

Immediate Loading of the Edentulous Mandible: Delivery of the Final Restoration or a Provisional Restoration—Which Method to Use?

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Purpose: Edentulous patients desire restoration of their chewing ability as soon as possible after placement of dental implants. The purpose of this article is to provide clinicians with evidence that immediate loading of implants placed into the anterior mandible can predictably provide the patient with early functional rehabilitation. Two methods are presented that illustrate delivery of the final restoration or a provisional implant-borne prosthesis immediately after implant placement.

Materials and Methods: A literature search was performed which produced 14 articles in the English literature that provided sufficient evidence that immediate loading is now not experimental and can be recommended as an acceptable treatment alternative.

Results: Two practical methods to achieve immediate function are presented in a step-wise manner to illustrate how to deliver this service to the patient.

Conclusion: Based on our literature review, immediate loading of the edentulous mandible with an implant-borne restoration is an acceptable and predictable method to deliver efficient return of function for the edentulous patient.

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Restoration of the edentulous mandible has been achieved with the use of dental implants and various types of prostheses.¹⁻³ The traditional 2-stage technique with a stress-free healing period has been well documented.¹⁻³ When using the 2-stage implant system with primary gingival closure after implant placement, interim relined dentures are used to restore function for periods up to 6 months. However, the first several weeks are uncomfortable to the patient and limit their function during the entire implant integration period. To shorten the period of patient

discomfort, treatment options using immediate implant-borne prostheses have been developed to minimize the time that the patient experiences functional disability. The decision to provide the patient with improved function immediately after implant is placed is patient-driven. The overall success rate for immediate rehabilitation of the edentulous patient is similar to the traditional 2-stage method.

Clinicians will decide to immediately rehabilitate the edentulous patient based on evidence that this method is equivalent in success compared with traditional delayed techniques. There is clear evidence justifying immediate loading of implants placed between the foramina of the edentulous mandible.⁴⁻¹⁷

Early attempts used extra or expendable implants that were placed into function with a temporary restoration at the time of surgery.¹⁸ All implants were integrated including those loaded immediately. In another study following the same approach,⁶ 4 of 28 implants failed; these 4 implants were placed in the posterior mandible and were 7 mm in length. Tarnow et al⁵ used a provisional approach to restore 6 mandibles and 4 maxillas. They reported a high rate of successful integration

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Table 1. LIST OF CLINICAL STUDIES ON IMMEDIATELY LOADED ANTERIOR MANDIBULAR IMPLANTS

Study	Implant Location	No. of Implants	Time to Implant Loading	Type of Restoration	Length of Follow-Up	Success Rate of Immediately Loaded Implants
Balshi & Wolfinger, 1997 ⁴	Mandible (n = 10)	130	Immediately loaded (n = 40)	Fixed provisional	N/A	80%
Tarnow et al, 1997 ⁵	Mandible (n = 6) Maxilla (n = 4)	107	Immediately loaded (n = 69)	Fixed provisional	1-5 yr	97.1%
Schnitman et al, 1997 ⁶	Mandible (n = 10)	63	Immediately loaded (n = 28)	Fixed provisional	10 yr	84.7%
Brånemark et al, 1999 ⁷	Mandible (n = 50)	150	Immediately loaded (n = 150)	Fixed final prosthesis	6 mo to 3 yr	98%
Randow et al, 1999 ⁸	Mandible (n = 27)	118	Within 20 days (n = 88)	Fixed final prosthesis	18 mo	100%
Horiuchi et al, 2000 ⁹	Mandible (n = 12) Maxilla (n = 5)	140	Immediately loaded (n = 140)	Fixed provisional	8 to 24 mo	97.2%
Jaffin et al, 1998 ¹⁰	Mandible (n = 23) Maxilla (n = 4)	149	Immediately loaded or within 72 hrs (n = 149)	Fixed provisional	N/A	95%
Chow et al, 2001 ¹¹	Mandible (n = 27)	123	Immediately loaded (n = 123)	Fixed provisional	3-30 mo	98.3%
Colomina, 2001 ¹²	Mandible (n = 13)	61	24 hrs (n = N/A) 10 days (n = N/A)	Fixed provisional	18 mo	100% 96.7%
Ganeles et al, 2001 ¹³	Mandible (n = 27)	186	Immediately loaded (n = 161)	Fixed provisional	25 mo	99%
Grunder, 2001 ¹⁴	Mandible (n = 5) Maxilla (n = 5)	91	Within 24 hrs (n = 91)	Fixed provisional	2 yr	92.3% overall 87.5% maxilla 97.2% mandible
Cooper et al, 2002 ¹⁵	Mandible (n = 10)	54	Immediately loaded (n = 48)	Fixed provisional	6-18 mo	100%
Ibanez & Jalbout, 2002 ¹⁶	Mandible (n = 5) Maxilla (n = 5)	87	Immediately to 48 hrs (n = 87)	Fixed provisional	1 yr	
Testori et al, 2003 ¹⁷	Mandible (n = 15)	103	Immediately loaded to 36 hrs (n = 103)	Fixed provisional or fixed final	4 yr	98.9%

NOTE. A fixed provisional is an acrylic relined denture or preformed shell crowns which are fixed to implant abutments and can be either screw or cement retained, with the final definitive prosthesis fabricated after implant integration. A fixed final prosthesis is a definitive restoration including hybrids, bars, or cement retained crowns.

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in 67 of 69 loaded implants. All of these implants were cross arch stabilized.

