

# A Retrospective Analysis of 125 Single Molar Crowns Supported by Two Implants: Long-Term Follow-up from 3 to 12 Years

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**Purpose:** The purpose of this study was to analyze retrospectively the survival rate of implants used in pairs to support a single molar crown over a long-term follow-up period and to compare the efficacy of this technique to other existing methods of treatment. **Materials and Methods:** The charts and radiographs of 105 patients who each received two implants to support a screw-retained single molar were examined according to the following criteria: age, gender, location of implant, time of loading (delayed versus immediate), opposing dentition, and the existence of adjacent implants. **Results:** Patients with follow-up between 3 and 12 years were selected to illustrate the long-term outcomes of the two-implant replacement procedure. Two hundred fifty implants were placed in 125 molar sites in 105 patients. Five of the 250 implants failed, resulting in a cumulative survival rate of 98.0%. Seven of 125 restorations experienced porcelain fracture (5.6%), seven prosthetic screws loosened (5.6%), and one abutment screw loosened (< 1.0%). **Discussion:** The placement of two implants to support a screw-retained single molar successfully reduces rotational forces that create stress on the implant. A single regular-diameter or even a wide-diameter implant is susceptible to these forces, which may lead to fatigue over the long term. **Conclusions:** Two implants for the replacement of a single molar represent an effective method that provides a high survival rate over a long-term follow-up period. This approach produced a cumulative survival rate higher than that usually seen in studies of single implants used for molar replacement. The two implant-supported molar crown showed fewer complications than single implant-supported molar crowns. *Int J Oral Maxillofac Implants* 2011;26:148-153

**Key words:** dental implants, molar replacement, osseointegration, teeth in a day, two-implant molar

Multiple techniques for molar implant restorations have been described that enjoy varying survival

rates.<sup>1-6</sup> The more effective implant procedures allow implants to successfully handle excess torque and rotational strain.<sup>7,8</sup> One proposed technique involves the use of single implants to support molar restorations.<sup>9</sup> In this method, one root-form implant is placed in a molar location. These implants are more susceptible to complications than other forms of restorations, such as fractures of the implant, abutment, and veneering material.<sup>10</sup> Single molar implants are also more susceptible to screw loosening.<sup>10-12</sup> An alternative technique is the use of wide-diameter implants to alleviate the strength-related complications of a single implant restoration. In this procedure, a single implant with a larger body diameter is placed in a molar position. This procedure provides a large implant shoulder area, which increases prosthesis stability and also increases the surface area of the bone-implant interface.<sup>13</sup>

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The discussion of the effectiveness and success of these methods has become increasingly interesting to clinicians. The use of Brånemark System implants has been shown to result in high survival rates in both the mandible and the maxilla.<sup>14-16</sup> This implant system has also been proven successful for the support of single molar restorations.<sup>17</sup> In Balshi's 1990 study,<sup>17</sup> two regular-diameter implants were used to replace a single molar using a variety of implant types. All implants had a machined surface until a new titanium oxide surface (TiUnite, NobelBiocare) was introduced in 1999. This method of treatment provides more surface area for osseointegration, spreads occlusal loading forces, and reduces lateral forces and bending moments that result from the use of single implants.<sup>18</sup> The use of two implants to support a single molar also more accurately recreates the crown-to-root ratio.<sup>10</sup> To date, the survival rate of these implants in a large retrospective study with long-term follow-up has not been assessed. The purpose of the present study, therefore, was to examine and evaluate the survival rate of patients with two Brånemark System implants replacing a single molar with a minimum of 3 years of follow-up, and to compare the efficacy of this technique with other existing forms of single molar replacement.

## MATERIALS AND METHODS

### Surgical Procedure

A standardized surgical technique was used for implants; graduated drills ending with the 3.0-mm-diameter twist drill were employed. A countersink drill was also used to create a coronal bevel in the bone. Brånemark regular-platform implants (Nobel Biocare) were then placed, usually with the shoulder of the implant 2 mm below the osseous crest. If immediate provisionalization was employed, 1-mm EsthetiCone abutments (Nobel Biocare) were placed and an acrylic resin prosthesis was constructed, creating a natural molar emergence profile from the socket. All implant crowns were placed using a standardized occlusal scheme, with strong centric contacts and no contacts in lateral excursions. Implants not immediately provisionalized were submerged in a conventional two-stage delayed loading protocol. Radiographic analysis of adjacent tooth roots and structures was used to aid in implant placement; no surgical guide was used.

