

Apical-Coronal Implant Position: Recent Surgical Proposals. Technical Note

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The conventional placement protocol for submerged and non-submerged implants was proposed in the 1960s and 1970s. Multicenter studies have reported satisfactory success rates for both protocols and a similar loss of crestal peri-implant bone after implant loading (0.5 to 1.5 mm). In recent years, placement of submerged implants using a single surgical procedure was introduced, with the immediate placement of a healing abutment. Some studies reported good short-term results using this approach. Recently, a supracrestal apical-coronal positioning of the implant collar has been proposed for posterior sectors using submerged implants. This positioning facilitates the second surgical phase, as well as fabrication of the prosthetic restoration, and limits the amount of crestal bone loss. (INT J ORAL MAXILLOFAC IMPLANTS 2000;15:865-872)

Key words: bone resorption, dental implants, endosseous dental implantation, preprosthetic oral surgical procedures

In 1969, Brånemark and associates¹ defined Osseointegration as direct bone-implant contact. They considered total submergence of the implant to be an indispensable factor for success. This submergence was intended to avoid premature function, risk of infection, and the apical migration of epithelial cells along the implant surface.^{1,2} Conventional protocol, therefore, made 2 surgical procedures necessary. Numerous studies confirmed the excellent long-term prognosis of osseointegrated implants.³⁻⁸ Early in the 1970s, Schröder et al reintroduced the concept of non-submerged implants placed in 1 surgical visit.⁹ They believed that complete submergence of the implant was not necessary for osseointegration to occur. Numerous

studies have reported satisfactory success rates with non-submerged implants,¹⁰⁻¹⁵ and direct contact between bone and the implant surface has been demonstrated with both submerged and non-submerged techniques.^{3,5,16-18} Various studies have confirmed equivalent loss of crestal peri-implant bone with both surgical approaches.^{3-5,19-22}

Placement of submerged implants has also been proposed using a single surgical procedure, with the immediate placement of a healing abutment.²³ This approach allows the second surgical phase to be eliminated. Many studies have reported good short-term results using this technique (Table 1). More recently, a supracrestal apical-coronal positioning of the implant collar has been proposed for posterior sectors using submerged implants (personal communication, R. Lazzara, Osseotite Global Research Forum, Palm Beach Gardens, FL, January 2000). This positioning simplifies implant placement and facilitates the second surgical phase, as well as fabrication of the prosthetic restoration.

The aim of this article was to present the various possibilities for apical-coronal implant positioning: the submerged implant, the non-submerged implant, the submerged implant with immediate placement of a healing abutment, and the submerged implant placed with the collar in a supracrestal position.

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Table 1 Short-Term Results of Submerged Implants Placed in a Single Surgical Stage

Authors	Year	No. of implants	Failures (%)
Ericsson et al ²³	1994	32	2 (6.3)
Henry and Rosenberg ³²	1994	24	0 (0.0)
Bernard et al ³³	1995	10	0 (0.0)
Becker et al ³⁴	1997	135	6 (4.4)
Collaert and De Bruyn ³⁵	1998	211	6 (2.8)

SUBMERGED AND NONSUBMERGED IMPLANTS: CONVENTIONAL POSITIONING

Surgical Protocols

The recommended conventional protocol for the placement of submerged implants requires widening of the cortical bone (counter-sink) before placement of the implant. This coronal widening of the bony site permits total submergence of the implant collar and often of the covering screw at stage I surgery. During the second surgical phase, the implant is uncovered, and a healing abutment or prosthetic abutment is screwed into the implant. The definitive prosthesis is fabricated after the soft tissues have healed (Figs 1a and 1b).

For non-submerged implants (ITI System, Institut Straumann AG, Waldenburg, Switzerland), the bone cortex is not enlarged, since the entire submerged portion is perfectly cylindrical. Beginning at the collar (the non-submerged part), the implant becomes progressively wider. During its placement, the implant is submerged up to the coronal part of its rough surface. The collar, the exposed part of the implant, has a height of 3 mm, a widened collar of 4.8 mm, and an internal thread that will receive the prosthetic elements. This transmucosal part has a smooth surface, which limits the adhesion of bacterial plaque, thereby permitting good mucosal integration. With non-submerged implants, obtaining a satisfactory esthetic result can be difficult in anterior sectors. Indeed, prediction of the soft tissue level around the implant after healing is often problematic.