A different approach to minimizing treatment time is to deliver the final prosthesis on the day or within days of the surgery. Brånemark et al⁷ used 3 implants in the anterior mandible and a screw-retained hybrid prosthesis and reported a 92% to 98% success. Castellon et al¹⁹ presented another approach, to deliver a

premade bar and final denture the day of surgery or within a week postsurgery.

In Table 1, there are 14 studies listing the results of 240 mandibles involving more than 1,277 implants, all supporting immediate restoration of the mandible. The success rates ranged from 84.7% to 100%, indicating that immediate loading of the edentulous mandible is a viable treatment. The lower success rates

Table 2. REASONS FOR IMPLANT FAILURE WITH IMMEDIATE LOADING OF THE EDENTULOUS MANDIBLE, AS CITED BY THE AUTHORS

Reason	Reference
Short implants placed posterior to foramen	6, 10, 13, 14
Ill-fitting prosthesis	9, 10
Poor surgical technique	7
Bruxism	4, 10, 12-14
Infection	11, 17

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from Balshi and Wolfinger⁴ and Schnitman et al⁶ have clear explanations for the failures. The remaining studies report success rates greater than 95% in the mandible.^{5,7-17} The reasons cited for implant failure involving immediate loading of the edentulous mandible (Table 2) include short implants placed into the posterior mandible, bruxism, ill-fitting prostheses,

poor surgical technique, and infection of the implants.

On careful review of the studies in Table 1, there are criteria that are consistently associated with successful patient treatment. These criteria include:

1. Adequate density of anterior mandibular bone with insertion torque greater than 20 N-Cm, often cited to be above 30 N-Cm;
2. Cross arch stabilization of the implants with either a rigid metal bar or resin;
3. The use of threaded implants of at least 10 mm in length;
4. Sufficient interocclusal space for fabrication of the framework and interim prosthesis; and
5. Patient dexterity and compliance with hygiene instruction and postdelivery care.

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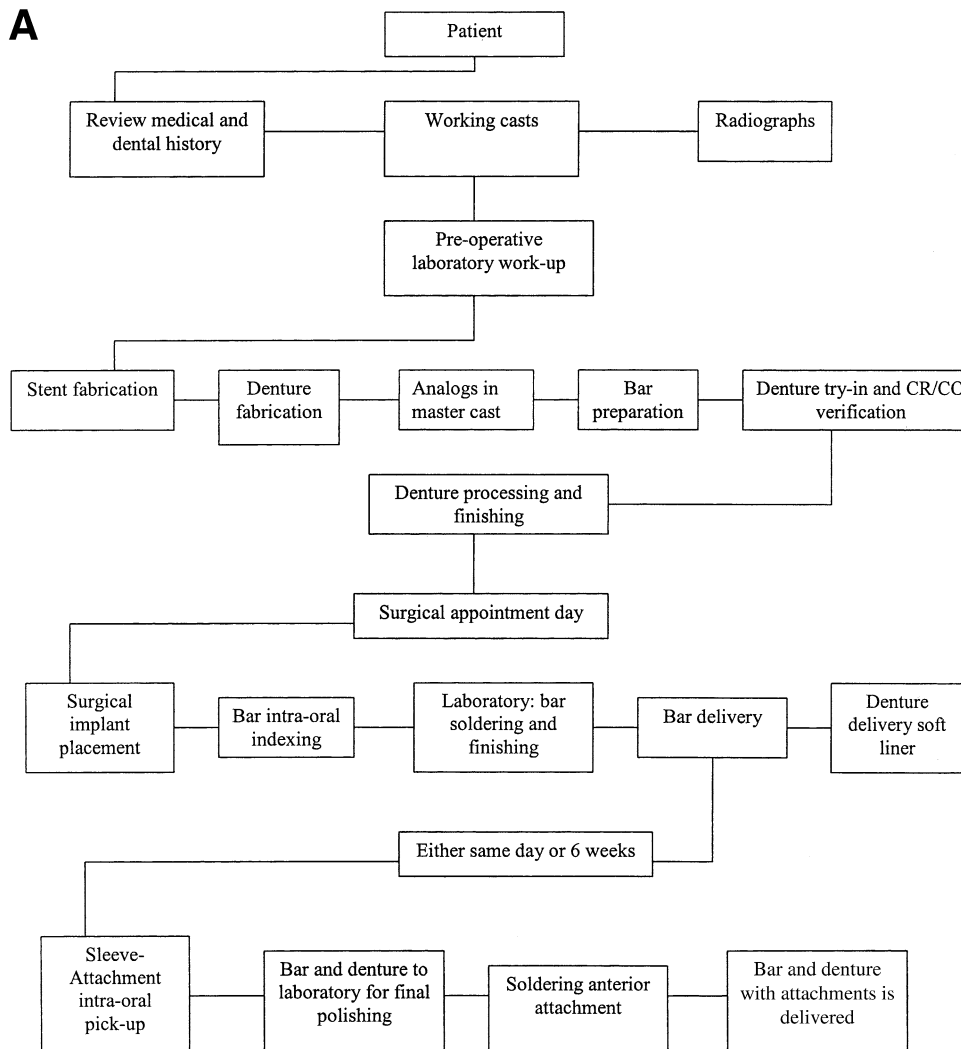


FIGURE 1. A, The chart presents the sequence of events for the restoration of the edentulous mandible with an immediate final prosthesis.