### Retrospective Analysis

The charts of all patients who underwent single molar replacement with two implants at a private practice (PI Dental Center, Institute for Facial Esthetics) were examined. Early failures, defined as those occurring earlier than 3 years, were noted. Consecutive patients

Table 1 Life Table Analysis

Period	No. of implants	No. of failures	Survival rate	Cumulative survival rate
3 y	250	5	98%	98%
4 y	199	0	100%	98%
5 y	163	0	100%	98%
6 y	129	0	100%	98%
7 y	103	0	100%	98%
8 y	75	0	100%	98%
9 y	47	0	100%	98%
10 y	17	0	100%	98%
11+ y	3	0	100%	98%

with follow-up of more than 3 years were selected for this study to illustrate the long-term effects of the two-implant replacement procedure. Ages of the patients at the time of implant placement were noted, along with general health, gender, location of the implants, and loading protocol. Both periapical and panoramic radiographs were obtained on the day of surgery, at the time of definitive prosthesis delivery, and annually thereafter. To ensure consistent angulations, a Rinn long-cone radiographic holder (Dentsply) was used to position the film. Panoramic radiographs were examined to determine whether the two implants were splinted to any adjacent implants and to note opposing and neighboring dentitions. If implant failures occurred, common possible medical complications such as diabetes, osteoporosis, smoking, and alcohol consumption were noted. In all patients with implant failures, the implants were removed and replaced after a healing period averaging 2 months.

## RESULTS

Two hundred fifty Brånemark System implants were placed in 125 molar sites in 105 consecutive patients between 1996 and 2005. One hundred eighty-two of the implants were placed in women and 68 were placed in men. The ages of the patients ranged from 18 to 82 years (mean age, 54 years). Two hundred twenty implants were submerged in a conventional two-stage delayed loading protocol, while 30 were immediately provisionalized. Sixty-six implants were placed in the maxilla and 184 were placed in the mandible. Two hundred forty-five of the 250 implants in this study remain screw-retained and in function, for a cumulative survival rate of 98.0%. Table 1 illustrates the number of implants in function and associated survival rates for each time period listed. Of the implants placed in the mandible, 98.4% survived; in the maxilla, 97.0% survived.

**Table 2 Failure Data**

Failure no.	Gender	Maxilla or mandible	Mesial or distal root	Immediate or delayed loading	Complication	Adjacent implants present
1	F	Maxilla	Mesial	Delayed	Fibrous encapsulation	No
2	M	Maxilla	Mesial	Delayed	Fibrous encapsulation	No
3	M	Mandible	Distal	Immediate	Lack of primary stability	Yes
4	M	Mandible	Mesial	Delayed	Fibrous encapsulation	No
5	M	Mandible	Distal	Delayed	Strong pain	No

**Table 3 Individual Survival Rates for Variables of Interest**

Variable	Survival rate (%)
Sex	
Male	95.6
Female	98.9
Time of loading	
Immediate	96.7
Delayed	98.2
Jaw	
Maxilla	97.0
Mandible	98.4
Location	
Mesial	97.6
Distal	98.4

No substantial changes to the surrounding gingiva were noted other than occasional inflammatory responses to sharp food or brushing injury.

Four of the five observed failures occurred within 9 months after placement, and the fifth implant failed in the third year after implant placement. Of the failures in delayed-loading cases, the time between loading and implant placement varied between 3 and 6 months to 2 years. In all of the failures, only one of the two implants at the given molar site failed, while the second retained functionality. This produced a 100% prosthesis survival rate. All five failures had natural teeth as the opposing dentition. Failure data are presented in Table 2.

Some complications other than implant failure were observed. Seven restorations experienced porcelain fracture (5.6%), seven had a prosthetic screw loosen (5.6%), and one had an abutment screw loosen (< 1.0%). Individual survival rates were calculated to assess the effects of variables of interest in Table 3.

Implant size, type, and diameter were also recorded and analyzed (Tables 4 and 5). The most common implant type used for this study was Mk IV, while the most common implants were 4 mm in diameter and 10 mm in length. One of the two 5.5-mm-diameter implants that was placed failed.

Radiographs of a 24-year-old man who received a two-implant molar restoration are provided in Figs 1a to 1e. The implants remain fully functional after 10 years.

