

Retrospective Study of Tapered One-Piece Implants Placed Over a Ten-Year Period in a Single Private Practice

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Today, clinicians have a variety of treatment modalities available to address the increasing number of implant procedures performed each year. Single-stage implant surgery is now commonly used in implant dentistry. With patients' demands for immediate restoration, the utilization of 1-piece implants is gaining acceptance. This article reports the results of tapered 1-piece implants (Zimmer Biomet) placed in a single practice over a 10-year period. A total of 33 1-piece dental implants were placed in 24 patients and provisionally restored out of occlusion at the time of surgery. All 33 implants were definitively restored with ceramometal crowns after 3 months of provisionalization. Implant survival and success rates were 100% after 2.6–10 years of follow-up. Only 1 minor complication of crestal bone remodeling occurred among the 33 implants placed. Adequately stabilized tapered 1-piece implants can be successfully restored out of occlusion at the time of implant placement and definitively loaded in occlusion 3 months without adversely affecting function or esthetics. Additional long-term controlled studies are recommended to further understand these findings.

Key Words: 1-piece dental implants, 1-piece tapered screw vent implants, implant placement, immediate restoration, success rates and dental implants

INTRODUCTION

The concept of a 1-piece dental implant is not new. Lambotte¹ developed a surgical steel 1-piece dental implant in the early 1900s. In 1947, Formaggini² further refined this implant modality as one of the first screw-type root-form dental implants for tooth replacement. Linkow³ is often credited for the growth in popularity of the plate-form or "blade" 1-piece implants quite popular in the 1960s through the 1970s, later developing a 1-piece root-form implant.

Over several decades, the replacement of missing teeth with implant-supported prostheses has become a widely accepted modality for rehabilitation of fully and partially edentulous patients. In the 1980s, Brånemark⁴ introduced a 2-stage, titanium, root-form implant designed to be placed under soft tissue for several months prior to restoration. It has since been demonstrated that 2-stage implant procedures with a submerged healing period is often not required for implants with adequate primary stability. Single-stage placement with immediate provisionalization or definitive restoration have been reported to achieve outcomes comparable to implants in a 2-stage delayed loading protocol.^{5–7}

Single-stage dental implants offer several advantages from a biologic, clinical, and biomechanical point of view. Numerous scientific investigations support the concept of immediate or early function as a modern therapeutic option.⁷ However, careful case selection, proper treatment plan, meticulous

surgery, and proper prosthesis design are essential for optimal outcomes.⁸

Data from 1 randomized study in the edentulous maxilla showed no differences between early and delayed loading in consecutive clinical cases, including short implants and soft bone.⁹ Additional studies comparing different surfaces and implant designs under immediate loading were reviewed.⁹ No differences were observed between implants with a moderately rough or smooth surface topography.⁹ This data adds to the previous bulk of evidence that various designs of implants can be loaded shortly after their placement in both the mandible and the maxilla.

One-piece implant designs

Technological advances over past decade have expanded the clinical use of 1-piece dental implants. One-piece implants in various diameters have been introduced by several manufacturers. More recently, the interest in zirconium dental implants has led to increased utilization of the 1-piece design, which features the abutment and implant sections manufactured as a solid unit. Modern 1-piece implants differ from contemporary 2-piece implants by eliminating the fixation screw and connections between the abutment and implant. One-piece dental implants are designed for a single-stage surgery and are best applicable for single tooth replacement, although they can be used as part of a multiple-unit restoration.