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When these 5 criteria are met in each patient, success should be expected if the remaining technical aspects of the implant procedures are properly performed.

Therefore, the clinician has the choice to deliver an immediate provisional prosthesis at the time of implant placement with the intention of fabricating the final restoration after the implants have integrated, or to deliver the final definitive prosthesis at the time of implant placement.

Using the above-mentioned criteria will help determine which treatment modality (traditional 2-stage method or 1-stage immediate loading) is optimal for each patient. For example, if there is inadequate interocclusal space to adequately place an interim hybrid-style prosthesis, a delayed approach may avoid vertical dimension problems involving a bar. In the situation of small interocclusal space, the clinician may use a fixed crown and bridge type temporary that requires less vertical dimension and avoids a bar, which requires more room for the bar, acrylic, and the teeth. If the 5 criteria mentioned above are met, the decision to

choose between an immediate final or an immediate provisional prosthesis is limited to questions of cost, preoperative time commitments, postoperative time commitments, laboratory support, and patient considerations.

The amount of preoperative clinical and laboratory work is different for the immediate final compared with the immediate provisional restoration. For the immediate final restoration the preoperative laboratory procedures require the assistance of a dental technician to fabricate the final prosthesis in various forms preoperatively and to finish the prosthesis in the immediate postoperative period. The necessary steps to fabricate this type of prosthesis have been previously described.¹⁹ When choosing the immediate provisional restoration, the patient's old prosthesis can be adapted and modified to be used as a hybrid prosthesis; thus less preoperative time is necessary.²⁰

Several techniques are available to achieve immediate delivery of a final prosthesis. Common to all of these techniques is the need to have excellent lab-

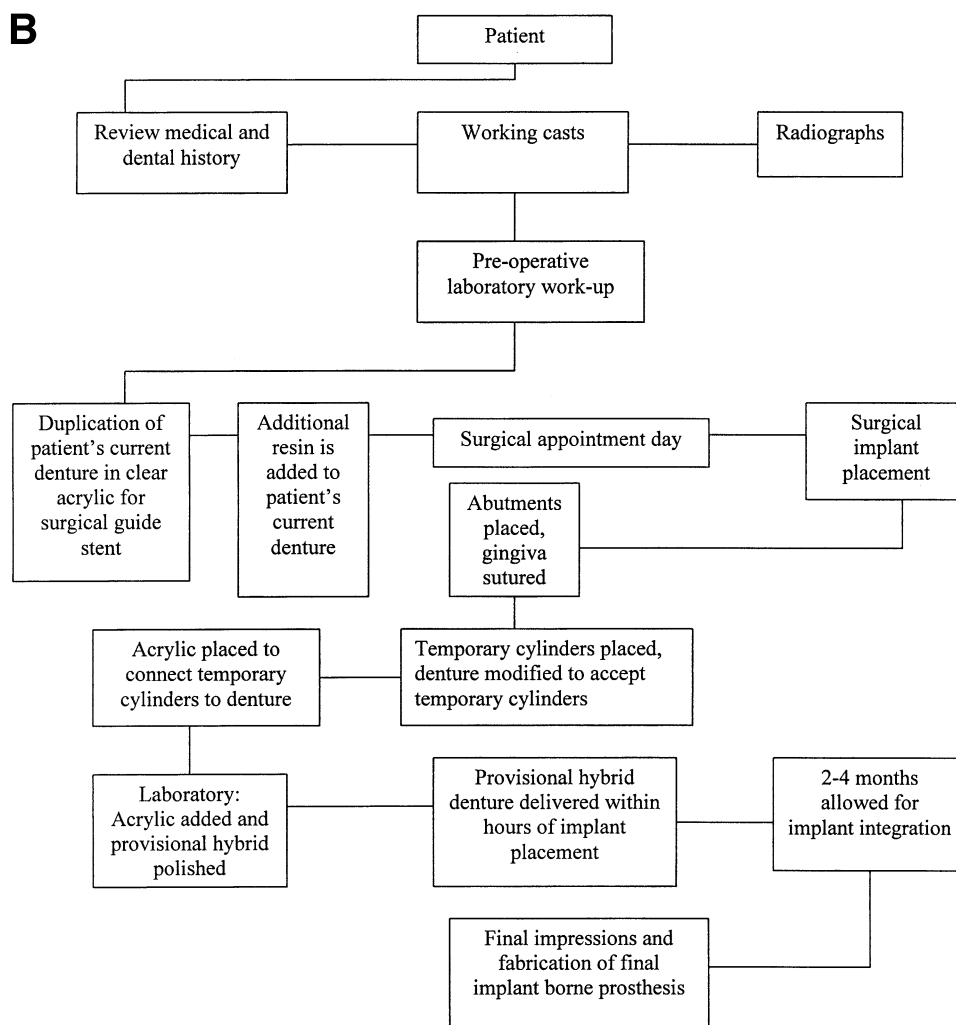


FIGURE 1 (cont'd). B, Events for delivery of immediate provisional prosthesis.

