The fixtures survived, the patient’s life quality improved and dental implants revolutionized the restoration of missing teeth. In May of 1982, Brånemark presented 15 years of implant research at the Toronto Conference on Osseointegration in Clinical Dentistry. Soon after clinicians were trained in Brånemark’s method in Sweden, they began to expand the application of implants to other treatment indications, such as single tooth and implant supported prosthesis.

In the 1990s, implants have undergone significant evolution in terms of biomaterials, designs, and surgical and prosthetic techniques. As clinicians offered more dental implants on a routine and elective basis, demand for better esthetic results grew as well. Implant dentistry experienced a transition from function to esthetics, with esthetics enhancing the patient’s needs and desires. Equal attention to ceramics and soft tissue continues to be the primary focus in the reconstruction of a natural tooth implant rather than the surgical placement of an implant. In fact, implant dentistry is known to be a prosthetic driven discipline with a surgical component.

Current Perspective
The new millennium, I believe, has compiled 20 years of research and clinical experience to deliver an optimum biological, functional and esthetic result. Current understanding of the relationship between bone and soft tissue, papilla height and advances in implant designs has enabled the clinician to expand into high-profile areas and offer predictable solutions ranging from two-stage implant therapy to one-stage immediate implant (fresh extraction site) placement, provisionalization, and loading.

Focus on Anterior Implant Esthetics in Daily Practice
The highest growing treatment option is the anterior single-tooth replacement. In fact, 70% of single-tooth replacements are central incisors (Table 1). Today replacing a missing single tooth with an implant-supported crown has a predictable success rate of 95% and greater. In addition, maintaining healthy tooth structure is a primary goal in successful restoration of pulpless teeth and the amount of remaining solid tooth structure is an important guideline for retaining or extracting. Once a tooth is compromised due to decay, resorption, or fracture, we can manage the hopeless tooth with an implant. Often an immediate implant is a favorable option. A 24-year-old patient with a severely decayed tooth #9 and healthy adjacent teeth presents to your office. What are the options? What is the best long-term prognosis for repair or replacement for this patient? Restoring tooth #9 with a crown lengthening, a cast post, and a crown is an option but would an implant crown be a more conservative and successful solution for this young patient?

Biological Principles Guiding Esthetic Implant Restoration

**Biological Width Principle:**
Gargiulo2 has shown the width of the dentogingival complex surrounding natural teeth to be approximately 3mm. A study by Cochran3 demonstrated a similar dimension in the peri-implant tissues. Based on this principle, the desired depth of placement of an implant below the free gingival margin of soft tissue should be 3mm to 4mm. This distance provides space for biologic width, proper emergence profile, and esthetics. This distance should allow bone remodeling which occurs during a one-year period.4

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**Reasons For Anterior Tooth Loss**

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The Papilla: The presence of interdental papilla between teeth is directly related to the distance between the contact point and the interdental crest of bone. The critical distance between teeth was reported to be 5mm or less. As the distance exceeds 5mm, the presence of the papilla drops significantly. It has also been shown that when an implant is placed adjacent to a tooth, the distance from the crestal bone on the tooth to the contact point should be 5mm or less in order to predictably reform a papilla. A period of six-month provisionalization is necessary to manage the emergence profile and the preservation of the papillae.

The Biologic Width in Implant Adjacent to a Healthy Tooth: The bone level interproximally is maintained at its original level because the biologic width at the tooth side remains undisturbed. This is particularly true if the implant is not placed in close proximity to the root surface. A minimum distance of 1.5mm between the implant and the adjacent tooth allows for preservation of the interproximal bone peak.

Tissue Biotype and Thickness: The type of periodontium (thin scalloped, or thick flat) determines the degree of scalloping of the bone (Table 2). The difference between the facial bone crest and the interproximal bone crest can range from 2.1mm to 4.1mm.

Dental Implant Design and Its Relationship to Long-Term Implant Success
Selecting implant characteristics that maximize the available surface area for bone contact is crucial in implant restoration success. This is especially true in poor-quality and intermediate fresh extraction sites. The distribution of force with natural teeth depends on micromovement induced by the periodontal ligament. Force distribution in implants differs from natural teeth in that implants do not have micromovement. Hence, most of the force (vertical and lateral) factor is concentrated at the crest of the ridge. Appropriate implant design selection is imperative to lower the magnitude of loads imposed on the implant-bone interface. It has been shown that roughened titanium surfaces can improve the clinical prognosis of implants by achieving a higher percentage of bone-implant contact and higher removal torque values in mechanical testing as compared with the smooth titanium surface.