Implant Innovations Inc (West Palm Beach, FL) has proposed a non-submerged implant (TG Osseotite). This implant design has the advantages of a non-submerged implant and of the Osseotite implant acid-etched surface.²⁴ The coronal portion of this implant is available in 2 heights (1.8 mm and 2.8 mm), permitting a choice of transmucosal parts that is appropriate for the thickness of the soft tissues. The coronal part of the implant (exposed) is widened and has a polished surface. The surgical material necessary for placement is identical to that

employed for the 2-stage technique (submerged implant). The surgical site is classically prepared, but cervical widening (counter-sink) is not done. The implant is submerged just to the cervical limit of the first thread.

Peri-implant Mucosa

Behavior of the mucosa around the implant depends on the quality of the soft tissues, the degree of submergence of the implant, the type of biomaterials used, and the implant's surface condition. The soft tissue/implant interface is composed of 3 well-delineated zones: the sulcular epithelium, the junctional epithelium, and the peri-implant connective tissue (Fig 2).

Various studies have shown the presence of stratified, non-keratinized sulcular epithelium.^{20,25} This sulcular epithelium is made up of 5 to 15 cellular layers. At the apical level, the number of layers decreases as the junctional epithelium is approached.¹⁸ At the level of the healthy peri-implant sulcus, an average probing depth of 2 mm has been recorded.²⁶

The height of the junctional epithelium is 2 mm, and the connective tissue attachment is 1 to 1.5 mm. Berglundh and Lindhe²⁷ observed in an animal experimental study that the average biologic width of the mucosa was around 3 mm and that bone resorption may occur to allow soft tissue attachment. The formation of this biologic barrier can ensure successful integration of implants.

Peri-implant Bone Level

Analysis of the first long-term clinical results led Albrektsson and coworkers²⁸ to decide to include stability of the peri-implant crestal bone level among the criteria for success of submerged implants. Normal crestal bone loss must be less than 1.5 mm during the first year and less than 0.2 mm per year for subsequent years. Weber and colleagues^{22,29} obtained similar results with exposed (ie, non-submerged) implants. These authors found more significant bone loss in the maxillary arch before the implants were put into function. Long-term marginal bone stability has also been reported around implants supporting supra-implant prostheses in patients who are completely edentulous in the mandibular arch. Naert and others²¹ presented a radiographic evaluation of the bone level around 20 implants in use from 10 to 15 years and of 10 implants that remained submerged (dormant). The average bone loss at 18 months was 0.14 mm for the dormant implants and 0.90 mm for implants that were loaded. These authors concluded that the greater loss around the loaded implants was the result of surgical trauma from connection of the abutments. At 10 years, the peri-implant bone level

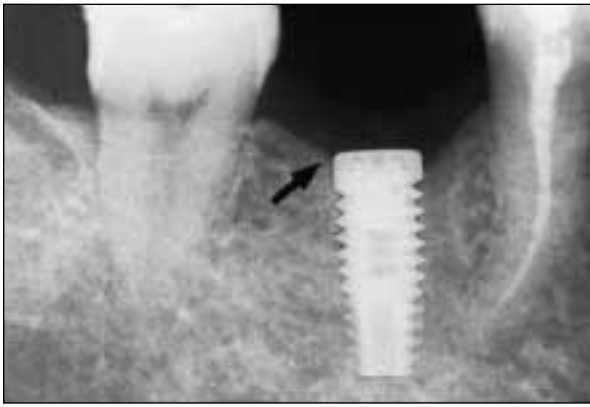


Fig 1a Periapical radiograph of a submerged implant. Note the bone level with the conventional protocol.