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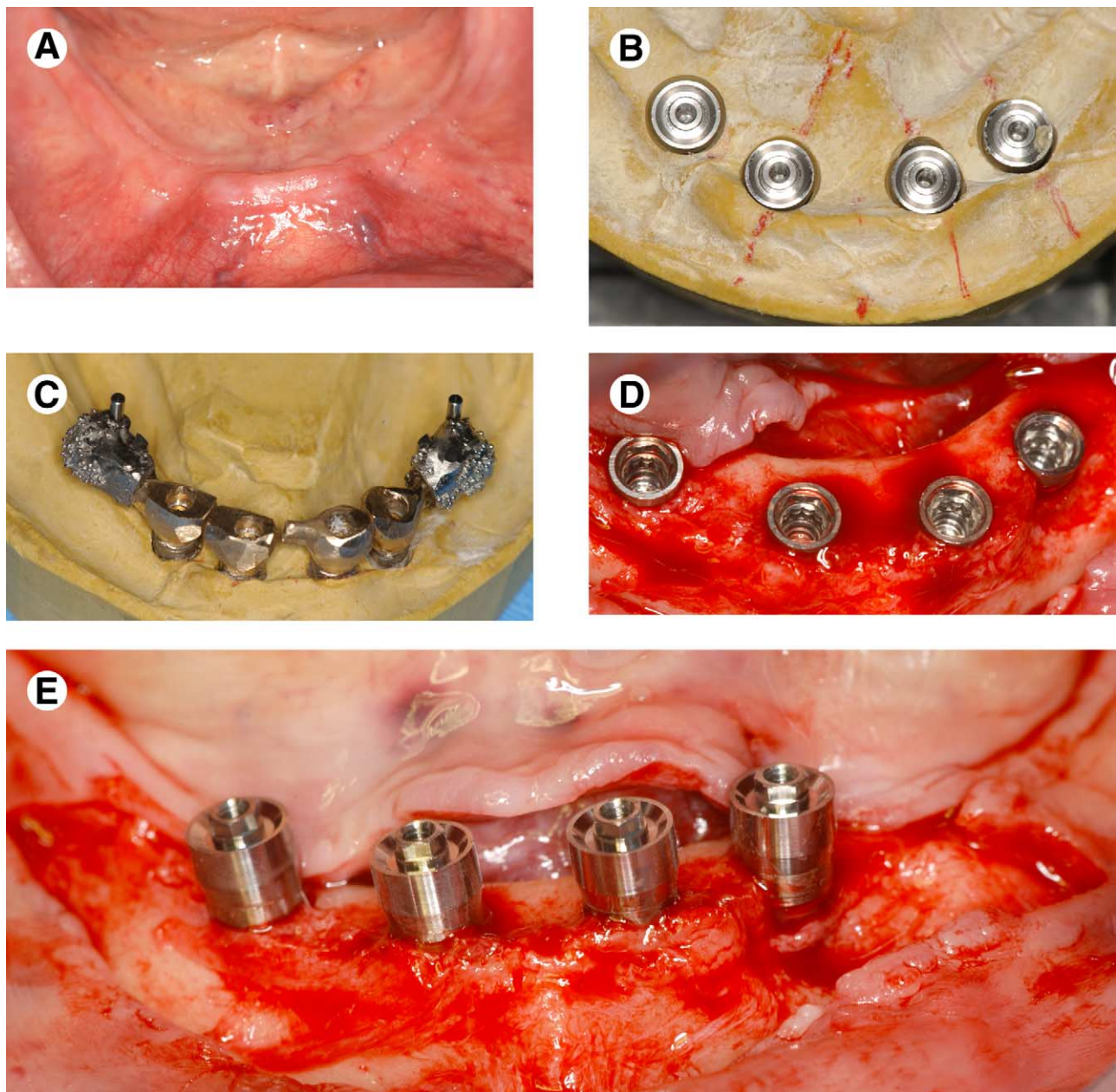


FIGURE 2. Case demonstrating delivery of immediate final prosthesis after implant placement. A, Edentulous mandible before placing implants. B, On the master cast, 4 implant-abutment analogs were placed, with the center implant 11 mm apart, and the distal implant 8 mm from the center implants. C, A segmented bar was fabricated in gold with the precision attachments ready to be picked up. The space between the segments is kept within 0.5 mm to allow for optimal strength after soldering. D, The implants were placed into the edentulous bone using a drill guide fabricated from the master case. E, The abutments are placed by the surgeon and torqued to 20 N-Cm to ensure that they do not loosen during the healing period.

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oratory support and preoperative fabrication of parts to facilitate indexing and completing the final prosthesis within 1 to 2 days after implant placement. One procedure¹⁹ uses master casts and lab fabrication of a segmented framework which is indexed and delivered the next day after a lab technician finishes the bar. Another method is de-

scribed by Tames et al.²⁰ After implant placement, a premade acrylic template is indexed, cast, and finalized within 36 hours to create the definitive hybrid prosthesis.

The Novum (Nobel Biocare, Yorba Linda, CA) procedure features a 1-day approach using precision fitting surgical and prosthetic templates to