Moreover, the literature has also addressed the effects of implant shape, diameter, length, and thread design on osseointegration. Growing bone concentrates preferentially on protruding elements of the implant surface such as ridges, crests, and edges of threads when load is transferred. Finite element analysis studies of implants indicate bone stress distribution and magnitudes vary with implant shape. It is for this reason most implant designs are threaded because the thread shape is particularly important in changing force at the bone interface.

The significance in implant length is found in initial stability and overall amount of implant-bone interface. The increased length can provide resistance to torque or shear forces when abutment is screwed in place. Less favorable success rates for shorter implants were observed in clinical studies.

Wider root-form implants have a greater area of bone contact than narrow implants of similar height and design resulting from their increased circumferential bone contact areas. This is important because a wider table can seal the crestal extraction site and the improved surface can encourage early bone formation. However, a wide anterior implant must be placed judiciously to prevent recession, interdental bone necrosis that can damage the anterior esthetics.

Abutment Connection
The original Brånemark protocol required externally hexed implants to fully restore edentulous arches, splitting the implants via a bar with a fixed prosthesis. The external hex, which was only 0.7 in height, was not designed for single teeth to prevent antitortion.11 Implant manufacturers had to compensate for this by changing the type of screw, the precision fit over the hex, and the amount of torque used to secure the new screws. Today, many implant systems have internal connection. One of the first internally hexed implants was designed with a 1.7mm deep hex. This feature is intended to distribute intraoral forces deeper within the implant to protect the retention screw for excess loading and to reduce the potential of microleakage. Internally connected implants also provide superior strength for the implant/abutment connection.

Radiographic Examination and the Use of a Surgical Esthetic Guide
It is essential to be able to identify prior to surgery the qualitative bone factors such as bone height, volume, and thickness of the cortical plates by CT scan. A full contoured diagnostic wax-up of the missing tooth can be made and used as a template for the fabrication of a radiopaque surgical stent. The patient wears the stent during the CT scanning. The benefit of computer-guided treatment planning in the anterior maxilla using software imaging and prefabricated drill guides made from the CT data can be beneficial for accurate results. The advantages of such techniques are to avoid vital anatomic structures (nerves, incisal foramen), gain more precision and predictable results by placing the implants in correct position, and to maximize existing bone volume.

![Figure 1: Papilla is maintained if the distance from the interdentist bone to the apical aspect of the contact area is equal or less than 5mm.](image1.png)

The optimal implant position in relation to FGM and adjacent teeth in order to maintain papilla, interproximal bone and ideal emergence profile.

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If an immediate replacement of a failing tooth is considered, a
diagnostic evaluation begins with a radiographic assessment of
the failing tooth. Clinical symptoms such as pain, exudation,
fistulation, and radiographic findings of apical pathosis and
presence of chronic infection or granuloma with bone loss can
be a contraindication for immediate implant placement. Also,
the interproximal bone level should be at a normal height of
1mm to 2mm apical to the cement-to-enamel junction of the
adjacent teeth. If the above criteria are not met, bone grafting
and possible soft-tissue grafting should be performed. The area
should heal between four to six months. The healing depends
on the amount of facial bone loss and healing of the site. The
use of surgical guide to compensate for the lack of vision dur-
ing immediate placement is recommended. The surgical esthet-
ic guide should demonstrate the facial contour and the extent of
the free marginal gingiva (FMG) of the implant crown. This is
the reference point used by the surgeon to place the implant
3mm to 4mm apical to the FGM (Fig. 3).

The Immediate Implant in Fresh Extracted Sites
One of the principle advantages of the immediate technique is the
prevention of post-extraction bone resorption. According to
Carlsson, the bone loss may affect approximately 23% of the ante-
oral alveolar crest during the six months following extraction. This
averages out to about 4mm in the buccal direction. Preservation
and optimization of the soft-tissue contour, reduction of treatment
sequences, enhanced patient comfort and aesthetics because the
patient leaves with a fixed provisional are the many advantages of
immediate implant with same day provisionalization.

