Functional Restoration of Implants on the Day of Surgical Placement in the Fully Edentulous Mandible: A Case Series

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ABSTRACT

Purpose: The purpose of this article is to report the clinical experience and outcome of a study of the functional rehabilitation of 16 completely edentulous mandibles with immediately loaded cross-arch screw-retained hybrid prostheses at the University of Southern California.

Materials and Methods: After signing informed consent forms 16 patients (9 male, 7 female) aged 47 to 84 years (mean age, 62.6 ± 11.6 years) received 90 Brånemark System® Mk III dental implants (Nobel Biocare USA, Yorba Linda, CA, USA). Stability and radiographs of the dental implants were evaluated at the time of surgery, at 3 months, at 1 year, and at 3 years post loading.

Results: Three implants failed to meet the criteria of success, bringing the cumulative success rate to 96.6%, with a 100% prosthetic success rate at 3 years. Thirty-nine (43.3%) of the dental implants placed were 15 mm in length. Seventy-seven (85.5%) of the dental implants were placed in high-density bone. At 3 years post loading, the average bone loss was −1.2 ± 0.1 mm.

Conclusion: Within the limitations of this study, restoration of implants by unreinforced hybrid prostheses at the time of placement provided satisfactory results. The outcome was stable at 3 years post restoration. Mandibular rehabilitation by functional loading of the implants on the day of the insertion requires the comprehension and proper application of surgical and restorative principles.

KEY WORDS: dental implant, immediate loading, osseointegration

The surgical insertion of dental implants is associated with microfractures in the surrounding bone. Microfractures heal following a cascade of events including neoangiogenesis, migration of osteoprogenitor cells, formation of the woven bone, lamellar bone deposition, and remodeling.[1–3] At the very early stage of wound healing, high sensitivity of the migrating osteoprogenitor cells to mechanical stimuli can lead to cellular disorientation.[4] Micromovements exceeding 100 to 150 μm at the bone-implant interface may result in fibrous encapsulation of the implant and failure.[5–7] In the fully edentulous mandible, primary stability of the properly distributed dental implants, passive fit of the implant-supported temporary prosthesis, and cross-arch stabilization may overcome the challenge of micromotion upon occlusal load.[8–14] While the two-stage protocol of implant dentistry provides satisfactory short- and long-term outcomes,[15–21] fully edentulous mandibles present challenges.

Wearing no prosthesis for a minimum of 2 weeks after implant placement, discomfort of the removable temporary prosthesis thereafter, and numerous visits for relining or repair of the removable prosthesis have significant psychological and social impacts during

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the transition from a removable to a fixed type of prosthesis.[22,23] Additional surgery is required as well to expose the fixtures.

The purpose of this study was to determine the 3-year clinical outcome of a functional screw-retained hybrid prosthesis inserted on the day of implant placement.

MATERIALS AND METHODS

Patient Selection

After granting informed consent, 16 patients were treatment-planned for implant-supported cross-arch screw-retained hybrid prostheses to be inserted on the day of implant placement. The procedures were performed at the School of Dentistry, Advanced Periodontics and Prosthodontics Programs, the University of Southern California.

The criteria for inclusion were as follows:

- Completely edentulous mandible
- Restoration by full cross-arch screw-retained hybrid type of prosthesis
- Placement of four or more dental implants
- Sufficient length (ie, implants $\geq$ 10 mm)
- Primary stability of 40 Ncm

Exclusion criteria were:

- Active infection, inflammation or systemic medical conditions compromising healing (severe bruxism and parafunctional habits)
- Intolerance to the duration of the treatment (surgical and prosthetic time)

Surgical Procedures

Surgical sites were evaluated by computerized tomography and periapical radiography. Preoperative prophylactic antibiotic therapy consisted of amoxicillin 2 g or clindamycin 600 mg 1 hour before surgery and rinsing with 0.12% chlorhexidine gluconate for 1 minute. Postsurgical medication consisted of ibuprofen 400 mg 4 times a day for 2 days.