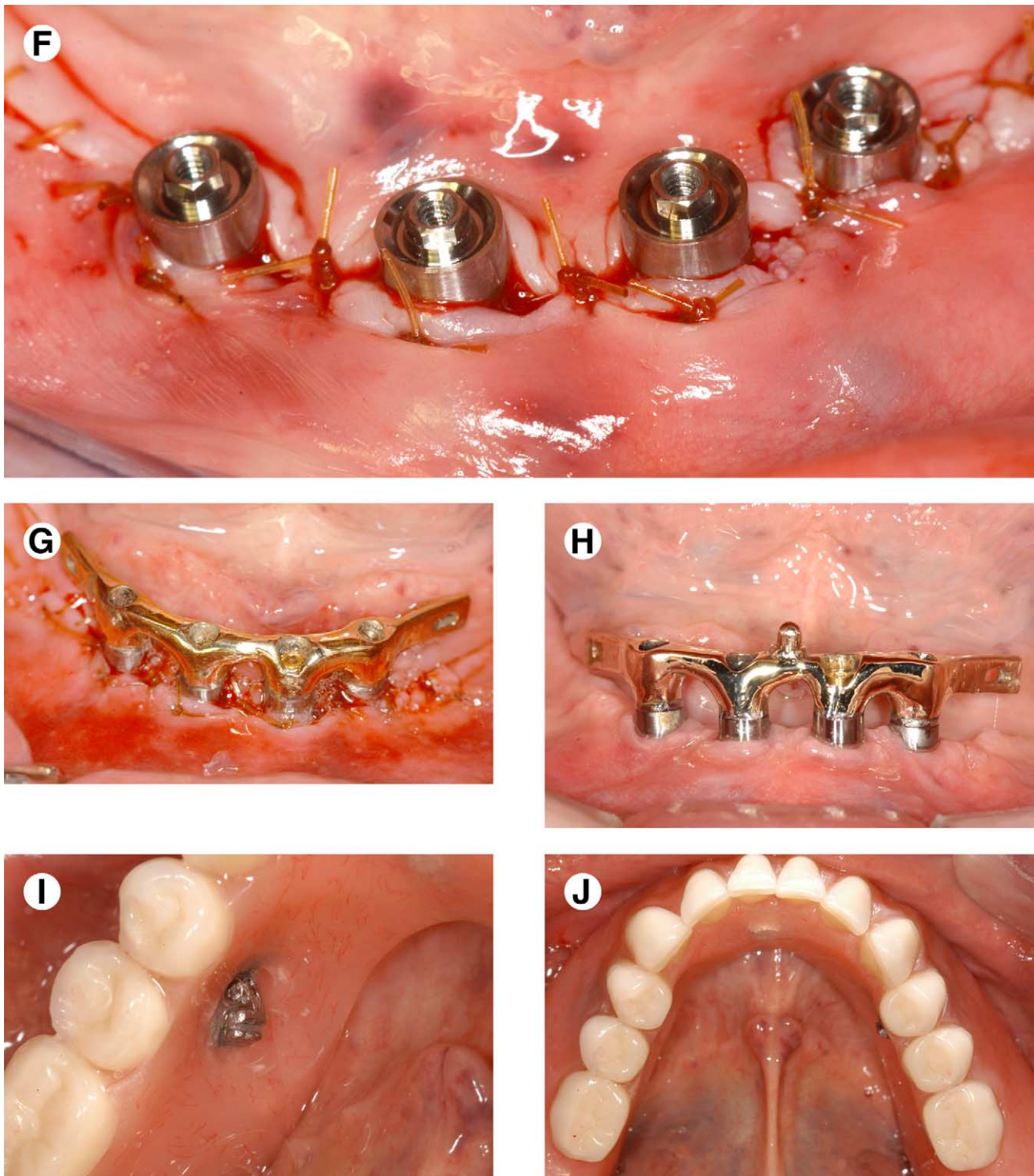


FIGURE 2 (cont'd). *F*, The gingiva is sutured around the abutments, leaving the abutments exposed for the dentist to index the segmented bar on the day of implant placement surgery. *G*, The segmented bar is placed and indexed with resin, then soldered in the laboratory and placed into the patient's mouth within 24 hours of implant placement. *H*, After occlusion is confirmed, the attachments are placed and an anterior o-ring type of retentive device is soldered or laser welded to the bar. *I*, A swing-lock type device is placed to secure the prosthesis to the precision-milled bar. *J*, After the swing-locks engage the distal aspect of the bar, the interface is smooth and the mandibular prosthesis functions as a fixed prosthesis.

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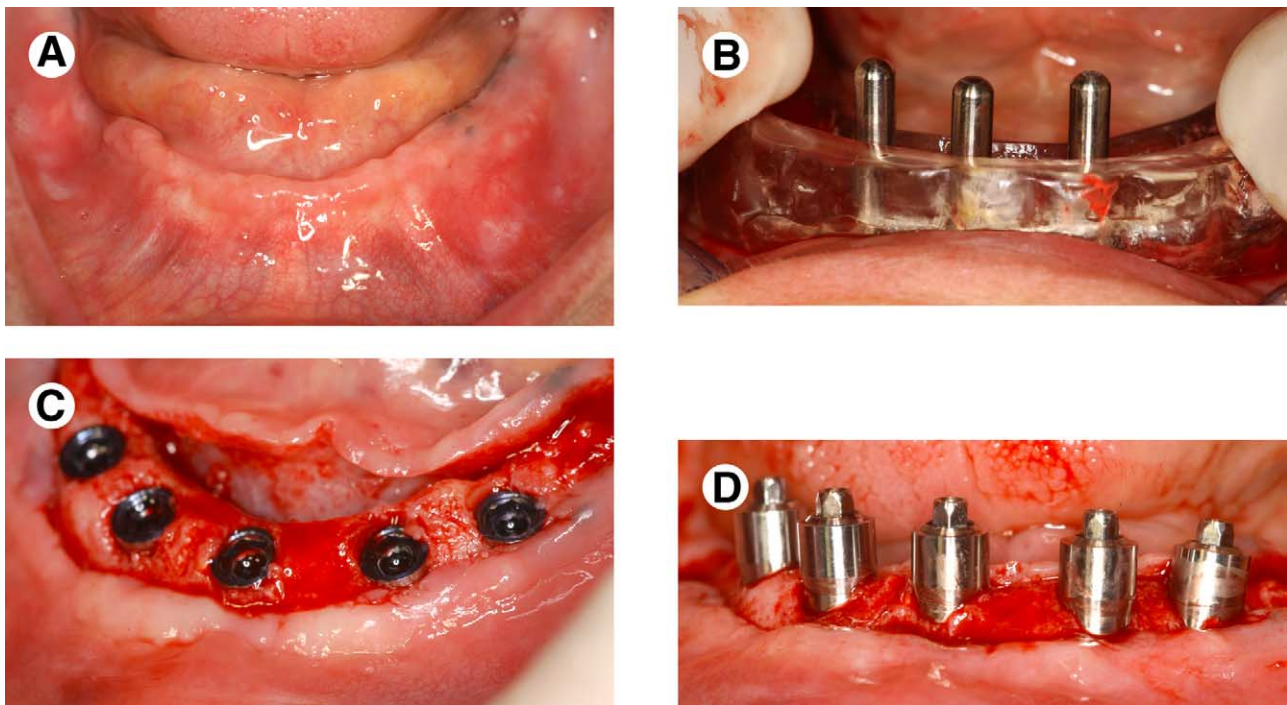