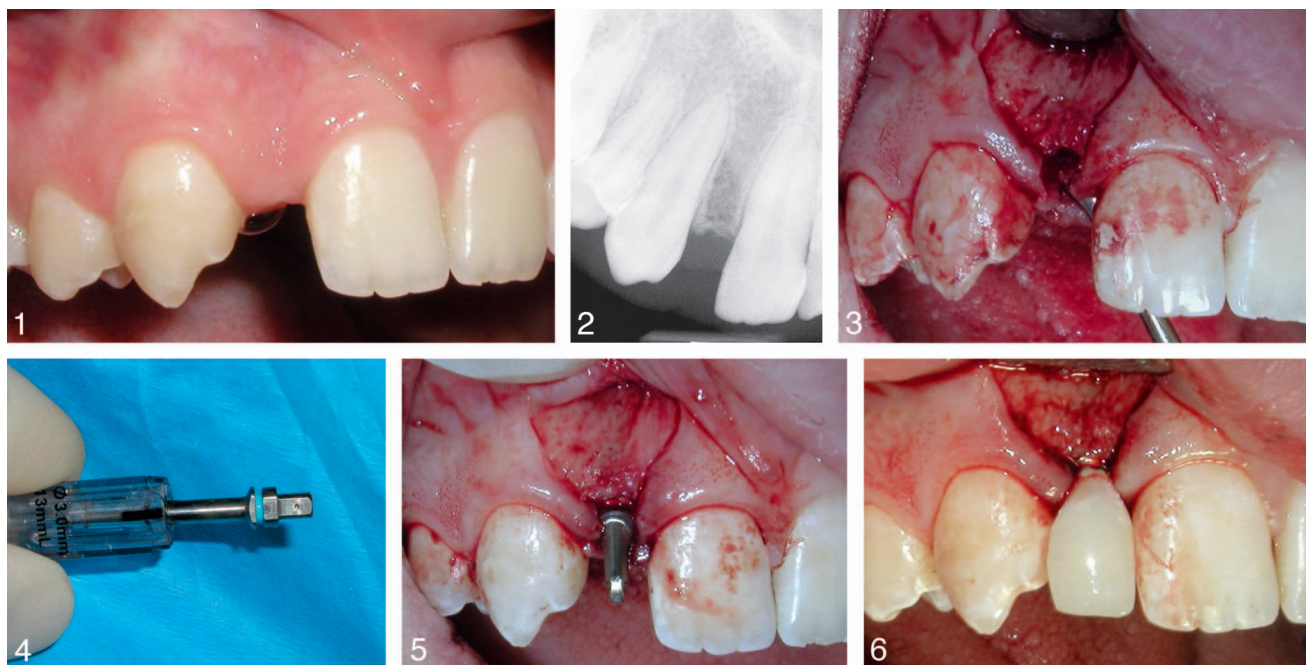
One-piece dental implants offer several advantages over 2-piece implants. With the increased need for temporary restoration and immediate implants, 1-piece implants allow for the delivery of faster esthetic restorations. Since there are no abutment connections to the implant, prosthetic screw

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FIGURES 1–6. **FIGURE 1.** Preoperative view of one of the subjects. Edentulous space area of maxillary right lateral incisor. **FIGURE 2.** Periapical radiograph showing minimal interradicular space allowing for a 3-mm diameter 1-piece tapered implant. **FIGURE 3.** Full thickness mucoperiosteal flap was raised to allow for access to implant osteotomy site. **FIGURE 4.** One-piece implant on delivery holder marker indicating facial margin of the abutment. **FIGURE 5.** Tapered 1-piece implant placed with lower facial margin of the abutment placed 1 mm above the crestal bone. **FIGURE 6.** Plastic sleeve contoured to a provisional placed on the implant abutment to allow for precise marginal fit.

loosening is eliminated. The solid connection between the implant and the abutment also eliminates micromovements of the abutment portion of the implant, which may be one of the contributing factors in crestal bone remodeling. The solid construction of the 1-piece dental implant also eliminates microleakage into the implant, a suspected contributor to peri-implantitis. Implants placed in a single procedure provide the patient with fewer surgeries, lower morbidity, shorter treatment time, and faster functionality than do conventional 2-piece implants. The purpose of this study was to retrospectively evaluate the efficacy and survival rate of a 1-piece tapered implant design placed in a single private practice.

MATERIALS AND METHODS

A retrospective figure review was undertaken to identify all patients consecutively treated with tapered 1-piece implants in a single private practice. After patient health histories were carefully reviewed, each patient underwent a complete hard and soft tissue exam, oral examination, and periodontal evaluation as indicated by probing. The surgical area was evaluated carefully for tissue type, occlusion, health of adjacent teeth, bone quality, and bone volume (Figure 1). Diagnostic study models, radiographic analysis, and photographs were obtained preoperatively as required (Figure 2). Patients were treated only if judged to have no contraindication for minor oral surgery with local anesthesia or conscious sedation. Each patient provided signed informed consent prior to surgery. For these reasons, the only inclusion criterion for the present retrospective analysis was prior treatment with the designated

implants. Both smokers and nonsmokers were included in this study, and no treated patients were excluded from the analysis. Implants were classified as survivors if they failed to exhibit pain, clinical mobility, peri-implant pocket depths greater than 5 mm, or peri-implant radiolucency requiring removal. Implants considered successful were surviving implants that fulfilled their intended original prosthodontic functions and were deemed esthetically pleasing to the both the patient and the clinician.