A crestal incision extending from molar to molar area was performed, and a full-thickness flap was elevated to expose mandibular basal bone. Mental foramina were located after a midline vertical release was incised. A minimum of 17 mm of prosthetic clearance from the anticipated implant platform to the opposing occlusion was provided by horizontal ostectomy if needed.[24] Commercially pure titanium root-form fixtures (Brånemark System® Mk III, Nobel Biocare USA, Yorba Linda, CA, USA) were placed as close as 1 mm to the anterior loop of mental foramina,[25] and additional implants were then optimally distributed in between them. No countersinking was performed, and the platforms of the implants were placed 1 mm supracrestally. Due to the high bone density, a screw tap was used in all of the osteotomy sites prior to implant placement. Tapping of the osteotomy sites has primarily two advantages: it facilitates the introduction of the dental implant in cortical bone and reduces excessive pressure that may result in necrosis of the surrounding bone.

A primary stability of $\geq$ 40 Ncm (as measured by the electronic torque drive of the surgical motor) was achieved for all loaded implants. Multiunit prosthetic abutments (Nobel Biocare USA) 4 mm in height were placed, and surgical flaps were sutured around them.

Prosthetic Procedure

The protocol proposed by Chee and Jivraj[22] was followed. Cross-arch screw-retained hybrid acrylic prostheses were delivered within 5 hours after the surgical procedure. Direct and indirect techniques were used to fabricate the provisional prostheses. The direct technique (Figure 1) consisted of intraoral pickup of the temporary cylinders (Nobel Biocare USA) by the transitional denture. The indirect technique (Figure 2) consisted of impression at the abutment level and confection of the temporary denture in the laboratory. No metal wire or caste bar was used to reinforce the hybrid prostheses. No distal extensions were included in the prostheses. The complete sitting and the passive fit of the prostheses were clinically controlled and were reevaluated by periapical radiography. Balanced occlusion upon functional movement was established. No specific postoperative instructions (eg, change of diet, night guard) were given to the patients.

Clinical Recording

Measurements were recorded on a standardized form by two calibrated examiners (> 90% reproducibility). Implants were radiographically evaluated through periapical radiography at the surgical phase, at the final restorative phase (3 months), and at 1 and 3 years post restoration. At each of these visits prostheses were