FIGURE 3. Case demonstrating delivery of immediate provisional prosthesis after implant placement. A, Edentulous patient before receiving implants. B, The implants were placed with their axis lingual to the planned dentition, enabling the screws to emerge posterior to the teeth and not labially. C, Five implants have been placed flush with the bone at similar heights around the anterior mandible. D, Four-mm tall abutments are placed and torqued to 20 N-Cm to ensure that they do not loosen during the healing period.

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deliver a hybrid prosthesis in 1 day.^{7,21,22} A newer technique creates the final definitive restoration form of generated models, with the generation of a surgical template for precision implant placement, and the preoperative fabrication of a hybrid prosthesis that is delivered within 1-hour of surgery.²³ Both techniques require adequate pre-prosthetic preparation and intensive laboratory and computer support to fabricate the final prosthesis within a day or minutes of the implant placement surgery.

Methods to Deliver Final Prostheses Immediately After Implant Placement

The following discussion will illustrate 1 technique (Fig 1A) to deliver a final prosthesis immediately after implants are placed into the edentulous mandible.

PREOPERATIVE LABORATORY PROCEDURES

The mandibular arch is evaluated for implant placement. From the denture set-up and the use of a mandibular master cast, the preoperative workup will result in a working model of the planned implant placement from which the surgical stent will be made and a segmented bar will be cast. A surgical stent is fabricated on the mandibular cast and the mandibular

denture duplicated in clear acrylic. The surgeon and restorative dentist will then place implant analogs in the cast using conventional surgical drills. Metal tubes are placed in the stent to provide the surgeon with an accurate prescription.

After the implant analogs are secured in the cast, a type-N gold bar will be constructed in 4 sections. The 2 distal extension segments consist of a 2° plastic premilled bar with a 1.5 mm hole drilled through the bar to receive a retentive attachment. The 2° plastic premilled bars should be placed over the crest of the mandibular ridge with no more than a 15 mm cantilever. The 2 middle sections have extensions towards the distal abutment to be luted together with pattern resin after the incisions are closed with sutures.

After the 4 segments have been cast, 2 metal sleeves that will house the retentive attachments are fabricated. The sleeves are used to provide support to the denture and help position the attachment at delivery. The sleeves are cast in nonprecious metal (patent pending). An anterior attachment is fitted to the anterior segment when the sleeves are completed to provide anterior stability.

After the bar and sleeves are completed the bar is blocked out to accept the final denture. Once the denture is processed and finished, the denture is