Patients were administered preoperative surgical antibiotic prophylaxis (amoxicillin 2 g orally [by PO] 1 hour preop or clindamycin 600 mg by PO 1 hour preop followed by 3 times per day for 1 week postoperative). Patients were prepared for implant surgery with anesthesia (with or without conscious sedation) induced by administering 0.5% bupivacaine with 1:200 000 epinephrine or 2% lidocaine with epinephrine 1:100 000 (Cook-Waite, Abbott Labs, North Chicago, Ill) via local infiltration, greater palatine nerve block, or mandibular inferior alveolar nerve block. A full thickness mucoperiosteal flap was elevated with an incision over the lingual portion of the crest of the ridge with vertical buccal releasing incisions, where indicated (Figure 3). In some cases, only a flapless approach or vestibular incision was utilized during immediate implant placement at the time of tooth extraction.

Implant osteotomies were performed following the protocol recommended by the manufacturer. After a pilot drill was used for centering, a 2.1- to 1.6-mm drill was utilized to initiate the osteotomy at a depth of 6–8 mm. After verification positioning with a surgical try in abutment, the drilling sequence was continued. Drilling continued to depth with

radiographic verification of drilling position. Next, a 2.3-mm drill was used to widen and extend the osteotomy to the desired depth. Both internal and copious external irrigation were used to cool the surgical site. Bone density was evaluated during the drill sequencing. Soft bone surgical protocol was followed to allow for expansion of the bone during placement of the tapered implant. When indicated, osteotomes were incorporated within the drilling sequence to provide expansion of the bone prior to drill insertion. If dense bone was encountered, an additional final drill was utilized (ZOP28D, Zimmer Biomet Dental, Palm Beach Gardens, Fla) 2.8- to 2.4-mm diameter. In wider ridges, 3.7-mm or 4.7-mm diameter 1-piece implants were utilized, and the appropriate soft/hard drilling sequence was used with the 3.7-mmD or 4.7-mmD drills.

In all cases, the tapered 1-piece implants (Zimmer One Piece Implants, Zimmer Biomet Dental) were placed without difficulty in various tooth locations. Implants were delivered to the patient using the handpiece driver or ratchet at 30 Ncm torque. Manufacturer driver tools were used to engage the implant externally. To position the lower facial margin of the implant in the proper location, the vertical marker on the driver was aligned to the facial aspect (Figure 4). During placement, the apical position of the implant's abutment section was determined at each full rotation of the implant. The prefabricated facial margin of the abutment was lower than the lingual margin, allowing for immediate restoration with minimal or no abutment preparation. Ideal implant positioning of the 1-piece was obtained by placing the facial margin of the abutment 1–2 mm from the crest of the bone (Figure 5). If necessary for prosthetic construction, the incisal aspect of the abutment portion of the implant was adjusted with a high-speed carbide bur with copious water irrigation. These implants were placed in various tooth locations.

Once the implant was fully seated and esthetic profiles confirmed, a temporary snap-on acrylic coping was placed on the abutment portion of the implant by aligning it with the contours of the abutment margins. If necessary, the abutment cap was adjusted accordingly. A snap-on coping was roughened with an acrylic bur to allow for retention to the temporary restoration (Figure 6). An acrylic provisional crown was fabricated out of occlusion, modified and trimmed outside the mouth. Provisionals were cemented with temporary cement (Tempbond Temporary Dental Cement, Kerr Corporation, Orange, Calif). Flaps were approximated after trimming and washing off all extruded cement. Primary closure was performed with either 4-0 or 5-0 chromic gut or Vicryl (Ethicon, Inc, Piscataway, NJ) sutures (Figure 7).

Patients were given postoperative instructions and left the operatory hemostatic with stable vital signs. Prescriptions for 500 mg amoxicillin 3 times daily for 5 days (clindamycin 150 mg for those allergic to amoxicillin) and analgesics for 3 days (oxycodone 5 mg/325 acetaminophen every 4 hours as necessary). Patients were seen 1 week postoperatively for examination of the soft tissues and occlusion.

