Immediate Loading in the Maxillary Arch: Evidence-Based Guidelines to Improve Success Rates: A Review

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The reliability of immediately loaded dental implants in the mandible has prompted many to investigate their application in the maxilla. Although the body of literature is growing, the long-term survivability of immediate loading in the maxilla is still pending. This review of literature investigates the status of immediate loading of dental implants in the maxilla to determine its predictability as a treatment option for partial and complete maxillary edentulism. Current terminology in the field is summarized first. Subsequently, the rationale and advantages of immediate loading in the maxilla are reviewed, and the relationships between immediate loading and osseointegration, primary stability, implant design, micromotion, immediate implant placement, and bone character are explored. The importance of a prosthodontically driven implant treatment plan emphasizing the role of splinting a high-precision and passively fitting implant restoration with reduced micromotion under function is summarized. The reliability and predictability of immediately loaded implants as a treatment option are proposed, and recommended guidelines for the successful delivery of immediately loaded implants in the maxilla are presented.

Key Words: immediate loading, maxilla, immediate restorations, immediate implants, functional loading, immediate provisionalization, temporary restorations

INTRODUCTION

Ever since dental implants were first successfully employed in restoring completely edentulous mandibles in 1965,[1] implant-supported dental rehabilitations of various designs and complexity have been shown to be a reliable and predictable treatment option for both partially and fully edentulous patients.[2–6] The original Branemark protocol dictated that the initial phase of implant integration should be at least 4–6 months before any restoration is placed.[7] *Conventional loading,* as it is now known,[8] is a reliable, safe, predictable, and accepted treatment modality that has been used as a point of comparison for other dental implant–loading protocols.[9] Within the last decade, clinicians have increasingly begun to explore the possibilities of shortening treatment periods by earlier delivery of the

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implant-supported restoration, or by placement of implants in extraction sockets at the time of extraction.[2,3,10–13]

Investigators are increasingly reporting protocols designed to promote shortened treatment periods for implant-supported prostheses.[13–15] Various terms have been used in description of differing loading protocols. A summary of those terms is outlined in the following section.

Terminology

Regardless of the time of implant placement (whether in a healed extraction socket or at the time of extraction), consensus is needed regarding the terms used to express the timeline of prosthetic loading of implants. Cochran et al[8] published their recommendations on loading protocols based on an exhaustive review of the implant literature, leading to promotion of the following terms: (1) *immediate restoration* (also known as *immediate provisionalization*)—the restoration is delivered within 48 hours of implant placement but not in occlusion with the opposing dentition; (2) *immediate loading*—the implant-supported restoration is placed within 48 hours of implant placement and is functionally restored in occlusal contact with the opposing dentition; (3) *early loading*—the implant is restored with a fully functional restoration (in occlusion with opposing dentition) at a second procedure between 48 hours and 3 months from the time of implant placement; (4) *conventional loading*—the restoration is attached to the implant(s) in a second procedure 3–6 months after implant placement surgery; and (5) *delayed loading*—an implant-supported prosthesis is placed onto the implant(s) after a period longer than the conventional loading time (3–6 months).

In recent literature publications, immediate loading protocols have been reported with increasing frequency. Immediate loading has been referred to as *functional loading,* whereby the restoration is placed into occlusion (and thus would simply be called *immediate loading* as stated by Cochran et al[8]), and *nonfunctional loading* (effectively referring to *immediate restoration* as per Cochran et al[8]). *Nonfunctional loading* describes provisional restoration of the implant satisfying patients' esthetic demands, while avoiding occlusal contacts in both static and dynamic occlusion. The terms cited in this review and other terms relevant to implant placement and restoration have been debated repeatedly and subsequently refined and now are generally accepted as described here.[2,8,16]

Advantages of Immediate Loading

Immediate loading satisfies patient demands for reduced length of treatment time; it also presents several other advantages when compared with conventional loading protocols, such as the following:

- Reduction in overall treatment time[2,17]
- Reduction in alveolar ridge resorption[2,4,10,18,19]
- Esthetically acceptable and/or pleasing restorative solution[4,17,20–22]
- Psychological benefit resulting in increased patient acceptance[2,4,17,20,22]
- Quicker return of function[4,17,20,22]
- Avoidance of a removable prosthesis that may interfere with healing or simultaneous bone grafting and/or may require additional maintenance during the healing period[2,4,22]
- Potentially superior soft tissue profile when accompanying immediate dental implant placement[12,15,17,23]
- Reduced surgical trauma and ease of surgery[17,19,24]
- Use of fewer implants to support a prosthesis because immediate loading can potentially permit the placement of longer implants, thus providing greater support (an advantage of older loading protocols