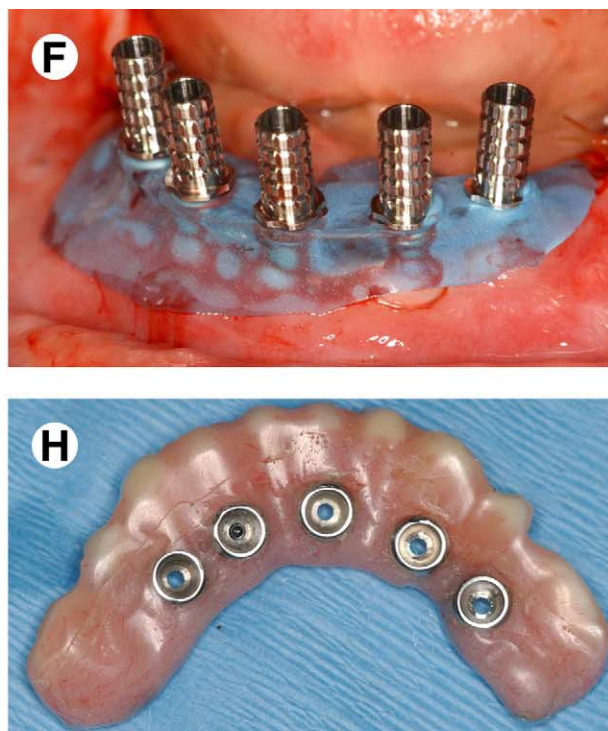
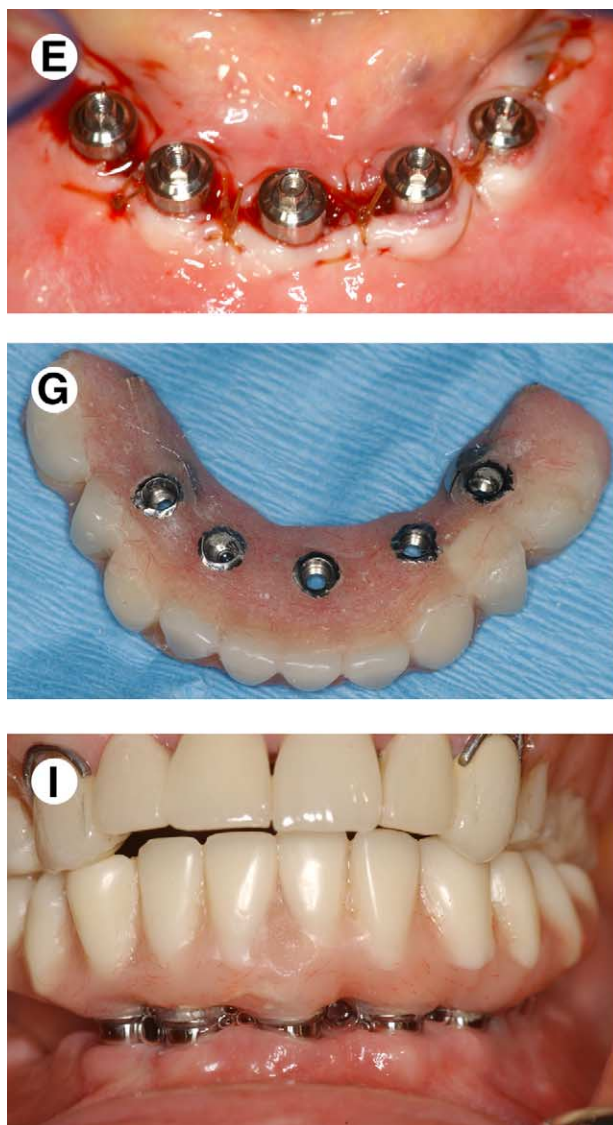


FIGURE 3 (cont'd). *E*, The gingiva is sutured to leave the abutments exposed for the dentist to attach the temporary cylinders to the modified denture. *F*, The restorative dentist places the temporary cylinders and a rubber dam to prevent resin from entering the surgical site. The denture is marked and hollowed, the tall cylinders are shortened, and acrylic is placed to lute the temporary cylinders to the denture. *G*, The acrylic is polished and smoothed and all flanges are removed to create a provisional hybrid-type prosthesis. *H*, The lingual aspect is polished smooth. *I*, The prosthesis is secured to the implants on the day of surgery with hand-tightened screws. The patient leaves with a fixed set of teeth in occlusion.

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seated back onto the original cast with the bar. At this point the preoperative workup is completed and the patient can have surgery performed.

The implants should be placed following established surgical procedures using the guide stent to assure proper placement. Each implant should be placed with at least 20 N-Cm torque for primary stability. The implants should be placed level in the bone to avoid significant vertical discrepancies. An appropriate abutment should be placed for each implant so that the interface will be 2 mm above the level of the gingiva. The most commonly used abutments have 3 or 4 mm gingival collar heights. The abutments are secured to the implants and torqued to 20 N-Cm. The incisions are then sutured to approximate the gingiva to the abutments, using resorbable sutures.

INDEXING THE BAR

Once implant placement is concluded, the sections of the bar are luted together with either light cured material or autopolymerizing resin. The bar is removed from the patient's mouth and the bar is taken to the laboratory for soldering.

Once the bar is finished and delivered, the denture is relined with soft liner in occlusion. As necessary, the inner aspect of the denture is adjusted.

Depending on the preference of the team, the final placement of the attachments into the prosthesis can be performed on the same day as implant placement, or after the resolution of the local anesthesia, or after soft tissue swelling has resolved. The attachments are fitted over the bar, and the denture is tried-in to verify the occlusion. The attachments are then picked up using autopolymerizing resin material. The occlusion

is verified. The denture is taken to the laboratory for a final polishing. The anterior stabilizing attachment is also placed (Fig 2). The completed bar and denture are delivered to the patient.

Methods to Deliver Provisional Fixed Prostheses Immediately After Implant Placement

The following illustrates a method to provide immediate provisionalization and loading after implants are placed into the edentulous mandible (Fig 1B).

PREOPERATIVE LABORATORY PROCEDURES

Once the treatment plan for an immediate hybrid provisional has been confirmed, the dentist should fabricate a surgical guide stent by duplicating the patient's existing denture in clear acrylic resin. An alternative is to fabricate the surgical guide stent in clear acrylic resin from the wax try-in or use a provisional denture. The stent should be prepared by drilling a slot lingual to the teeth to form a channel from first premolar to first premolar, indicating where 4 to 6 implants should be positioned to avoid screw emergence from the labial surfaces of the teeth. The screws securing the hybrid prosthesis should emerge lingual to the incisive edge of the teeth or within the fossas of the premolar teeth.

Before surgery, the denture to be used as the provisional prosthesis will need to be thickened by adding additional denture resin in the buccal-lingual dimension to avoid fracture when drilling the holes to secure the prosthesis to the implants. This will provide additional strength to the prosthesis. The provisional should be relieved internally; however, the distal bases and periphery should not be relieved to reproduce the correct occlusion.