## DISCUSSION

When examining the survival of single molar implants, it is essential to look at long-term studies in which the implant and crown face more fatigue over time, particularly since higher masticatory forces are present in the molar region.<sup>19</sup> Becker et al achieved cumulative survival rates for single implant restorations over 6 years of 91.5% in the mandible and 82.9% in the maxilla.<sup>3</sup> The placement of a single implant in a molar region fails to replicate the crown-to-root ratio, which is susceptible to overload because of occlusal forces.<sup>10</sup> Other complications include abutment and porcelain fracture and loosening of the crown.<sup>10</sup> A previous study that directly compared the efficacy of one implant and two implants in the molar position indicated that 48% of single implants experienced complications such as screw loosening, while only 8% of the two-implant restorations experienced these complications.<sup>11</sup> Another study reported that 13% of single implants displayed screw loosening.<sup>12</sup> Screw loosening in single implant molars can lead to more serious complications, such as implant fracture, which has been shown to arise over time with single implant restorations.<sup>20</sup> Other reported complications include prosthesis mobility, abutment looseness, and unsatisfactory prostheses.<sup>10</sup> Such complications are the result of lateral forces, which create a bending moment at the marginal bone, and axial forces, which induce bending from the implant axis in the mesio-distal direction.<sup>11</sup>

Table 4 Failure Rate by Implant Type

	Implant type						
	Ebon	MK II	MK III	MK IV	Nobel Perfect	Standard	All
Cases (no. and %)	16 (6.4%)	40 (16.0%)	58 (23.2%)	90 (36.0%)	12 (4.8%)	34 (13.6%)	250
No. of failures	0	1	1	1	0	2	5
Survival rate	100.0%	97.5%	98.3%	98.9%	100.0%	94.1%	98.0%

Table 5 Implant Survival Rates by Diameter and Implant Length

Implant diameter	Total placed	Implant length (mm)						No. of failures	Survival rate
		8.75	10	11.5	12	13	15		
3.75 mm	38	2	24	0	0	12	0	1	97.4%
4 mm	192	0	118	0	0	64	12	2	99.0%
5 mm	18	0	10	2	6	0	0	1	94.4%
5.5 mm	2	0	0	0	0	2	0	1	50.0%
Totals	250	2	150	2	6	78	12	5	
No. of failures	5		2		1	2			
Survival rate	93%	100%	98.7%	100.0%	83.3%	97.4%	100.0%		