TABLE 1

Previously suggested factors for case selection and treatment planning of successful immediate loading of dental implants

1. Bone quality and quantity should be appropriate.
2. The rate of bone formation in a given region of the jaw should be considered.
3. If required, extractions should be atraumatic.
4. Initial implant stability (torque at the time of placement) at the time of surgery is crucial.
5. Implant positioning should be prosthodontically driven.
6. All forms of parafunctional habits should be avoided.
7. Caution should be taken in patients with specific and recent (within 2 years) systemic conditions (eg, radiotherapy), excessive chronic smokers or alcohol users, and those with uncontrolled systemic conditions (eg, poorly controlled diabetes).
8. Implants should not be placed into extraction sockets if they are currently infected.
9. Balanced occlusion against natural teeth or prosthesis should be ensured.
10. A minimum of 32 N·cm of torque should be used at the time of implant placement (although some protocols suggest torques as low as 25 N·cm).
11. The implant system should be conducive to high primary stability/initial torque.
12. Splinting of implants (and cross-arch stabilization) should be performed when possible.
13. Prosthodontic rehabilitation should be balanced and passively fitting, and, if possible, a nonfunctional occlusal scheme should be implemented.
14. Rough surfaced rather than smooth surfaced implants should be used.

that utilized *secondary implants* as an interim for final restorations, which were supported by *primary implants*[4–6])

Site-Specific Immediate Loading

Despite early fears of implant failure due to loss of osseointegration,[4,5,17] immediate loading in the lower jaw has been repeatedly shown to have excellent survivability and now is considered a reliable treatment option for edentulism in the mandible. Chiapasco[3] described the overall survivability of immediately loaded overdentures as 98% and of fixed partial dentures as 95%. These studies included implants placed both interforaminally and more posteriorly in the mandible. Whether the restoration type was rigidly fixed or of an overdenture design, the survivability observed was not significantly affected. Another notable point was that the type of opposing dentition was not a clear prognostic indicator in evaluating survivability.

The reported success of immediate loading in the mandible has encouraged the application of similar treatment in the maxilla. While establishing the foundation for others to follow, Tarnow et al[6] demonstrated that immediate loading in the maxilla was possible when they reported 100% survival of immediately loaded implants restored with a full-arch fixed prosthesis. However, a more limited degree of success in the maxilla vs the mandible has often been attributed to poorer bone density.[2,19] Lekholm and Zarb[25] described maxillary bone as more trabecular and softer in nature (also known as type 3 or type 4), while mandibular bone is more cancellous and denser (type 1 or type 2). This anatomic difference results in lower primary stability, greater micromotion, and a greater likelihood of fibrous healing and failure of implants to osseointegrate in the maxilla when implants are immediately loaded.[16,19,26–28] Despite the risks of failure in the maxilla, reports demonstrating its viability, reliability, and success can be readily found in the literature and are investigated throughout this paper.

Based on previous reports, authors have proposed both qualitative and quantitative factors to help guide the treatment planning of immediately loaded implants (Table 1). These factors advise the placement of rough surfaced implants into a prosthodontically driven location in noninfected bone of adequate density and quantity to achieve the initial stability of implants.[2,8,12,15,17,29–32]

Achievement of osseointegration is the end point of current recommendations. *Osseointegration* has been defined as "direct contact of the implant surface with bone at the light microscopic level of analysis."[8] Despite fears that micromotion of implants would impede osseointegration,[3] immediate loading has not been shown to compromise osseointegration in the maxilla (Table 2). Moreover, some reports reflect that immediate loading has achieved similar success rates as those noted with conventional approaches (delayed/early protocols).[3,13,14,17] Others have reported that immediate loading can produce greater levels of osseointegration and in some cases a more favorable bone architecture with which to resist functional loading.[33–37]

Primary Implant Stability and the Concept of Micromotion

Researchers have focused on controllable factors that affect the healing of bone around the implant. Central to these factors is the concept of primary stability with micromotion.

