Immediate Implants: Their Current Status

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Immediate implants are implants placed into a prepared extraction socket following tooth removal. Short-term animal and human studies have shown these implants to be comparable to implants placed into healed bone. The advantages of the procedure include fewer surgical sessions, elimination of the waiting period for socket healing, shortened edentulous time period, reduced overall cost, as well as preservation of bone height and width. Although immediate implantation is more demanding both surgically and prosthetically compared to the conventional placement technique, the advantages make it very appealing to patients who are in need of both extractions and implant therapy.
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With the introduction of "osseointegration technology" to North America at the 1982 Toronto Conference, prosthodontic treatment of patients was to change significantly. It became possible to anchor prostheses firmly to osseointegrated implants and significantly improve comfort for those who for so many years were "sentenced" to wearing removable prostheses. Original studies reported high success rates related to implants placed in the anterior symphysis of the mandible of edentulous patients.[1,2] It is based on these success rates that the implant procedure became more common in restoration of the maxillae and then used for the partially edentulous patient and in craniofacial reconstruction. With experience, demands of placing restorations for the partially edentulous patient in less than ideal locations prompted the development of newer surgical devices and techniques (sinus and ridge grafting, local bone grafting at individual implant sites) to assist in implant placement. New prosthetic components that would allow for prosthetic correction of angulation and esthetic difficulties were developed.

In situations where teeth required extraction, original protocol suggested a 6- to 12-month wait for healing of the site before implant placement[3–5] to allow the complete ossification of the extraction socket.[6] Placement of an implant directly into a prepared extraction socket at the time of extraction has several advantages that have the potential to improve patient acceptance of the procedure:

1. Elimination of the waiting period for socket ossification
2. Fewer surgical sessions required
3. Shortened edentulous time period
4. Reduced overall cost
5. Preservation of alveolar bone height and width allowing for optimal placement in relation to implant length, width, and angulation

Literature Review

Several investigators reported placing implants directly into extraction sockets before the North American osseointegration era.[7–12] These studies generally reported poor success rates with soft tissue noted at the interface.

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Aluminum oxide intraosseous implants have been placed into extraction sockets of rhesus monkeys and baboons showing low "survival rates" of smooth and horizontal fin implants, respectively.[13,14] Human studies have shown poor success rates at 5 years (57%)[15] and at 8 years (23%).[16] The Tübingen implant has been placed into extraction sites as well as healed bone of human subjects with a high degree of success.[17-20] Long-term controlled animal and human studies using occlusally loaded Tübingen implants (placed into fresh extraction sockets) have yet to be reported.

Research showing that hydroxyapatite (HA) produces bony ankylosis attachment when placed into extraction sockets[21] has led to its evaluation in immediate implantation. Hydroxyapatite implants, designed to be loaded with a crown, were placed into extraction sockets and showed immobile fixation; however, failure occurred because of poor strength of the material, implant fractures,[22] as well as cement breakdown between the titanium post and the HA.[23] Immediate implantation of HA plasma-sprayed implants have been shown to integrate with a great degree of success.[24-27]

Earlier research using animal models to evaluate unloaded titanium implants in extraction sockets showed high degrees of bone at the implant interface.[5,28] Barzilay et al[29,30] compared pure titanium implants placed into extraction sockets of monkeys with implants placed into healed bone. After a loading period of 7 months, clinical, radiographic, and histologic data indicated no significant difference between immediate and conventional implants.

Although not evaluating implants placed into extraction sockets, investigators have reported high success rates with titanium implants placed at the time of extraction following radical alveolectomies or alveoplasty.[31,32]

There have been many recent reports of immediate implants with the techniques of guided tissue regeneration. The technique appears useful in situations of dehiscence and fenestration as well as when gaps are present between prepared bone and the implant. Recent research evaluating tissue regenerative procedures using membranes around titanium implants has shown enhanced bone formation at extraction sites when dehiscences were present.[33] Other studies have shown improved bone fill around titanium implants when membranes were used versus when they were not used.[34,35] Clinical reports have documented this technique to be useful in the healing of immediate implants.[36-39]

Recent research into the use of bone augmentation materials and enhancing agents to increase bone healing have suggested their usefulness in the immediate implantation procedure.[40-42] These materials have been used with and without barriers. More research is needed before these materials can be used routinely in clinical practice.