The dental implants were allowed to heal out of occlusion for 3 months and radiographs were taken prior to provisional removal. After 3 months of soft and hard tissue healing, the provisionals were removed, a snap-cap impression coping was placed on the abutment section, and an impression with poly

vinyl siloxane (Splash Max Poly-Vinyl Siloxane Impression Material, DenMat, Lompoc, Calif) was performed (Figure 8). A contoured abutment analog was snapped into the impression coping with the corresponding facial alignment. The final impression along with opposing model and bite registration were sent to the laboratory for the fabrication of the final ceramometal restoration utilizing a prefabricated burn-out waxing sleeve corresponding to the appropriate abutment diameter.

Two weeks after impression, a final prosthesis in occlusion was delivered to the patient. Marginal fit was confirmed clinically and radiographically, the occlusion and esthetics were evaluated. Cementation of the prosthesis was completed with either Tempbond (Kerr Corporation) or Durelon Carboxylate Luting Cement (3M, St Paul, Minn). Excess cement was removed, and the patient was given oral hygiene instructions and placed on a recare schedule (Figure 9).

COMPLICATIONS

One issue that may arise with 1-piece implants is misalignment of the prosthetic portion of the implant into proper position relative to adjacent teeth. One must ascertain that there is enough mesial-distal width for the prosthetic component and whether the buccal-lingual angulation will present a complication in restoration. There are also occlusal considerations, such as insufficient interarch space when placing the finish margin of the 1-piece implant at the crest of the bone. Another concern with 1-piece implants is the emergence profile and confirming the labial prosthetic aspect of the restoration.

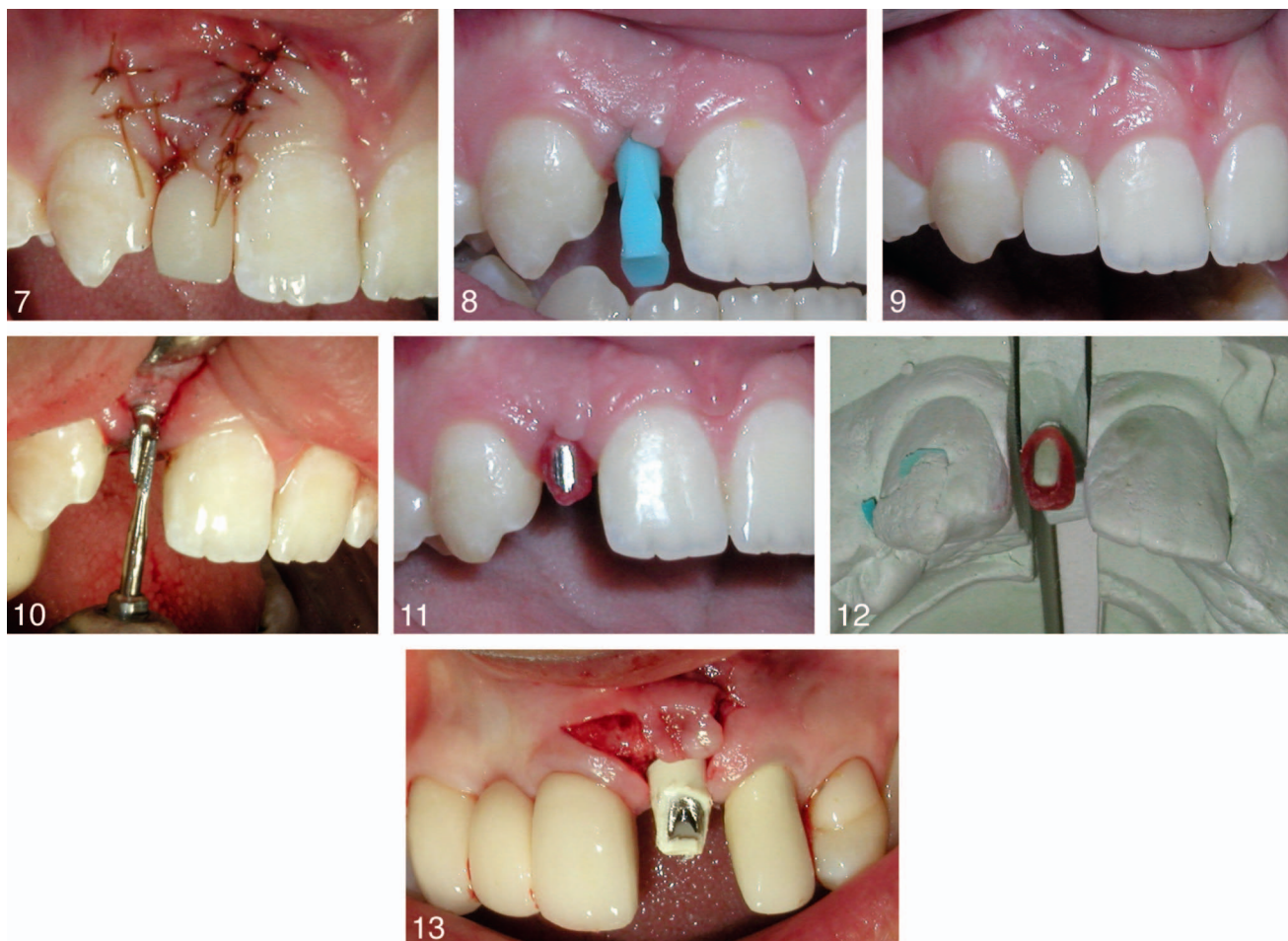
During the 1-piece implant placement, prosthetic issues included the position of the abutment portion of the implant in relation to the adjacent teeth, angulations, and occlusal clearance. Provided that the final gingival margins were not altered, the coronal aspect of the abutment portion was sometimes modified intraorally using a SSW FG-702SL carbide burr (SS White, Lakewood, NJ), with a Pattern Resin LS (GC America, Alsip, Ill) jig made to assist in the transfer (Figure 10). Any modifications were relayed to the prefabricated implant analog (Figures 11 and 12). The prosthetic temporary sleeve was modified as needed to fabricate a provisional restoration with the proper contours in the correct position (Figure 13).