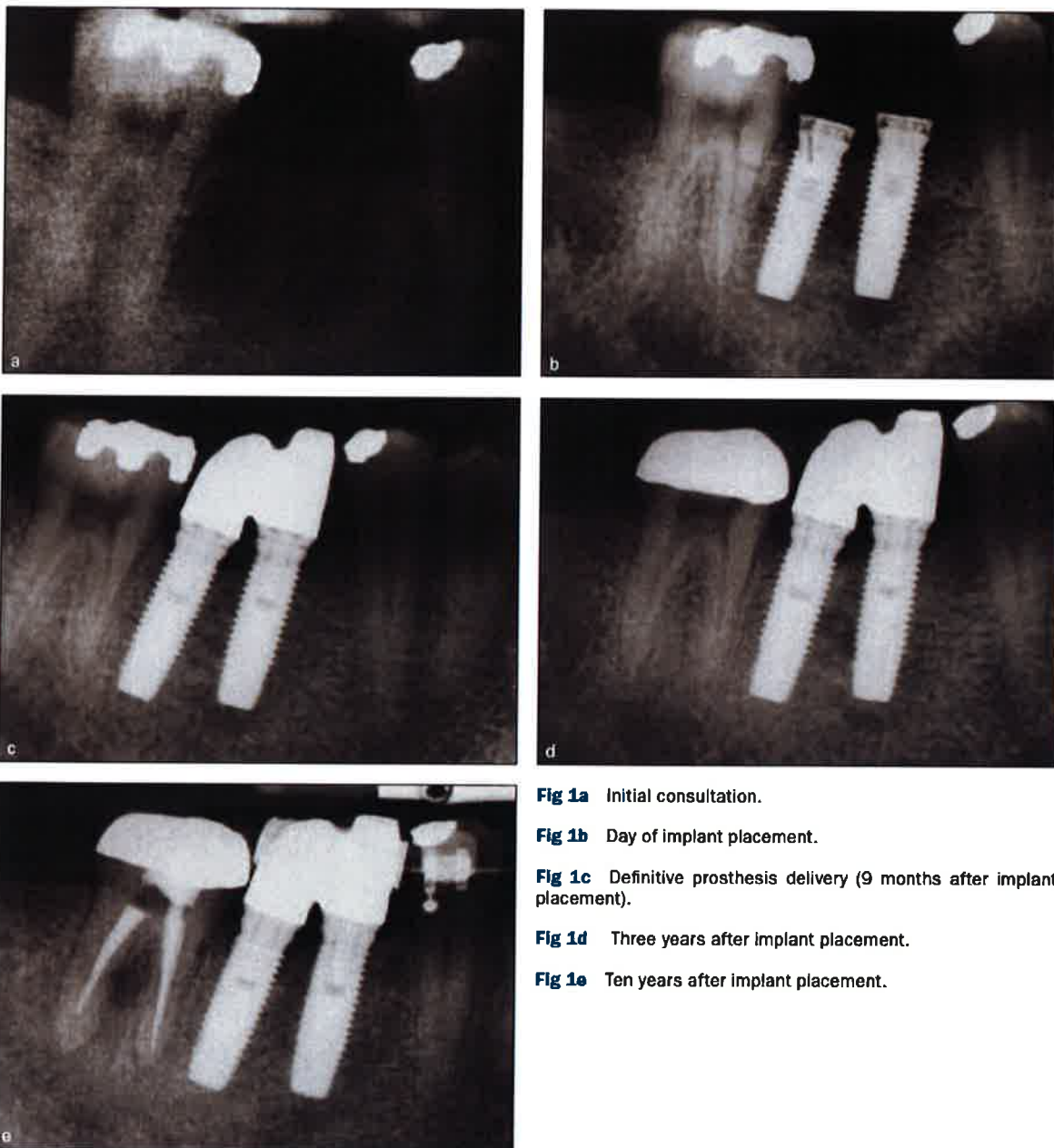
Another common technique for molar replacement is the use of a wide-body implant and restoration. Although there are limited data on the long-term survival rates of these implants, multiple studies have examined the short-term efficacy of this technique. A previous study has indicated that wide-body Brånemark implants in the molar position achieved a 92% cumulative survival rate after 3 years.<sup>1</sup> A second study with 5 years of follow-up observed a 76% survival rate for wide-diameter implants.<sup>21</sup> This method is effective for sites with spatial constraints. However, wide-diameter implants do not fully replicate the ideal crown-to-root ratio, and they still leave cantilevered portions of the restorations that produce potential mechanical and leverage issues.<sup>10</sup> Wide-diameter implants are also problematic in that if the implant fails to osseointegrate, an implant that is even wider for immediate replacement may not be available.<sup>18</sup>

Some clinicians argue that the use of two implants for a single molar creates biologic constraints by constricting the interproximal space and interfering with oral hygiene. The present study and earlier work have shown that oral hygiene is minimally affected by this procedure and, in most cases, superfloss and floss threaders can be used effectively.<sup>10</sup> In some cases where space is more limited, orthodontic repositioning and enameloplasty can be used to restore appropriate interproximal spaces.<sup>10</sup>

Past studies analyzing the performance of various molar implant replacement techniques have produced varying survival rates over short-term follow-up periods. The present study displayed that two-implant molar restorations are highly successful over prolonged periods of time; after 3 to 12 years of follow-up, 98.0% of patients receiving two-implant single-molar restorations retained functional crown restorations. The type of implant used did not affect survival rates. With each of the failed implants, only one of the two implants failed, and the second continued to support the crown until the failed implant was replaced, producing a 100% prosthesis survival rate.

The use of two implants to replace a single tooth provides several biomechanical advantages.<sup>10</sup> Two implants spread occlusal forces and reduce bending and rotational forces by more effectively replicating natural crown-to-root ratios. These implants also provide more surface area for osseointegration, which minimizes the restoration's susceptibility to overload.<sup>10</sup> To fully illustrate the benefits of this technique, further studies need to be conducted that evaluate other types of implant systems using different implant and abutment configurations.

**Fig 1** Periapical radiographs of a patient treated in this retrospective study.



**Fig 1a** Initial consultation.

**Fig 1b** Day of implant placement.

**Fig 1c** Definitive prosthesis delivery (9 months after implant placement).

**Fig 1d** Three years after implant placement.

**Fig 1e** Ten years after implant placement.

## CONCLUSION

The use of two Brånemark implants to support a single molar restoration provided a high survival rate over the long term, rivaling and exceeding the survival rates of other forms of molar replacement while minimizing future complications.

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