While a review of the literature indicates a great interest in and promise for immediate implant treatment, much of the published information is based on short-term data. One must still consider this type of treatment new and not conclusively supported by long-term controlled clinical studies. If the procedure is to be undertaken, it can only be done with patient acknowledgment that placing an implant into an extraction socket at the time of extraction is a surgical "art" and not implant science.

Clinical Requirements for Immediate Implantation

As with all implant treatment, good initial diagnosis and treatment planning is essential. For the immediate implant patient this includes the standard procedures for conventional implant placement with special attention being given to:

1. The tooth that is to be extracted and surrounding structures
2. Surgical difficulties
3. Possible prosthodontic complications

The ideal scenario for an immediate implant involves an atraumatic extraction, stabilization of the implant within the confines of the prepared extraction socket so that it has maximal contact with freshly prepared bone and is in proper angulation, primary closure of the surgical flap, uneventful healing, and final restoration of the implant with a functioning prosthesis.

Evaluation of the Tooth and Surrounding Structures

In planning for an immediate implant procedure, it is vital that one considers the tooth that is to be extracted for its general dental health, root anatomy, and root orientation. The published animal studies generally evaluated extracted teeth free of signs of inflammation. Clinically, this may present as an unrestorable tooth with little or no active periodontal disease. It is important to consider that once the tooth is extracted, the implant site must be free of pathosis. This is best achieved by proper patient selection and waiting for the extraction socket to heal if disease is present in the area. Teeth with periapical pathosis or active periodontal disease are not prime candidates for immediate im-

plants. Whereas the presence of caries in itself is not a contraindication, its presence may make extraction of the tooth more difficult and thereby necessitate bone removal during extraction. This loss of bone would lead to an overall reduction of initial support for the implant.

An assessment of the root orientation must be made, since this has a direct bearing on the angulation of the implant. Maxillary incisors and canines are curvilinear in shape and as such the long axis of the root and the long axis of the crown are not parallel. Placement of the implant along the long axis of the extraction socket (long axis of the root) in these situations may result in buccally angulated implants. An assessment of the root's shape (round, ribbon-shaped, etc) must be made, since it has a direct bearing on both the type of implant-bone interface that can be expected once the implant is placed as well as the angulation of the implant.

Since there are a limited number of implant diameters available (most sizes being 3.75 and 4.0 mm) it is reasonable to assume that spaces exist between the implant and the prepared bone site because of the shape of the extraction socket. The implant-bone interface can be classified as type I, II, or III (Fig 1).

Type I Interface. Ideally, one would prefer to see an implant with freshly prepared bone along its complete periphery (type I). This can be accomplished when the root is smaller than the implant and is often seen when small teeth are extracted or when the teeth that are extracted have had periodontal disease and the remaining socket size is minimal. The type I interface can be created by placing the implant deep into the socket so as to engage only the apical portion of the socket and the prepared bone beyond the apex. In these situations, once the site is prepared the implant will be in contact with freshly prepared bone along its complete periphery. The type I interface can also be created when an alveolectomy is performed, thereby allowing the implant to be placed into basal rather than alveolar bone. Unfortunately, if the implant is forced into a deeper position, it may encroach on other structures (nerves, major blood vessels), be esthetically compromised, or have increased cantilever potential. The alveolectomy also reduces the potential implant length and therefore it may be preferable to have immediate implants stabilized within the confines of the socket at a more ideal occlusal height and then use guided tissue regenerative procedures to fill the bone-implant void.

Type II and III Interfaces. Because of the different shapes and sizes of roots there is a greater likelihood that when dealing with immediate implants a space will be present between the implant and the prepared socket. In the type II situation a space is present at the coronal aspect of the implant, while the apical portion of the implant is secured in freshly prepared bone (Fig 2). A type III situation exists when a space is present along the lateral border of the implant. This may be the reason that the immediate implantation procedure was slow to develop, since this gap may have initially concerned researchers as a possible mode for failure.