Fig 1b Radiographic view 2 years after loading. The bone level has stabilized at the first thread.

had decreased an average of 0.16 mm for the dormant implants and an average of 0.45 mm for the loaded implants. This stability of the marginal bone is in accord with the criteria for implant success.

In a radiographic evaluation of studies in dogs, Fiorellini et al³⁰ reported similar crestal bone loss around cylindric, rough-surfaced implants, whether submerged (0.99 ± 0.08 mm) or non-submerged (0.92 ± 0.08 mm), at 18 weeks after placement. However, these authors discovered a different chronology of bone loss over a period of time, depending on the type of implant. For the exposed implants, bone loss was greater in the first few weeks following their placement. However, for the submerged implants, the greatest bone loss occurred after the second surgical intervention (performed at 12 weeks). Bragger and associates¹⁹ performed a radiographic evaluation of the peri-implant bone level 1 year after placement of 57 ITI implants (screw or press-fit) in 40 partially edentulous patients. These authors reported an average interproximal bone loss of 0.78 mm, according to periapical radiographs.

SUBMERGED IMPLANTS PLACED IN A SINGLE SURGICAL PROCEDURE

The good results obtained with non-submerged implants have called into question the perceived necessity for submerging implants and requiring 2 surgical procedures, as is necessary with submerged systems. In a multicenter study, Buser and colleagues¹¹ reported 13 primary failures of 2,359 non-submerged implants. Osseointegration has also been obtained with submerged implants placed in 1 surgical procedure.^{23,31} Many teams have obtained excellent short-term results using this surgical approach (Table 1).

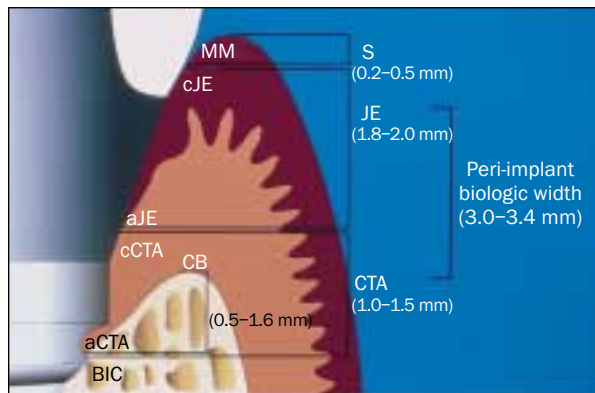


Fig 2 The peri-implant biologic width. MM = marginal mucosa; cJE = coronal junctional epithelium; aJE = apical junctional epithelium; cCTA = coronal connective tissue attachment; aCTA = apical connective tissue attachment; CB = crestal bone; BIC = bone-implant contact; S = sulcus; JE = junctional epithelium; CTA = connective tissue attachment.

The surgical sequence is similar to the conventional protocol recommended by Branemark and coworkers.³⁶ After placement of the implant, a healing abutment that is greater in height than the thickness of the soft tissues is screwed onto the implant in place of the cover screw (Figs 3a and 3b).

The placement of submerged implants in a single surgical visit has the advantages of simplifying the surgical protocol and reducing the number of interventions. However, this technique presents certain limitations, such as esthetic compromise (visibility of the healing abutment), difficult prediction of the level of healing of soft tissues, a risk of excessive compression of the healing abutment by an eventual removable prosthesis, and undesirable clinical repercussions in low-density bone (Table 2).

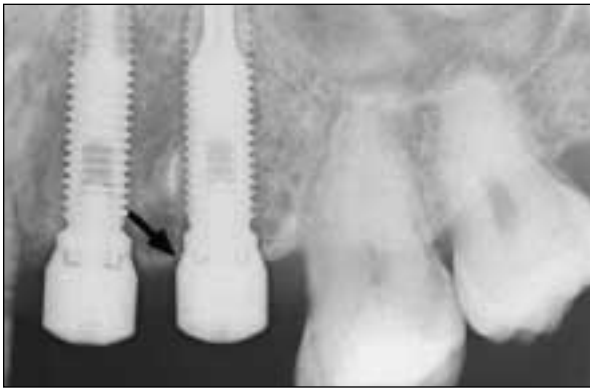


Fig 3a Radiograph after placement of 2 submerged implants with a healing abutment.



