

## Clinical performance of immediately loaded single-tooth implants up to 7-year: a retrospective study review article

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### Abstract

**Objectives:** This study retrospectively evaluated the survival rates of immediately loaded implants supporting single crowns, and investigated causes of failures.

**Methods:** A total of 90 dental implants (Brånemark System® and Replace® Select) supporting single crowns, were placed in 88 patients (35 male, 53 female, mean age: 51.9 years) in a private dental implant clinic. The implants were loaded by provisional crowns within 24 hours after surgery, and the definitive metal-ceramic crown was cemented after 3 months. A comprehensive list of factors that could influence the survival rate of implants, with all possible complications, was compiled. With this list, patient charts were retrospectively screened for possible events related to failure. The median observation time was 25.5 months. Implant survival data were evaluated using the Kaplan-Meier test, in addition to frequency counts and the Fisher Exact Test.

**Results:** Of the 90 dental implants, 86 (95.6%) implants were still in situ. Three implants (3.3%) were lost after 1, 12 and 19 months respectively, and one implant (1.1%) lost its occlusal screw 5 months after insertion. These implants were inserted in bone of quality type II or III with a torque of more than 32Ncm to get primary stability. One lost implant was inserted with a torque less than 32Ncm and did not have primary stability. The three implants that were lost were placed in the maxilla. The implant with the lost occlusal screw was inserted in the mandible. Three of the four failed implants were Brånemark System® implants, the other one was a Replace® Select implant. Due to the low failure rate, the causes of these failures are speculative, but parafunction seemed to be a risk factor. The mean survival time of the immediately loaded single-tooth implants was 18.8 months.

**Conclusion:** This retrospective study on the success rate of immediately loaded single-tooth implants yielded a 95.6% success rate. Due to the small number of failures, no definitive conclusion can be drawn concerning the factors leading to failures of implants supporting solitary crowns. This study, nevertheless, illustrates that immediate loading of single-tooth implants is successful, and that it is a reliable treatment option to replace missing natural teeth in order to restore aesthetics and/or function.

**Keywords:** Single tooth implants, Immediately loaded single-tooth implants, Success rate, Failure and survival.

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### Introduction

Teeth can be lost due to trauma, caries, and endodontal or periodontal reasons.<sup>(1)</sup> In general, people would like to have a replacement for their missing teeth to restore the aesthetics or function of their teeth. Although it might be difficult to achieve the standard of natural teeth, several treatment options are available, such as the traditional removable and fixed (partial) dentures, or prostheses supported by oral implants. Since Brånemark discovered the osseointegration of titanium in bone, the use of dental implants has become a popular alternative for the replacement of missing teeth. Restorations on implants are costly, but have a number of advantages when compared with conventional reconstructive dentistry.<sup>(2)</sup> One of the most important reasons for a patient to choose implants is that they are fixed, so the patient is able to speak and eat in the way they did before losing a tooth. In addition, the aesthetics are satisfactory and damage to the remaining adjacent teeth is minimized.<sup>(1,2)</sup>

After implant insertion, the bone needs time to heal and the implants have to become osseointegrated.

Therefore, the original protocol for the initial loading of a healed implant is 3-6 months after implant placement in the mandible and 6-9 months after implant placement in the maxilla. This healing period is necessary to achieve osseointegration.

The search for simplified treatment protocols with reduced healing times gave rise to a procedure with implants submitted to immediate loading.<sup>(3)</sup> Studies have shown that there is no significant difference between the survival of immediately loaded implants and the survival of delayed loaded implants.<sup>(3-19)</sup> The treatment time is shorter, and thus less expensive, and most importantly for the patient, there is no discomfort of wearing removable prosthesis during the healing period.<sup>(5)</sup>

This study retrospectively evaluates the survival rates of 90 immediately loaded dental implants (Brånemark System® and Replace® Select), placed in 88 patients (35 male, 53 female) supporting single crowns, and investigates causes of failures.