Primary stability, defined as "a sufficiently strong initial bone-implant fixation,"[38] has long been acknowledged as important for implant success[39] and has been cited as a crucial factor with immediately loaded implants.* The goal of primary stability is limitation of excessive micromovement. Micromovement can be influenced by the implant-to-bone relationship and by the prosthodontic design. In the maxilla, where bone quality is typically less favorable, this factor is of paramount importance.

First proposed in 1974 by Cameron et al[43] and later confirmed by Szmukler-Moncler et al,[44] micromovement must be limited if destruction of blood vessels that will later form the bone-to-implant interface is to be avoided and osseointegration maintained.[26]

* *References 3, 4, 15, 17, 27, 29, 30, 40–42.*

Excessive micromovement can result in fibrous healing rather than osseointegration.[4,16,18,26,27,30] Insertion torque has been cited as an indicator of primary stability[2] and as a nonlinear, indirect indicator of micromovement of an implant in bone.[26] Several clinicians encourage underpreparation of the surgical site to promote adequate torque at the time of implant placement.[34,45] However, this approach must be taken on a case-by-case basis, because achievement of high torque values at the time of implant placement is dependent on the bone quality at any given implant site.[46] It is interesting to note that higher torque values do not always have beneficial effects on osseointegration. In animal cortical bone, torque values of 100 N·cm caused excessive bone compression that resulted in weaker osseointegration.[47] Furthermore, torque values between 45 and 100 N·cm have been shown to produce the same degree of micromotion.[26] Even when very high torque values can be achieved, it is deemed sensible to aim for torque values that have shown predictable results in immediately loaded cases rather than striving for the highest possible torque with values of unexplored long-term impact.[46]

Bone Quality

The quantity and quality of bone at the implant site will also affect the primary stability. When compared with bone from the mandible, maxillary bone can be particularly challenging for immediate implant placement because it has lesser bone density, a thin cortical plate, and proximity to the maxillary sinus.[2,19] Understanding the quality and type of bone and preserving that bone via atraumatic extractions are necessary for promoting successful osseointegration when immediately loading implants.[40] Appropriate radiographic investigations (such as cone beam computed tomography [CT]

TABLE 2

Survival rates of immediately loaded rough surfaced implants in the maxilla

Authors, y	Patients, n	Implants, n	Implant Length, mm	Implant Diameter, mm	Torque, N.cm	Implant Survival, %	Evaluation Period, mo
Tealdo et al, 2008	21	111	≥10	4	≥40	92.8	12
Pieri et al, 2009	22	103	≥10	>3.3	≥30	97.1	12
Degidi et al, 2006	8	69	≥10	≥3.4	>25	100	12
Nordin et al, 2007	19	119	≥10	≥3.3 (110 had ≥4.1)	≥35	98.3	24
Palattella et al, 2008	17	18	≥10	4.8	35	100	24
Hassanet al, 2008	20	20	14–16	3.25–4	*	100	12
Boronat-Lopez et al, 2009	12 (7 Mx)†	36 (27 Mx)†	>13	4.2	*	97.2	12–18
Canullo et al, 2009	22	22	13	3.8 or 5.5	32–45	100	25
Collaert and De Bruyn, 2008	25	195	8–15	3.5–4	*	100	3
Machtei et al, 2008	20	33 Mx, 16 Md†	11–15	3.25–4	35–60	83	12
Degidi et al, 2006	44	388	*	*	*	98	60
Bergkvist et al, 2009	28	168	10–12	3.3–4.8	*	98.2	8 and 32
Degidi et al, 2008	20	153	*	*	*	100	12
Pieri et al, 2009	23 (9 Mx, 5 Md)†	144 (66 Mx, 78 Md)†	≥10	3.3 or 4	>30	98.6	12
Degidi et al, 2009	40	48	*	3	≥25	100	48
Schwartz-Arad et al, 2007	87	210	>13	≥3.75	*	97.6	6–52, avg 15.6†
Ostman et al, 2008	37 (20 Mx, 20 Md)†	*	*	*	>30	100	3–6
Degidi et al, 2009	780	780 (393 Mx, 387 Md)†	13–18	3–6.5	*	99.5	1–107, avg 36†
Mijiritsky et al, 2009	16	24	13–16	3.3–5.5	≥32	95.8	24–72, avg 40.7†

*Data not available.
†avg indicates average; Md, XXX; Mx, XXX.