Fig 3b Note the bone level (arrow) after 1 year of loading.

Table 2 Characteristics of the Various Surgical Approaches

Technique	Indications	Advantages	Disadvantages
Submerged	All types of edentulism	Good esthetics Limited micromovement	Two-stage surgical procedure
Non-submerged	Maxillary and mandibular posterior sectors Anterior mandibular sector	One-stage surgery	Esthetics in anterior difficult to check Implant micromovement
Submerged with abutment	Maxillary and mandibular posterior sectors Anterior mandibular sector	Good esthetics One-stage surgery Prosthetic restoration facilitated Management of soft tissues: emergence profile concept	Esthetics in anterior difficult to check Implant micromovement
Supracrestal	Maxillary and mandibular posterior sectors	Surgical act simplified Management of apico-coronal bone shift Limited loss of crestal bone Optimal initial stability	Esthetics in anterior difficult to check Implant micromovement

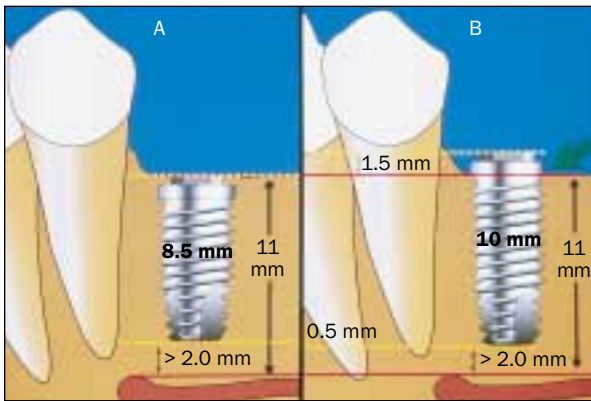
Technologic innovations permit better management of the peri-implant soft tissues. Two-part mucosal healing abutments eliminate the problem of unscrewing, which often causes peri-implant inflammation or infection. This type of abutment fits perfectly onto the implant through an internal hexagon and is attached by a titanium screw. A conical joint on the titanium screw prevents the passage of fluids to the interior of the implant. This abutment is available in many coronal diameters (5, 6, and 7.5 mm) and in many heights, permitting the operator to guide the healing of the soft tissue according to the cervical diameter of the future tooth replacement (“emergence profile” concept). The surface of this abutment is polished, permitting guidance of soft tissue healing for a better esthetic result.

On average, peri-implant bone stability using this surgical approach is similar to the conventional protocol. In a comparative study, Ericsson and col-

leagues³⁷ reported good crestal stability at 5 years in 61 implants with conventional submerged implants and submerged implants with healing abutments. The 61 implants observed showed stable marginal bone levels at 18 months and 5 years, regardless of the surgical technique used. However, the authors did not report peri-implant bone modifications with regard to the initial bone level.

SUBMERGED PLACEMENT WITH THE IMPLANT COLLAR IN A SUPRACRESTAL POSITION

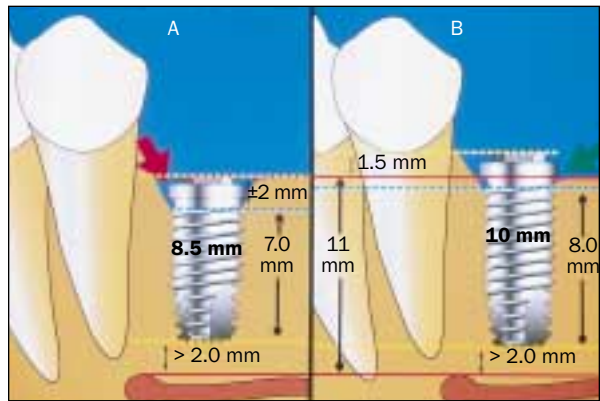
With this surgical option, submerged implants are placed with the implant collar in a supracrestal position. The surgical protocol is similar to that of implants that are submerged to the final bur opening of 3 mm to 3.15 mm, depending on bone quality.