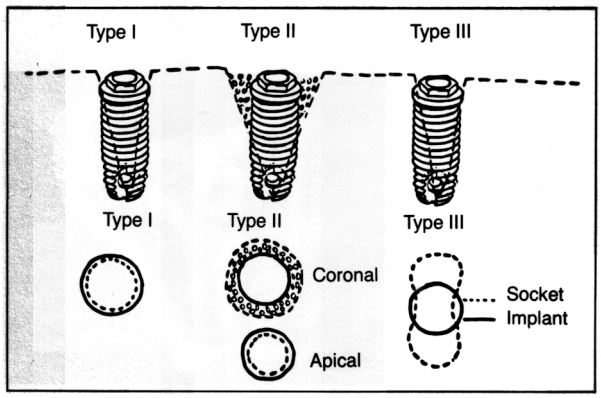

Fig 1 Classification of the implant-bone interface.

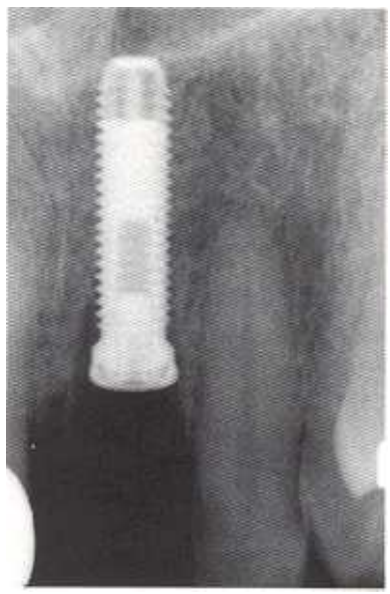

Fig 2 Radiograph of a maxillary right central incisor immediate implant at the time of insertion. Note the gap between the implant and the prepared bone site at the coronal end of the implant.

Fig 3 Cross section of an immediate implant placed into the palatal root socket of a maxillary molar of *M fascicularis*. Dense bone of the palatal cortex is supporting the palatal side (right) of the implant, while the buccal side (left) has only a thin layer of dense lammelar bone at the interface with minimal physical support. An implant extending from buccal to palatal cortex would be supported by more cortical bone for overall better physical support.

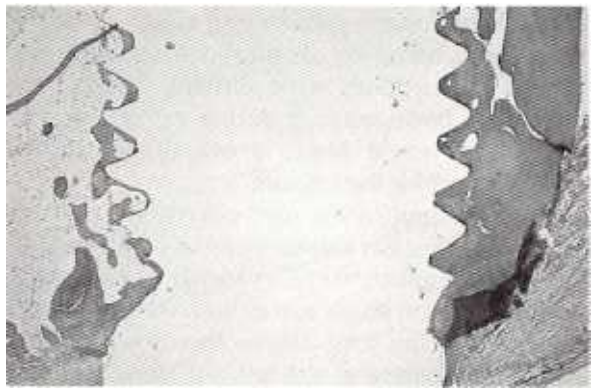

Fig 4 Histologic section of the immediate maxillary molar in Fig 3. Thick, dense lamellar bone is present on the palatal aspect (right), while only a very thin rim of lamellar bone is present on the buccal aspect (left). The buccal-side interface is supported by bone marrow. (Modified Masson-Goldner trichrome stain, original magnification ×25)