scans) can provide invaluable insights into the quality and quantity of bone at the surgical site—information that is essential for treatment planning.[30] Others have suggested Hounsfield units as a means of assessing the bone density of sites into which implants will be placed.[48,49]

Although early reports indicated that osseointegration could succeed with micromovements up to 500 µm,[50] currently accepted levels of micromovement ranging between 50 and 150 µm[2,4,17,26] are known to produce no detriment to osseointegration.[4,5] Consistent with these limits, recent recommendations indicate that torque values at the time of placement should be greater than 32 N·cm.[30,32] The long-term results of other investigations using torque ranges of 25–30 N·cm when immediately loading implants remain to be confirmed. Nevertheless, although they permit primary stability, these ranges of torque values are known to be nondetrimental to soft maxillary bone.[26] Furthermore, when immediately loading is performed within these torque ranges, collagen fiber formation has been shown to occur in a transverse manner with secondary osteon formation rather than parallel orientation with larger marrow spaces. This histoanatomic difference is more favorable to resisting the mechanical stresses of function following healing.[34] Other recommendations state that a minimum of 3–5 mm of vertical bone-to-implant contact should be attained to provide adequate primary stability to facilitate favorable osseointegration.[18] This recommendation is especially critical to consider when attempting immediate loading in a fresh extraction socket.

The timing of implant placement can also affect the quantity of bone volume that is available to receive an implant. It is known that within the first 3–12 months of tooth extraction, up to 50% loss of bone width[13,51–53] and 1.3–4.0 mm loss of bone height may occur. Factors such as whether the site is of a single tooth or of multiple teeth notably affect the rate of bone resorption.[13,52–54] Immediate placement of implants has been used to preserve crestal bone[10,12,18,19] and has been shown to produce similar or better results than delayed implant placement when bone levels are examined.[13,55,56] Two major observations have been associated with immediate implant placement in fresh extraction sockets followed by immediate loading (preferably nonfunctional)[19,57–61]: (1) the esthetic outcome seems to be equal, if not superior, to the conventional approach; and (2) similar survival rates with conventional loading can be achieved at single implant sites when rough surfaced implants, achieving high torque values, are placed by experienced clinicians.

Immediate Implant Placement

In addition to the benefit of bone preservation (described earlier), immediate implant placement provides the advantages of fewer surgeries[12,18] and decreased trauma, because the recipient site is already partially prepared.[51] This is desirable because drilling temperatures greater than 47°C for longer than 1 minute have been shown to cause bone necrosis.[17] Canullo et al[20] reported that extension of bone remodeling was less extensive in cases of immediate placement (1.7 mm) than with delayed placement (3.0 mm). Despite this limit in the healing zone, it has been shown that bone can fill osseous defects around implants if they are 3-walled in nature[13] and $<$1.5–2.0 mm wide.[12,13,18] Other interventions such as autogenous bone grafts have been shown to be more osteogenic when used in conjunction with immediately placed implants.[51] However, immediate placement does present some disadvantages. These may include unpredictable site morphology,[12] a potentially limited amount of soft tissue,[12] and the risk of failure due to residual periosteal infection.[47] Despite these potential disadvantages, immediate implant placement and immediate implant loading have shown to be favorable in maintaining or increasing bone heights around implants,[19] especially when certain guidelines are followed (Table 3).

Implant Design

Other means of promoting primary stability and overall implant stability following osseointegration employ variations in implant designs.[29] Implant designs that include threads and roughened surfaces significantly contribute to primary stability.[8,17,30,40,45,47,75] A titanium oxide surface layer is essential, as it becomes populated by various cells and proteins that promote healing, osteogenesis, and osseointegration.[9,17] The TiUnite surface

Table 3

Guidelines recommended by the Authors, if immediate implant placement and/or loading is to be considered

1.	Excellent primary stability/initial torque of placement[12,18,29,46]
2.	Rigid splinting preferred over lone-standing adjacent implants[6,62,63]
3.	Adequate keratinized tissue[12,64–70]
4.	Use of a surgical guide[31,71]
5.	Use of cone beam computed tomography scan technology[71]
6.	Prosthodontically driven implant placement[12]
7.	Absence of residual infection at the placement site by removal of all contaminated tissue[72–74]