Guidelines for Immediate Placement and Provisionalization
One-stage implants have demonstrated equal success compara-
tible to those of two-stage implants. When properly inserted in
good bone quality, and sufficient implant stability is achieved,
osseointegration was not compromised. Micromovement at the
bone implant interface resulting from inadequate primary insta-
Bilh is the cause of fibrous encapsulation. The range of tol-
erance of these micromovements is 50 to 150 for rough surfaces
and about 100 for smooth machined surfaces. Rough surfaces
appear to tolerate greater micromovements and therefore could
be placed under load at an earlier time. Also, the stability of
an implant depends almost on the mechanical interlocking
between the mineralized bone and the roughness of the implant
surface. Consequently, minimum insertion torques resistance of
35–50Ncm have been suggested during immediate loading of
implants. Usually, the blood clot is sufficient to initiate heal-
ing and bone grafting may not be necessary.

Surgical Protocol
A conservative, flapless surgical technique maintains vasculari-
ization and bone volume so it can prevent soft-tissue recession
and preserves interdental papillae especially in the presence of
thin, scalloped gingival architecture. Use of palatal wall as the
drilling guide is necessary as to not infringe on the facial aspect and allow room for the manage-
ment of the emergence profile and preservation of the papillae.
The depth of osteotomy must be of sufficient length to ensure
the best possible quality of anchoring. The consensus is to have
the drilling limit at a minimum distance of 3mm to 5mm
beyond the apical limit of the socket to get primary stability.
The gap between the implant and the socket wall at the crest
should not exceed 1mm. In this regard, a wider implant is desir-
able. However, the selection of an overly wider implant can
negatively affect the aesthetics due to interproximal resorption.
The distance between an implant and a natural tooth should be
kept at a minimum of 1.5mm to 2.0mm so papilla loss can be
prevented (Fig. 4).

Aesthetic Provisionalization and Current Concept in Restoration
Temporization is a major clinical step in the achievement of a
proper esthetic result in an anterior restoration. Dimension and
contour of the crown and stability of the gingival margin are
the primary concerns in assuring long-term esthetics in implant
dentistry. Custom guided tissue healing with a provisional
restoration is the most predictable way to achieve natural,
anatomically shaped tissue and optimal esthetics.

Surgical Indexing: Some clinicians prefer an implant registra-
tion or index be taken at surgery. The purpose of surgical
indexing is to provide a simple means during surgery to record
the relationship of the newly placed implant to the gingival soft
tissue. This method will allow fabrication of a custom impres-
sion coping, which is an accurate and efficient method to trans-
fers the record to the laboratory. This allows the implant team to

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immediately place an ideal contoured provisional restoration after surgery (Fig. 5). This process guides the soft tissue to heal in a natural morphology that replicates the final tooth form. Because of the discrepancy in the diameter between the implant head and the natural tooth diameter at the CEJ level, anatomically correct abutments have been manufactured to improve and maximize the esthetic outcome. These abutments dramatically improve the emergence profile, increase prosthetic stability and avoid use of ridge-lap design.

The soft peri-implant tissues are subject to recession of 0.6mm to 1mm. This can occur during the first three months after surgery. For this reason a provisionalization period should remain for at least six months before proceeding with the final restoration. Such delay ensures better emergence profile management and papillae preservation.

Ceramic Abutments: They are usually used in cases in which the labial soft tissue is too thin to allow passage of reflective light from a nonmetallic abutment. Also, due to the anticipated soft-tissue remodeling after implant placement, the use of tooth-colored, ceramic abutment connections has been widely advocated. Aluminum oxide is used as an abutment and restorative material. This material has a high strength, is aesthetic, and maintains an epithelial attachment similar to titanium. Another material, the zirconium surface has also demonstrated reduced bacterial colonization when compared to titanium. The final restoration can be delivered to the patient as an all-ceramic crown (i.e. Procera) cemented over the abutment, or the abutment itself can be fired with porcelain, acting as the final restoration.

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Conclusion
Recent concepts and clinical protocols for an implant-supported anterior single tooth restoration were described and key factors for aesthetic implant therapy were identified. When specific criteria are carefully followed to eliminate unnecessary risks, we can achieve a high success rate in terms of an esthetically optimal result. Proper soft-tissue management and proper prosthetic coordination are the main factors to achieve a natural-looking implant crown. New focus on reduced treatment times, greater procedure knowledge, and improved public awareness will drive increased implant therapy in daily practice. In fact, implant placement may not be perceived as surgery by the patient, due to the smooth procedures possible with immediate implant function. So now what? Certainly you can improve your patient’s smile and offer them the “tooth-in-a-day” concept and know that you can provide them with an excellent service because our patients deserve the best.