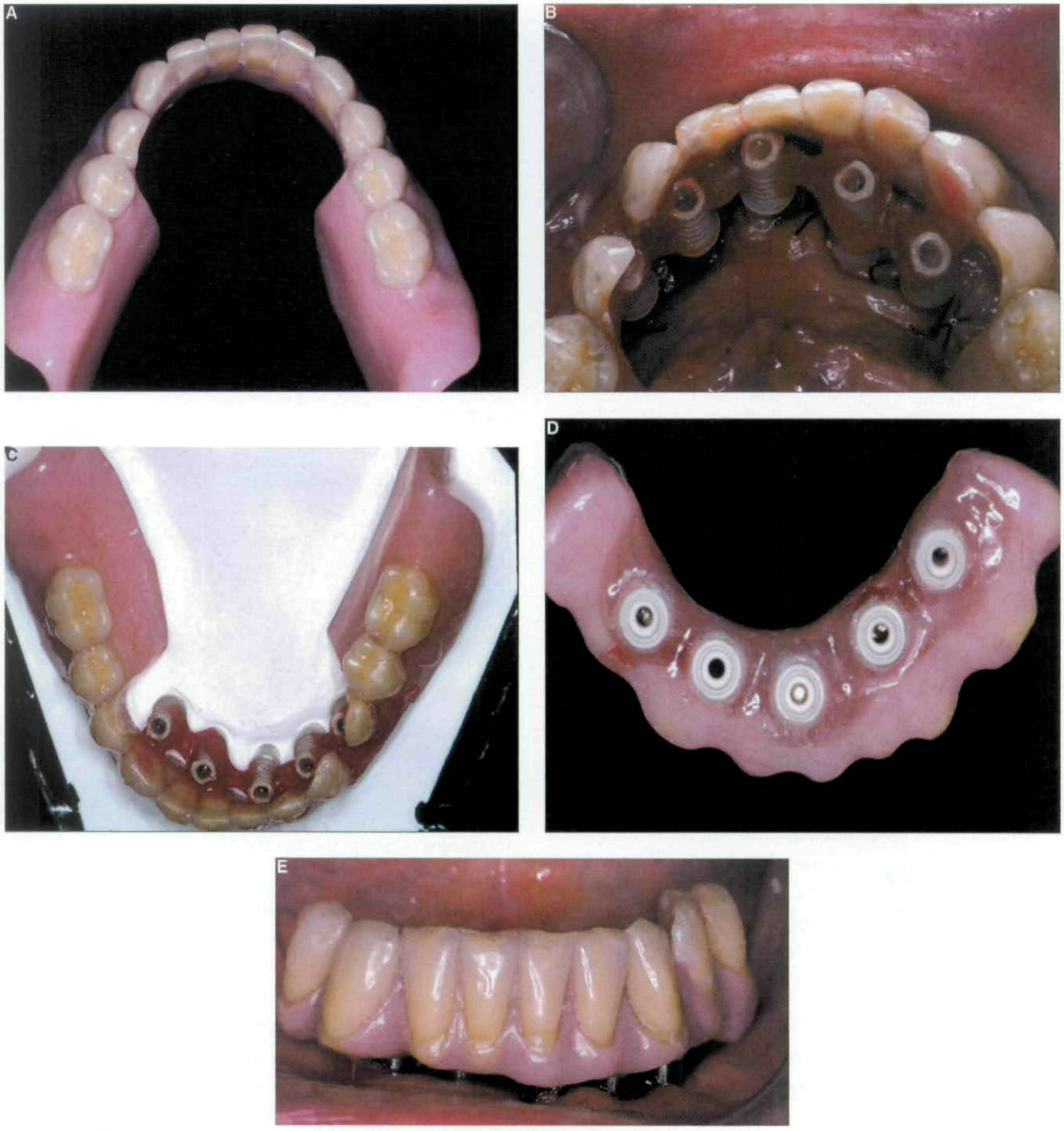

Figure 1 *A,* Temporary prosthesis, hollowed out to accommodate pickup impression; note that the posterior flanges are kept for stabilization. *B,* Temporary cylinders, splinted and picked up with acrylic material. *C,* Laboratory analogues have been placed, and the impression has been poured up; the prosthesis is ready for packing and finishing. *D,* The temporary prosthesis is highly polished and decontaminated prior to delivery. *E,* The temporary hybrid prosthesis, delivered on the day of surgery.

removed to test for implant mobility (with the handles of two dental mirrors). The criteria of success were the patient's comfort and satisfaction, absence of pain, and absence of inflammation and pathologic peri-implant radiolucencies.[26] To evaluate bone loss around the implants, measurements were taken from the prosthetic interface to the bone loss located at the implant threads.

RESULTS

Three implants failed prior to the final restoration; no more implant failures occurred during the remainder