The provisional denture should be tried-in before starting the surgery. If necessary, any remaining teeth should be cut down to the tissue level to facilitate try-in. Occlusion should be carefully verified. The implants should be placed following established surgical procedures using the guide stent to assure proper placement. Each implant should be placed with at least 20 N-Cm torque for primary stability. The implants should be placed level in the bone to avoid significant vertical discrepancies. An appropriate abutment should be placed for each implant so that the interface will be 2 mm above the level of the gingiva. The most commonly used abutments have 3 or 4 mm gingival collar heights. The abutments are secured to the implants and torqued to 20 N-Cm. The incisions are then sutured to approximate the gingiva to the abutments, using resorbable sutures.

After the incisions are closed, heavy body putty or another similar material is placed in the intaglio space

of the provisional denture to mark the implant sites. The patient is instructed to occlude and the dentist must confirm that the occlusion is identical to the verified position at the beginning of the procedure. After the putty sets, the provisional is removed. The marks in the putty will reveal the location of the abutments and where holes should be drilled in the denture.

Temporary cylinders are screw retained to the abutments and a rubber dam with holes at the implant locations is placed over the abutments. On the most distal abutments, a distal extension support may be used to support a 15 mm cantilever. The extension should be luted to the distal temporary cylinder with resin. The denture is tried-in over the cylinders to confirm that there is no interference with the cylinders and the denture is fully seated. If necessary, further adjustment of the denture is preformed. The denture should be positively tissue supported with reproducible occlusion preoperatively. The temporary cylinders need to be reduced below the plane of occlusion of the denture.

The access holes for the temporary cylinders are filled with a removable material such as cotton to prevent acrylic resin from entering the retaining screws. Autopolymerizing acrylic resin is mixed, placed into a syringe, and injected to connect the temporary cylinders to the relieved denture. Occlusion is verified by having the patient close into the established vertical using the bite registration to verify that the denture is in the correct position. Centric occlusion is maintained while the acrylic resin is setting.

After the denture resin has set, the prosthesis with temporary cylinders is removed. In the laboratory, the dentist finishes the denture by adding acrylic resin to any areas with voids. Using an acrylic bur, the acrylic resin on ridge contact areas, all excess acrylic from the bottom of the denture between the cylinders, and the posterior cantilever beyond the first molars are removed. All surfaces are polished smooth.

The restoration is placed into the mouth to verify appropriate occlusion and tissue clearance. The retaining screws are hand-tightened to 20 N-Cm, and the screw access holes are sealed with resin and polished. Final impressions are made after the clinicians feel that integration of the implants is complete (Fig 3).

Discussion

Based on the literature review in [Table 1](#), it is now established that immediate loading of the edentulous mandible with an implant-borne prosthesis is not experimental. Therefore, there are limited reasons to

avoid immediate loading of edentulous patients who are planned for an implant-borne and implant-supported prosthesis. The limited reasons for not performing an immediate loading protocol include the lack of patient finances to pay for the provisional materials, limited vertical dimension preventing prosthesis fabrication, lack of patient or doctor availability to do the preoperative workup, lack of laboratory support, and inexperience of the operators.

Patient benefits from using the immediate loading protocol include reduced time from edentulism to function, avoiding the uncomfortable period of time with mobile removable dentures after implant placement when using a 2-stage protocol, improved self esteem, and improved nutrition from re-establishment of a normal diet soon after implant placement surgery.

Problems have been encountered using immediate loaded protocols. Most of the problems are the result of the learning curve in performing the procedures or less than optimal pretreatment planning and preparation.

Laboratory support may be excellent or may also include a learning curve. The laboratory technician must know how to solder or laser weld without strength concerns, and must also be able to fabricate a bar that has the correct taper and form.

Problems can occur if implants are not placed accurately. A duplicate of the patient's old or trial denture must be made to construct the surgical guide. Without this, the technique cannot be used because there will be no communication between the restorative dentist and the surgeon, and implants may be placed too labial in position, compromising the final result.

When cementing the analogs into the prepared holes in the cast, the top of the analog must be placed at least 2 mm above the crest of the stone. The top of the analog represents the top of the abutment in the mouth. By standardizing the position of the analogs, the surgeon can accurately finalize the position of the implant. Abutments with the correct gingival heights can then be chosen. This will allow for accurate placement of the cast bar. If the implants and abutments are placed too deep within the model, there will not be enough clearance for the bar above the gingiva. In addition, if the abutments chosen are too tall, they may interfere with the vertical space and result in thin prostheses which are prone to fracture.

Waxing of the bar must be performed to be made parallel to the existing cast of the ridge. For a bar-supported final prosthesis, the bar is made in a segmented manner. The bar is waxed and cast in 4 pieces. The spaces between the pieces should be small to ensure ease of soldering or welding unless the solder relationship is made. If the implants are placed too far apart from the planned position, the space between the segmented bar may be large and

thus result in strength deficiency after the space has been filled with solder.

When picking up the clip in the mouth, adequate blockout beneath the bar must be made to avoid resin being trapped beneath the bar. This will make removal of the denture difficult.

When following a provisional hybrid prosthesis protocol, either an old or newly constructed denture must be available. When drilling holes in the denture to accommodate the copings, breakage of the denture can occur. The denture must have adequate bulk to accommodate the copings, which will carry the prosthesis on the implants. When attaching the copings to the denture, resin must be used to fuse the copings to the prosthesis. The screw holes should be protected and only minimal amounts of resin should be used.

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