RESULTS

Results were tabulated over a 10-year period (Table). From September 2005 to July 2014, a total of 24 patients (13 males, 11 females) were treated. A total of 33 tapered 1-piece implants were placed with 12 in the mandibular and 11 in the maxillary jaw (Figure 14). Patients ranged in age from 15 to 76 (mean = 48.83) years.

A majority of patients were between the ages of 51–76. Of all the patients involved, the 41–60 age groups was highest in males, and the 61–70 age group was highest in females (Figure 15).

For the majority of patients in this study, postoperative follow-up visits revealed surgical sites healing well at 1 week postoperative clinical exam. Some of the patients had slight to



FIGURES 7–13. **FIGURE 7.** Closure with 5-0 chromic gut suture after cementation of the provisional restoration. **FIGURE 8.** Snap-on impression coping in place immediately prior to impression. **FIGURE 9.** Final insertion of porcelain fused to metal ceramic restoration. **FIGURE 10.** View showing intraoral adjustment of abutment by utilizing a 702 bur to reduce the facial component on prosthetic portion of the implant. **FIGURE 11.** Pattern Resin LS constructed intraorally on abutment during any modifications to create a transfer jig. **FIGURE 12.** Pattern Resin LS transfer jig placed on the prefabricated dye to allow for modification prior to wax up. **FIGURE 13.** If 1-piece implant abutments were adjusted, the temporary sleeves were modified intraorally prior to provisional fabrication.

moderate postoperative pain and swelling. A few patients mentioned bruising a few days postsurgical. Following a 3-month healing period after surgical placement, the implants were restored in occlusion with ceramometal restorations.

Out of the 33 implants placed during the study, cumulative survival and success rates were 100%. Radiographic examination of all the implants in this study did not show any peri-implant radiolucency (Figure 16). One of the patients exhibited a minor complication of crestal bone remodeling.