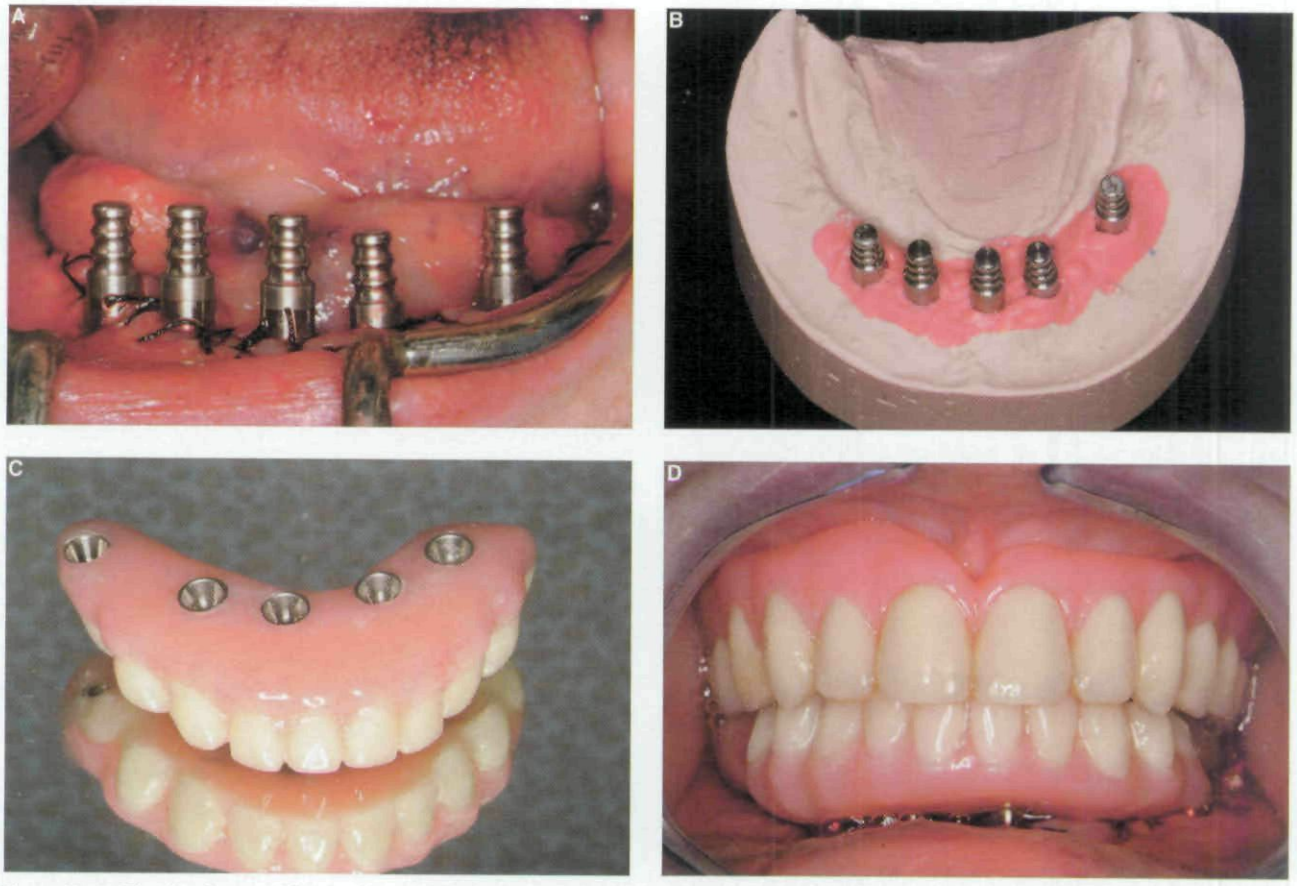

Figure 2 *A,* Five implants with intraforaminal placement; Brånemark System Multiunit® abutments (Nobel Biocare USA) and impression copings are placed, and soft tissue is secured prior to any prosthetic manipulation. *B,* Master and soft tissue cast. *C,* Finished highly polished and decontaminated screw-retained unreinforced acrylic temporary hybrid prosthesis. *D,* Temporary hybrid upon delivery.

of the study. After 3 years, the cumulative success rate of the dental implants was 96.6% (Table 1). Despite the failure of three fixtures, the success rate of the final restorative phase (using Kaplan-Meyer survival tables) was 100%. Table 1 describes the cumulative success rate.

Demographics

The patients (9 male, 7 female), aged from 47 to 84 years (mean age, 62.6 ± 11.6 years), received 90 dental implants.

TABLE 1 Life Table Analysis

Time Period (mo)	Functioning Implants	Failed Implants	Withdrawn Implants	CSR (%)
0–3	90	0	0	100
3–12	87	3	0	96.6
12–36	87	0	0	96.6

CSR = cumulative success rate.

Patients who smoked more than 10 cigarettes per day were considered smokers in this study. Five patients (31.2%) were smokers (a mean of 15 cigarettes per day).

Location and Length of Implants

The preferred location of the dental implants was the infra-foraminal area, but to accommodate a proper anteroposterior distribution, 10 fixtures were placed distal to the mental foramina.

An attempt was made to achieve bicortical stabilization by placing the longer implant in consideration of the anatomic landmarks. Of the total implants used in this study, 43.3% (39 of 90) were 15 mm in length. All 10 implants placed distal to the mental foramina were 10 mm in length (Figure 3).