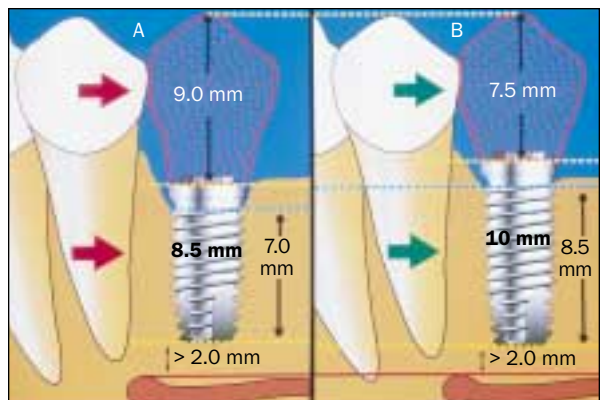
Figs 4a and 4b (Left) Conventional apical-coronal implant placement. (Right) Supracrestal implant collar placement. The implant must be placed at least 2 mm above the mandibular canal.

Cervical widening (counter-sink) of the implant site is not done. This surgical preparation allows placement of the implant, while it leaves the collar in a supracrestal position (Figs 4a and 4b). The cover screw is screwed into the implant. Depending upon the thickness of the mucosa, sutures assure partial or total closing of the implant sites. A second surgical procedure is necessary if the mucosa envelops the cover screw. Very often the surgical intervention is simplified, because the cover screws are apparent. The cover screws can be removed and replaced by the definitive abutments, the healing abutments, or even the impression transfer copings directly. If there is little soft tissue thickness, the cover screw, which is apparent, can serve as a healing abutment and perhaps, therefore, be reinserted after an impression is taken of the implant head.

This surgical technique is indicated primarily in posterior sectors. It permits the operator to correct for an eventual crestal bone discrepancy of 2 mm between the edentulous site and the adjacent teeth. The supracrestal position of the base of the implant collar allows, in effect, a gain of 1 to 2 mm in implant length and a better apical-coronal relationship to the adjacent teeth. It also limits bone loss because sufficient peri-implant biologic width is formed. Crestal bone loss up to the first thread, which is classically observed after the loading of submerged implants, results from the formation of this biologic space (Figs 5a and 5b). For Abrahamsson and coworkers,³⁸ "a minimum width of the peri-implant mucosa is required. If this soft tissue dimension is not satisfied, bone resorption occurs to ensure that a biologic width of the epithelial/connective tissue attachment is established."^{38p217} Recently, an experimental animal study, which compared the peri-implant tissues around submerged



Figs 5a and 5b Crestal bone loss to the first thread is normally observed after implant loading. The bone resorption is more important with the conventional protocol (at left).



Figs 6a and 6b A supracrestal implant placement (at right) allows for a better clinical crown/implant relationship.

and non-submerged titanium implants, confirmed the formation of a peri-implant tissue system; the height of the mucosa was about 3 mm, the length of the junctional epithelium was about 2 mm, and the zone of connective tissue integration was 1 mm long.³⁹ Abrahamsson and coworkers³⁹ noted that the most marginal position of bone-to-implant contact after 6 to 9 months of healing was located between 0.68 mm (non-submerged protocol) and 0.85 mm (submerged protocol) apical to the implant/abutment junction (unloaded implants).

The supracrestal position of the collar also permits improvement of the clinical crown/implant ratio and the implant anchorage surface. In posterior sectors, an implant that is 1.5 mm longer may be used, which permits a significant gain in anchorage, and the association of a rough surface and a supracrestal position will increase implant anchorage considerably (Figs 6a and 6b). Moreover, the absence of coronal widening of the implant site will



Fig 7a Clinical view of a mandibular distal edentulous extension.



Fig 7b Final surgical preparation before implant placement in a supracrestal position. No countersink was performed.



Fig 7c Buccal clinical view. Note the supracrestal position of the implant collars.