DISCUSSION

Over the years, clinical guidelines were established for the predictable achievement of osseointegration in patients. These included: (1) placement of implants using a low-traumatic surgical technique to avoid overheating the bone during preparation of a precise implant recipient site, (2) the need to achieve initial implant stability, and (3) a caution that implants should not be functionally loaded during a healing period of 3–

6 months.¹⁰ Provided that these guidelines were followed, successful osseointegration was considered a predictable outcome for both submerged implants requiring a 2-stage procedure, and nonsubmerged implants characterized by a 1-stage surgical procedure.¹⁰

Biomechanical forces were also deemed central to avoiding problems with implant designs. Key factors for favorable biomechanics include: (1) the nature of the biting forces on the implants, (2) how the biting forces are transferred to the interfacial tissues, and (3) how the interfacial tissues react biologically to stress transfer conditions.¹¹

In the past, it was shown that the requirement for extensive delayed loading periods was necessary for osseointegration. Factors for failure included patients with poor bone quality and quantity, nonoptimized implant design, short implants, poor surgical placement, nonoptimized surgical protocol, and poor biomechanically designed prosthesis. Extrapolation of the requirement for long healing periods from these particular conditions to contemporary situations involving refined surgi-

TABLE

Data used in the statistical analysis of 33 immediately loaded tapered 1-piece implants

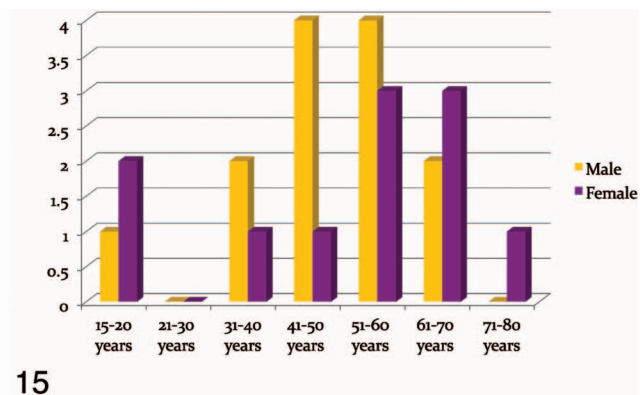
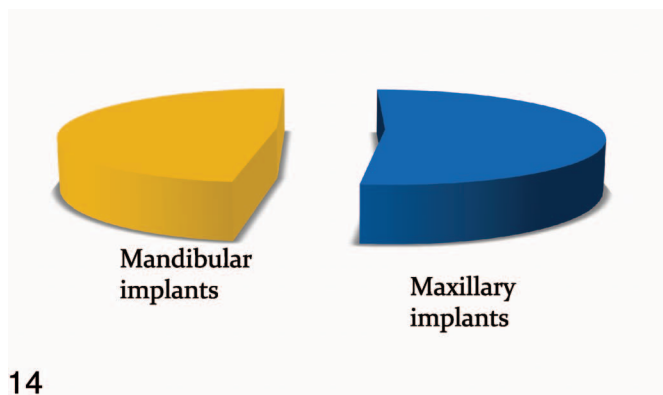
Patient No.	Surgery Date	Patient Code	Age (yrs)	Sex	Tooth No.	Arch	Implants (No.)	Results (%)	
								Survival	Success
1	September 13, 2006	CJ	37	M	25	Mandible	1	100	100
2	February 9, 2007	ML	18	F	7	Maxilla	1	100	100
3	May 23, 2007	CA	51	M	23, 24	Mandible	2	100	100
4	July 31, 2007	GA	51	M	24, 26	Mandible	2	100	100
5	August 13, 2007	JJ	58	F	9	Maxilla	1	100	100
6	July 30, 2008	FM	49	M	9	Maxilla	1	100	100
7	October 15, 2008	MM	44	F	24	Mandible	1	100	100
8	January 2, 2009	LB	20	F	7	Maxilla	1	100	100
9	February 11, 2009	FP	36	M	25	Mandible	1	100	100
10	April 6, 2009	HH	42	M	24, 25	Mandible	2	100	100
11	April 13, 2009	VR	56	F	24, 26	Mandible	2	100	100
12	May 5, 2009	MS	62	M	7	Maxilla	1	100	100
13	May 22, 2009	LJ	45	M	25	Mandible	1	100	100
14	June 29, 2009	MI	54	M	24, 25	Mandible	2	100	100
15	July 8, 2009	II	52	F	24	Mandible	1	100	100
16	July 17, 2009	RB	66	F	8	Maxilla	1	100	100
17	September 23, 2009	TV	68	F	24, 25	Mandible	2	100	100
18	November 27, 2009	TR	67	F	26	Mandible	1	100	100
19	December 8, 2009	EG	15	M	10	Maxilla	1	100	100
20	February 22, 2014	DL	37	F	26	Mandible	1	100	100
21	December 21, 2010	PT	65	M	7	Maxilla	1	100	100
22	August 29, 2008	GP	76	F	5, 6, 7	Maxilla	3	100	100
23	July 18, 2014	MV	56	M	9	Maxilla	1	100	100
24	July 18, 2014	MS	47	M	4, 5	Maxilla	2	100	100
Total	September 13, 2005 to July 18, 2014						33	100	100

cal protocols and careful patient selection; this has led to development of more modern surgical protocols.¹² In recent years, clinicians have been increasingly using a 1-stage approach in implant placement, which generally incorporates some immediate or early function and includes fewer surgical interventions, shorter treatment time, and reduced trauma for the patient.¹³