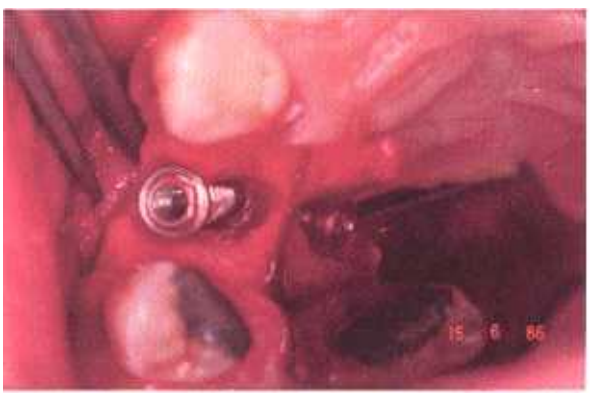

Fig 5a Pure titanium screw-shaped implant has been positioned within the prepared root socket of a maxillary first premolar. The implant engages bone in the apical region of the socket and along the buccal socket wall but is not in contact with bone along most of its palatal surface (good example of a type III interface). The site was augmented with freeze-dried decalcified bone and a nonresorbable membrane. (Courtesy of Dr M. Arlin, Weston, Ontario.)

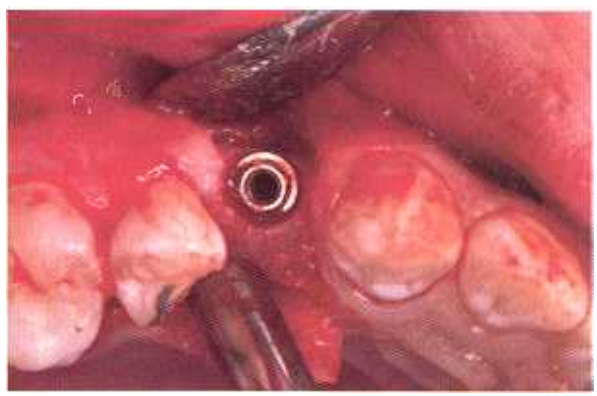

Fig 5b At the time of uncovery, bone can be seen filling the void that was present at the time of implant placement. (Courtesy of Dr M. Arlin, Weston, Ontario.)

Surgical Difficulties

Surgical complications encountered with immediate implantation can be associated with several factors:

1. Complicated extractions
2. Perforation of the cortical plate
3. Socket anatomy that precludes ideal implant placement
4. Close proximity to adjacent teeth, sockets or implants
5. Difficulties associated with barrier techniques
6. Problems associated with flap closure

Complicated extractions lessen the amount of alveolar bone available for implant support. Once the tooth is extracted, the socket must be closely evaluated for the most ideal location to secure the implant. Ideally, an implant placement guide should be used to orient the implant surgeon as to the proposed placement of the clinical crown. The implant should be placed so that its coronal surface is approximately 3 to 4 mm apical to the cementoenamel junction of the adjacent teeth, and the screw access should exit through the cingulum or the central groove of the final crown. While keeping these factors in mind, the implant surgeon must place the implant within the confines of the socket

and maximize contact between prepared bone and the implant. The implant should be placed so that it contacts cortical plate, wherever possible, to improve stability. This is difficult because a superior cortical plate is unavailable (as a result of extraction). The inferior, buccal, lingual, or palatal cortices should be engaged if possible. This is most important in areas of poor bone quality (posterior maxillae and mandible) (Figs 3 and 4).[30] When an ideal bone-implant interface (type I) cannot be achieved, it becomes necessary to use guided tissue regenerative procedures to augment areas of the interface that are not in contact with bone (Figs 5a, 5b, and 6). However, using this technique makes it difficult to approximate the edges of the flap because of the increased bulk of material under the flap. Although it may not always be necessary to approximate the edges of the flap, it is desirable.

Ideally, the flap should be approximated to allow for primary healing of the surgical site. When dealing with conventionally placed implants this is not a problem, because intact tissue was originally incised to raise the flap. An immediate implant does not have the tissue to close as a result of the extraction. The flap edges can be approximated by releasing the periosteum, creating a sliding pedicle flap, or interdigitating the papillae to close the surgical site. When placing the implant into the extraction socket, it should be submerged below the level of the surrounding bone. In such instances, primary closure of the flap may preclude the guided tissue regenerative procedure.[30]