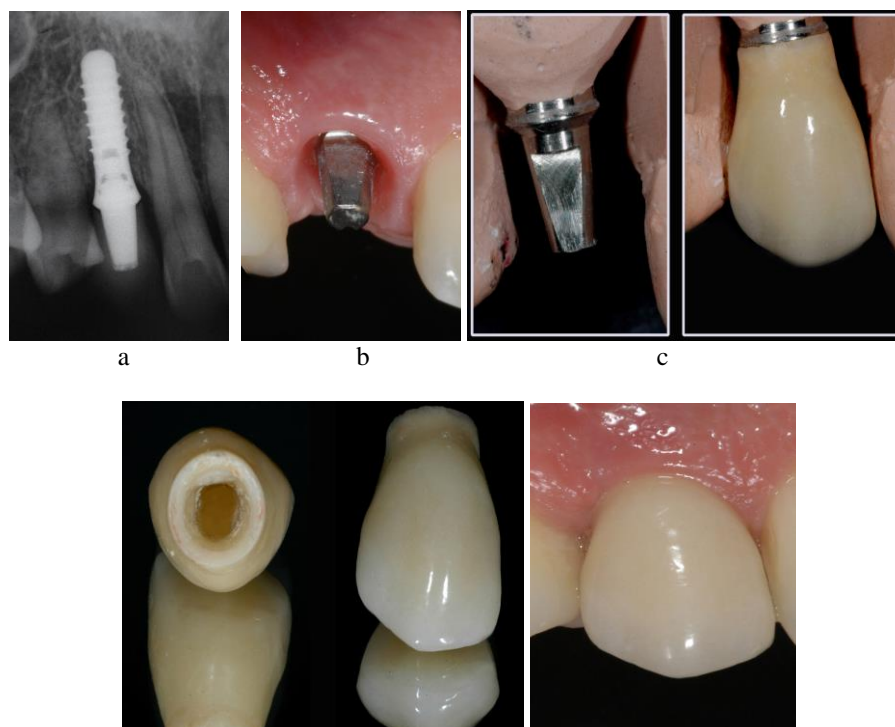
## Materials and Methods

Patient files of a private dental implant clinic in São Paulo (Brazil) were selected for this study, based on the presence of at least one single crown supported by a dental implant. Cases of bone augmentation during implant placement surgery were excluded.

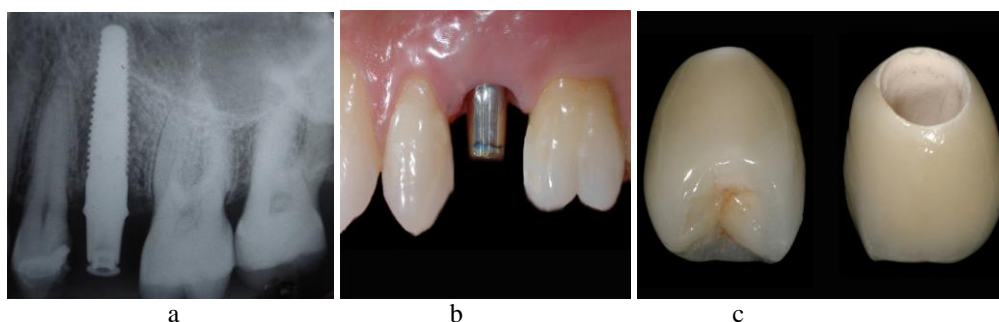
The patient files of 88 patients (35 male, 53 female) aged between 20 and 81 years (mean 51.9) were examined. Between April 2000 and May 2007, a total of 90 implants (Brånemark System® and Replace® Select Tapered) supporting single crowns were placed in this clinic. The implants were placed in the anterior and posterior regions of the maxilla and the mandible.

The periodontium was required to be completely healthy (i.e. free of diseases) before the implant was placed. One hour before implant surgery, the patients each received antibiotics (amoxicillin 2g) and corticosteroids (4mg) to decrease swelling.