(Nobel Biocare, Yorba Linda, Calif) has been recommended because of its characteristics of providing increased roughness, surface area, and bone-to-implant contact, which result in more homogeneous and densely packed bone after osseointegration is complete.[9] Other reports describe acid-etched surfaces as potentially osseoinductive.[28]

Implant diameter and length are often emphasized in reports, because these values give insight into the bone-to-implant surface area that an implant will provide. Avila et al[17] explained that larger implants provided greater bone-to-implant contact and less susceptibility to cantilever forces following restoration. More important, thread design and dimensions dictate the functional bone-to-implant surface area that will resist forces when a given implant is loaded along a given functional axis.[76] Tapered implants offer a conical shape that is consistent with a natural root form but have less surface area; this in turn results in increased crestal bone stresses and less primary stability.[76] Irinakis and Wiebe[46] described that a newly designed implant, the NobelActive (Nobel Biocare), produced a predictable and consistent initial torque greater than 30 N·cm at the time of placement in 100% of mandibular implants and in 82.5% of maxillary implants. Of interest is that the design of the implant was shown to permit less surgical preparation while affording the option of redirecting the implant's direction and stress "release" at the time of placement. Previous recommendations have cited a minimum diameter of 3.3 mm and length of 10.0 mm to afford good primary stability. However, innovations in implant design require these values to be revisited. Current literature suggests that a high degree of survivability can be consistently and reliably reproduced with implants that are at least 3 mm in diameter and 8 mm in length when splinted with other implants (Table 4).

Restoratively Driven Implant Dentistry

Implant rehabilitation should always be prosthodontically driven.[12,15,17] This philosophy promotes a reduction in implant micromovement through appropriately positioned and loaded restorations. If restorations are inappropriately designed, loss of osseointegration and/or prosthetic failure is more likely to occur. Axial implant loading is a desirable treatment goal because lateral forces greater than 30 N·cm have been shown to produce micromotions greater than 100 μm.[26] Nonaxial loading can also contribute to loosening of abutment screws, a major cause of prosthodontic failure.[19,30,75,77–79] Nordin et al[19] described that a high-precision and passively fitting prosthesis reduced stresses and strains that could be detrimental to a healing implant. In their study, they utilized the Cresco precision method to allow a high-precision passive fit, intended to reduce stress and strain on the implant-bone interface during prosthetic fixation. Some researchers have implemented splinting and cross-arch stabilization on implants that are not loaded along their long axis. In an effort to avoid the maxillary sinus,

TABLE 4

Lengths and diameters of immediately loaded maxillary implants

Authors, y	Patients, n	Implants, n	Implant Length, mm	Implant Diameter, mm	Torque, N.cm	Implant Survival, %	Evaluation Period, mo
Horiuchi et al, 2000	5	44	≥10	*	≥40	96.5	*
Olsson et al, 2001	10	61	*	*	*	95.4	12
Jaffin et al, 2004	34	236	≥8	*	*	93	*
Nikellis et al, 2004	40	102	*	*	*	100	12–24
Gallucci et al, 2004	8(Md+/Mx)†	68	*	*	*	97.4	8–20
Balshi et al, 2005	55	552 (submerged implants included)	*	*	*	99	*
Tealdo et al, 2008	21	111	≥10	4	≥40	92.8	12
Pieri et al, 2009	22	103	≥10	>3.3	≥30	97.1	12
Misch and Degid, 2003	2	18	*	*	*	100	*
Degidi and Piattelli , 2003	14	133	8–15	3.2–5.5	<35	98.5	2–60
Degidi et al, 2006	8	69	≥10	≥3.4	>25	100	12
Bergkvist et al, 2005	28	168	*	*	*	98.2	*
Ostman et al, 2005	20	123	≥8	>3.3	*	99.2	12
Nordin et al, 2007	19	119	≥10	≥3.3, 110 had ≥4.1	≥35	98.3	24
Palattella et al, 2008	17	18	≥10	4.8	35	100	24
Hassanet al, 2008	20	20	14–16	3.25–4	*	100	12
Boronat-Lopez et al, 2009	12 (7 Mx)†	36 (27 Mx)†	>13	4.2	*	97.2	12–18
Canullo et al, 2009	22	22	13	3.8 or 5.5	32–45	100	25
Collaert and De Bruyn, 2008	25	195	8–15	3.5–4	*	100	3
Machtei et al, 2008	20	33 Mx, 16 Md†	11–15	3.25–4	35–60	83	12
Degidi et al, 2006	44	388	*	*	*	98	60
Bergkvist et al, 2009	28	168	10 or 12	3.3–4.8	*	98.2	8 and 32
Degidi et al, 2008	20	153	*	*	*	100	12
Pieri et al, 2009	23 (9 Mx, 15 Md)†	144 (66 Mx, 78 Md)†	≥10	3.3 or 4	>30	98.6	12
Testori et al, 2004	19	116	>8	≥3.75	≥32	97.4	37.8
Degidi et al, 2009	40	48	*	3	≥25	100	48
Ibañez et al, 2005	41 (23 Md, 26 Mx)†	343 (217 Mx, 126 Md)†	*	3.75–5	*	99.42	12–74