Bone Density

For the purpose of this study, the Lekholm and Zarb classification of bone density was modified and

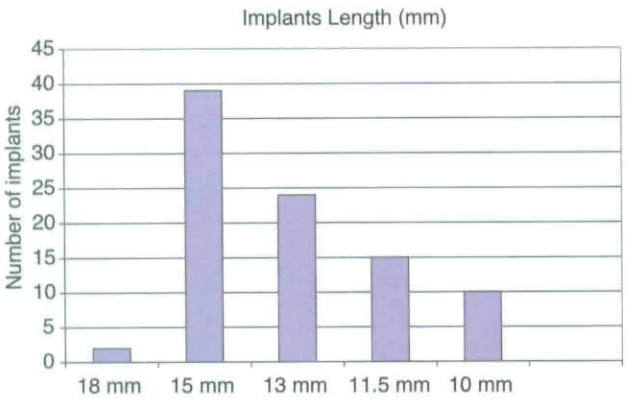

Figure 3 Distribution of implants used in the study, by length. Note that the 15 mm was utilized in 43.3% of the total implants placed.

simplified[27]: bone of types 1 and 2 were classified as high-density bone, and bone of types 3 and 4 as low-density bone.

Of all implants, 85.5% (77 of 90) were placed into high-density bone. A primary stability of 40 Ncm was measured for all 90 implants.

Bone Level

Radiographic assessment of marginal periimplant bone loss was done with periapical radiography. Measurements were taken from the mesial and distal aspects of the restorative interface to the bone crest at the surgical phase, at the final restorative phase, and at 1 and 3 years post restoration. Marginal bone changes were recorded by two examiners using a loupe of $\times 7$ magnification, and an average was calculated. At 3 years after loading, the average bone loss was -1.2 ± 0.1 mm (Table 2).

DISCUSSION

The present study evaluated the 3-year clinical outcome of 16 mandibles immediately restored with a cross-arch screw-retained temporary hybrid-type prosthesis. A success rate of > 96% was measured in the study. Primary stability of the dental implants, passive fit of the restorations, and cross-arch stabilization may overcome the challenge of micromotion upon occlusal load.[28–31]

Becker and colleagues[32] evaluated 92 machined-surfaced dental implants in 20 patients and reported a survival rate of 96.3%; the reported prosthetic survival rate was 100%. The authors attributed the high success rate to proper treatment planning and adequate surgical and prosthetic execution. In the present study unreinforced screw-retained prostheses were delivered within 5 hours after surgical procedure. Unreinforced temporary prostheses do not require a laboratory fee for casting and are consequently more affordable. Also the risk of wound disturbance induced upon late delivery of the prosthesis at a very significant time of the healing cascade is reduced. However, the success rate is still the same when a delay of 48 hours to 1 week is applied for laboratory confection of the temporary prosthesis.[21,23,33] Wolfinger and colleagues[34] compared two groups in a prospective study: (1) a developmental group consisting of 10 patients (130 Brånemark implants) who received acrylic prostheses on the same day of surgery and the final prostheses 6 weeks later and (2) a test group (simplified protocol) consisting of 24 patients (144 Brånemark implants) who received acrylic prostheses that remained in place for 3 months before removal. Despite a survival rate of 100% for the prosthesis, the survival rate for the developmental group was 80%, compared to 97% for the simplified-protocol group.

The screw-retained mode of retention was used to provide a less traumatic removal of the prosthesis if removal was needed although Ganeles and colleagues[35] reported no difference among 161 implants (in 27 patients) with different prosthesis designs (laboratory processed or processed in office, cemented or screw retained).

Smoking did not seem to affect the success rate in the present study. Bain and Moy[36] reported a failure rate of 11.3% for smokers as compared to 4.8% for nonsmokers. De Bruyn and Callaert[37] evaluated machined-surfaced dental implants in the mandibles of smoking and nonsmoking patients and reported only 1 failure in 208 fixtures placed. Some authors reported a higher failure rate for implants in the maxilla.[38] Of 10 failures in a total of 244 implants, 7 failed in smokers. The impact and significance of smoking need further investigation.

TABLE 2 Mean Crestal Bone Loss

Time Period (mo)	Mean (mm)	SD (mm)
0–3	1.1	0.2
3–12	1.3	0.0
12–36	1.4	0.1

SD = standard deviation.

CONCLUSION

Within the limitations of this study, restoration of implants by unreinforced hybrid prostheses at the time of placement provided satisfactory results. The outcome was stability at 3 years post restoration. Mandibular rehabilitation by functional loading of the implants on the day of insertion requires the comprehension and proper application of surgical and restorative principles.

ACKNOWLEDGMENTS

We would like to thank the Advanced Periodontics and Prosthodontics Department and, in particular, Dr. Eva Berroeta and Dr. Mamaly Reshad for echonographic contributions to this article.

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