Albeit premature loading has been interpreted as inducing fibrous tissue interposition between the implant and osteotomy walls, immediate loading per se is not responsible for fibrous encapsulation; it is the excess of micromotion during the healing phase that interferes with bone repair. A threshold of tolerated micromotion has been postulated to exist

somewhere between 50 μm and 150 μm.¹² Indeed, it has been reported that immediately loaded implants present with similar survival rates to those implants loaded in a delayed approach.¹⁴ When certain loading forces are applied immediately after implant placement, bone formation may actually be stimulated.^{10,15} By applying load, the amount of mineralized bone at the bone-to-implant interface may increase.¹⁶

The tissue integration of nonsubmerged titanium implants has been widely examined with numerous in vivo studies over the past 25 years. The first histologic studies were performed in the early 1970s by the research team of Prof Andre Schroeder¹⁷ at the University of Berne, Switzerland, which provided the scientific basis for nonsubmerged titanium implants. Titanium



FIGURES 14 AND 15. FIGURE 14. Pie figure illustrating number of mandibular implants vs maxillary implants placed in this study. FIGURE 15. Bar figure illustrating the breakdown of males to females and age groups in the study.



FIGURE 16. Postoperative radiograph of final restoration of the 1-piece implant.

hollow cylinder implants with a titanium plasma-sprayed surface were evaluated in the mandibles of monkeys. The examination of unloaded and loaded implants by means of nondecalcified histologic sections demonstrated excellent bone integration, with direct contact between living bone and the microporous rough titanium implant surface.¹⁷

The implants in this present study followed a nonsubmerged placement protocol and could be immediately loaded or nonloaded during the healing phase. One-piece implants are indicated for single or multiple, splinted or nonsplinted tooth replacement. Disadvantages of this procedure are that the clinician must be skilled at implant surgical positioning, which is crucial for proper restoration since little to no abutment correction is possible. Chair time requirements are usually longer than 2-stage implants since placement of a comfort cap or provisional restoration is required at the time of implant placement. Another disadvantage is that the implant's short abutment portion provides minimal retention.

The advantages of a 1-piece implant are that they allow for simple, immediate provisionalization of the implant. This design is also quite beneficial for increased strength of abutment-to-implant connection—particularly true of small-diameter implants. The implant design used in the present study provided a facial, subgingival margin for esthetics.

The results of this study provide evidence that immediate restoration of the implant can generate survival and success

rates similar to conventional 2-stage implants.¹⁸ All the implants were still in function after 2.6–11 years of clinical monitoring. Little to no crestal bone remodeling around these implants was noted radiographically, and both function and esthetics were maintained. The excellent survival rate corresponds to similar studies on 1-piece implants.¹⁸

The solid 1-piece implant and abutment design imparts the benefit of no screw connection between the abutment and implant body. This design precludes any possibility of abutment loosening or screw breakage, which lengthens the implant's restorative life and eliminates the microgap between the implant and the abutment, which allows for less crestal bone remodeling since there is no need for the tissue to reestablish a biologic width below the connection.¹⁸

This factor, in combination with no subgingival abutment-to-implant microleakage, may be the reason for the long-term survival rates seen in this study.

CONCLUSION

Many patients require dental implant treatment for the restoration of single teeth. The clinician has choices of utilizing a 1- or 2-stage implant surgery. Single-stage implant surgery is becoming more common in implant dentistry. When placing a single-stage implant, the clinician has the choice of a 1-piece implant design.

Within the author's patient population and considering the limitations of this retrospective study, adequately stabilized tapered 1-piece implants can be successfully loaded out of occlusion at the time of implant placement and definitively loaded in occlusion 3 months later without adversely affecting function or esthetics. Further long-term controlled studies are recommended to further understand these findings.

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NOTE

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