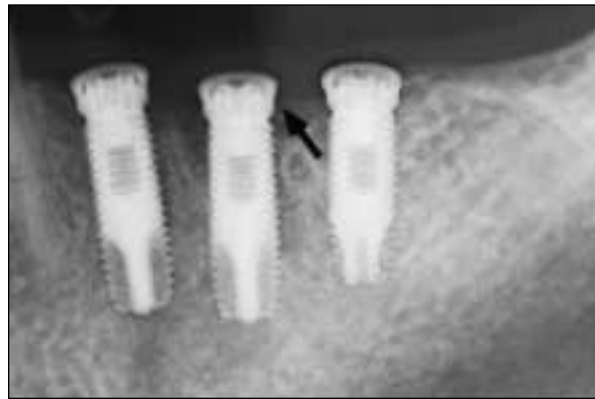


Fig 7d Radiographic view after implant placement. Arrow indicates bone level.



Fig 7e Clinical view at 3 months. Note the appearance of the cover screws.

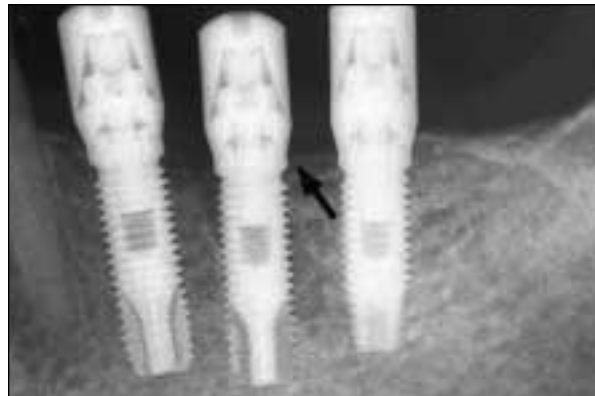


Fig 7f Note the similar bone level (arrow) after abutment placement (3 months after implant placement).

optimize initial stability of the implant because the collar is "blocked" in cortical bone (Figs 7a to 7g). The conventional positioning of the implant creates too great a submergence with relation to the adjacent teeth, as well as insufficient initial stability in the presence of thin or non-existent cortical bone.

Numerous parameters must be evaluated when determining the apical-coronal position of an implant. A minimum difference in crestal bone level between the implant and adjacent teeth, limited or inadequate prosthetic space (less than 6 mm), and/or very thin mucosa may be contraindications for this surgical technique. These factors may cause a difference in the level of the marginal gingiva, a short prosthetic crown (which can make prosthetic restoration impossible), or an unacceptable esthetic result because of a direct view of the metal (or an indirect view through the semi-opaque soft tissue) at the cervical level.

CONCLUSION

Conventional placement of submerged and non-submerged implants has shown very good long-term clinical and radiographic results. Limited initial crestal bone loss that remains almost stable over a period of time has been reported. Recent use of submerged implants placed in a 1-stage surgical procedure, with immediate placement of a healing abutment, allows the operator to simplify the operative protocol. Acceptable short-term and long-term results have been reported with this interesting surgical approach. A new proposal adopts a supra-crestal apical-coronal position of the implant collar. This permits simplification of the surgical procedure and facilitates the prosthetic restoration. In addition, peri-implant cervical bone loss is limited.

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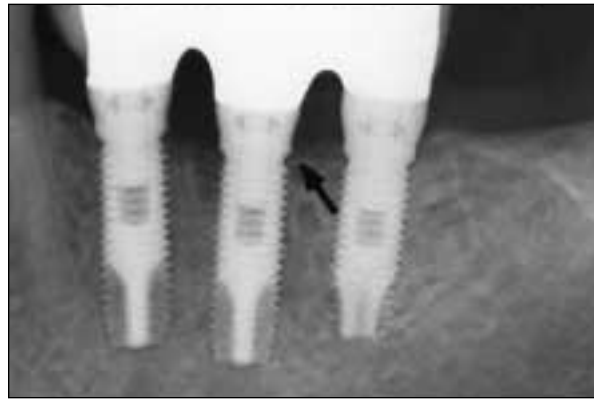


Fig 7g Periapical radiograph at 1 year after loading.

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