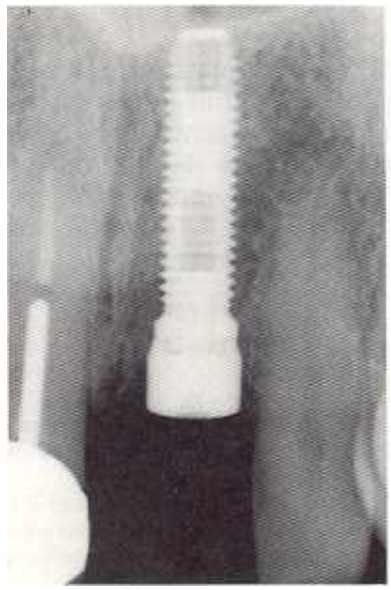

Fig 6 Radiograph of maxillary right central incisor immediate implant shown in Fig 2 after guided tissue regeneration and a 6-month healing period. Radiographic evidence of bone fill can be seen in the coronal portion of the implant.

Fig 7 Immediate implant placed into a maxillary premolar site shows severe buccal angulation.

Prosthodontic Complications

Prosthodontic complications associated with the immediate implant procedure can be encountered immediately after the surgical implant placement. These complications include:

1. Reduced vestibular depth
2. Angulation problems
3. Deep or shallow implant placement within the socket

By approximating the flap edges, a loss of vestibular depth may occur and make reinsertion of the patient's interim prosthesis difficult. The denture border must be adequately reduced, and a soft liner is placed to minimize pressure on the displaced vestibule.

The most common problem faced by this author is that of poor implant angulation (Fig 7). Most of these problems are easily managed with "angulation abutments" that reorient the screw access of the crown. Angulation problems can also be managed using cementable components.

A surgical tendency to place the implant deep within the socket (to engage more bone) can lead to prosthetic difficulties in restoration as well as in patient maintenance of a prosthesis. Shallow placement makes esthetic restoration difficult if a minimal amount of gingival tissue is present. Components bringing the prosthesis to a level close to the implant body itself help with this type of problem.

Conclusion

Short-term research (animal and human studies) has shown that immediate implants are comparable to implants placed using the conventional technique. The procedure is more demanding both surgically and prosthodontically but provides significant advantages for the patient. Long-term studies are needed to conclusively prove the usefulness of this procedure.

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Marginal Adaptation of Castings Made With Dual-Arch and Custom Trays

The dual-arch impression technique, which incorporates the maxillary and mandibular impression and a jaw relation record into one procedure, has gained wide popularity. The purpose of this study was to compare the marginal fit of castings made with custom acrylic resin trays and castings made with metal or plastic dual-arch impression trays. Standard clinical and laboratory procedures were used to make 36 gold castings, 12 castings with each type of tray, for a metal typodont die. Marginal openings of the castings were determined on the metal die with a measuring microscope at six precisely marked locations on the die. Mean marginal openings were between 25 and 28 μm in all test groups. **There were no significant differences in marginal opening based on tray type** or location of measurement on the metal die. The results of this study support and strengthen the findings of previous studies which used linear measurements to compare the accuracy of the impression techniques. **The authors conclude that the limitations of the dual-arch impression technique are related to the development of occlusion rather than the accuracy of the dies.**

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Microleakage Full Crowns and the Dental Pulp

The purpose of this study was to test three crown margin preparations to determine whether margin preparation affects microleakage. Thirty freshly extracted molar teeth, all noncarious or with small restorations, were mounted in acrylic resin blocks and prepared with a full shoulder, a chamfer, or a shoulder and a bevel. All crowns were cemented with zinc phosphate cement. All teeth were cycled 100 times between 4°C and 60°C water baths containing 0.05% crystal violet dye. Total immersion time was 100 minutes. The crowned teeth were then embedded in clear autopolymerizing acrylic resin and sectioned buccolingually into three equally thick sections. All crowns leaked regardless of the type of crown margin preparation. The leakage pattern was the same and the leakage followed the dentinal tubules directly into the pulp in every case. **Since this study demonstrated that there is leakage in every tooth regardless of which crown margin preparation is used, dentists must be aware of the possibility of subsequent microbiologic damage to the pulp through the dentinal tubules. The authors conclude that microleakage could be a cause of pulpal inflammation, and even pulpal death, under complete crowns.**

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