Table 4
Continued

Authors, y	Patients, n	Implants, n	Implant Length, mm	Implant Diameter, mm	Torque, N.cm	Implant Survival, %	Evaluation Period, mo
Schwartz-Arad et al, 2007	87	210	>13	≥3.75	*	97.6	6–52, avg 15.6†
Ostman et al, 2008	37 (20 Md, 20 Mx)†	*	*	*	>30	100	3–6
Degidi et al, 2009	780	780 (393 Mx, 387 Md)†	13–18	3–6.5	*	99.5	1–107, avg 36†
Mijiritsky et al, 2009	16	24	13–16	3.3–5.5	≥32	95.8	24–72, avg 40.7†

*Data not available.
†avg indicates average; Md, XXX; Mx, XXX.

Tealdo et al[42] placed distal implants in an angulated manner. This technique has shown bone loss around the distal implants that is similar to that seen with more conventionally placed implants. Others have demonstrated 100% survivability using a similar concept called *V-II-V,* whereby 6 implants are placed into the maxilla at 30–45 degree angulations to the occlusal plane in the posterior maxilla to avoid the maxillary sinus.[80]

Splinting

Some researchers have reported that a similar prognosis could be expected whether or not the splinting of implants is utilized.[3,11,28] Especially when evaluating implant treatment in the maxilla, it is more common to find reports supporting reductions in micromovement and increases in overall survivability and success when splinting and cross-arch stabilization are used.[16,30,47] Various combinations of prosthodontic materials are available, including all-resin, metal-reinforced resin and ceramics, and all-ceramics. Literature describing the ability of each type of restoration to adequately splint immediately loaded implants to permit osseointegration suggests that stability, rather than the material used, is the critical factor.[14,35,40,81] However, Collaert and De Bruyn[22] reported resin fractures leading to prosthodontic failure; they subsequently altered their protocol to utilize metal-reinforced fixed prostheses. Nordin et al[19] reported failures of distal implants supporting all-resin full-arch prostheses. This failure is consistent with the experiences of Ibanez et al,[28] who reported that stability from splinting is the primary concern for success rather than other factors such as implant length, and Bergkvist et al,[78] who described impaired healing of implants under a removable prosthesis. Nordin et al[19] subsequently cited material thinness as the likely cause of inadequate rigidity, suggesting that if adequately thick, an all-resin fixed prosthesis would provide adequate splinting and cross-arch stabilization.

Because implants are susceptible to overload with excessive micromotion, and because they do not possess a periodontal ligament, pathologic bone strain[4] and fibrotic healing[18] are more likely to occur with poor occlusal management. An occlusal scheme that is perpendicular to the long axis of the implant, has freedom in centric relations, avoids cantilever forces, does not have interferences during excursive or protrusive movements, and is in group function where possible also reduces nonaxial forces on the implant and on screw fixation components.[31,69]

Conclusion

Current reports (Table 2) suggest that the prevalence of implant survivability has increased, and that previous recommendations [8,12,15] may not reflect the survivability that current treatment planning and delivery options afford. Careful surgical preparation and performance—considerations in restoration design and maintenance—a regular recall regimen, and good oral hygiene can predictably and consistently yield successful results. This has been proved continuously in the literature on the mandible. Although the maxilla has yet to prove itself in long-term evidence-based studies, the interim results of various investigations suggest that by carefully following guidelines (Table 3) and respecting the biology of the ''softer'' maxillary alveolar bone and the anatomic limitations of the upper jaw, clinicians may achieve long-term success rates similar to those consistently realized in the mandible.

Abbreviation

CT: computed tomography

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