A standardized 1-stage surgical procedure was used to insert the implant. The implant was placed by a 'torque controller' to a certain torque, in most cases 45 Ncm. On occasion, the final insertion was made by hand (to 60-70 Ncm). After implant placement, a CeraOne abutment (Nobel Biocare, Göteborg, Sweden) or Easy abutment (Nobel Biocare, Göteborg, Sweden) was tightened with a torque force of 32Ncm for immediate loading. (Fig. 1a-b and Fig. 2a-b).



**Fig. 1:** a) Radiograph of a Brånemark System® implant inserted in the maxilla (13). b) CeraOne abutment immediately tightened. c) Definitive restoration on master model. d) Definitive restoration. e) Definitive restoration in situ





**Fig. 2: a) Radiograph of a Replace® Select implant inserted in the maxilla (25) b) Easy abutment immediately tightened c) Definitive restoration on master model d) Definitive restoration e) Definitive restoration in situ**

Postoperatively, the patients received amoxicillin 1.5g/day during the first week and were instructed to eat a soft diet and to avoid placing food on or near the implant for a period of six weeks. When necessary, analgesics were used.

Immediately after implant placement surgery, impressions were taken to make a provisional crown. This crown was fabricated either by a dental technician laboratory or in the private dental clinic in Sao Paulo, where the provisional (acrylic) crown was placed with Zinc phosphate (SS White, Rio de Janeiro, Brasil) within 24 hours after surgery. The provisional crown had no occlusal contact in the intercuspal contact position (ICP) and no contact during lateral movements of the mandible.

Patients were seen in the private dental implant clinic within 24 hours after surgery for a regular check. During the first month, the patients returned every week for check ups. After this period, the implant was evaluated every two weeks. All patients were under control of a periodontal specialist. Three months after surgery, the provisional crown was removed and the definitive metal-ceramic crown was cemented (Zinc phosphate, SS White, Rio de Janeiro, Brasil). The definitive restoration was in normal contact in the retruded contact position (RCP) and during lateral movements of the mandible (Fig. 1c-e and Fig. 2c-e).

Patient files were screened for possible events related to failure. Data with relation to the patient's health and risk factors like smoking, alcohol use and parafunction were recorded, as well as data concerning the implant surgery and the implants themselves. The observation time from the moment of implant placement until the moment of file screening or failure amounts to 1 to 87 months (mean 25.5 months).

In this study, *survival* was defined as the implant and solitary crown being still in situ at the moment of screening the patient charts. *Failure* was defined as the loss of the implant or the loss of the occlusal screw of the implant. *Success* was defined as the implant being still in situ at the moment of screening, and in addition, showing no functional problems, pain or mobility.

All the data was entered into a database and analyzed using Minitab® for Windows (Release 14; Minitab Inc.). By using frequency counts, the situation of the patient and the characteristics of the implants were described. The two different implant systems were analyzed by frequency counts and the Fisher Exact Test. This test also examined the parameters versus failure/non-failure. The significance for statistical analyses was set at  $p=0.05$ . Implant survival data was evaluated according to the Kaplan Meier test. Due to the small number of failures, data concerning failure was not statistical tested.

## Results

Of the 88 patients, 52 patients (59%) were completely healthy (ASA-score I). Thirty-six patients (41%) had a mild systemic disease, of whom 5 (6%) were diabetic. Seventy-three patients (83%) were, at the moment of implant placement surgery, non-smokers, while 78 (88.6%) did not consume alcohol. Fifty three patients (58.9%) did not have a parafunctional habits. Nevertheless, of the 35 patients with parafunction, 21 (23.9%) had clenching, 9 (10.2%) had bruxism and 5 (5.7%) had bruxism and clenching.

The reasons for implant placement were especially due to endodontal ( $n=27$ ; 30%) and periodontal ( $n=27$ ; 30%) problems, which led to the extraction of a single tooth. In 56 of the 90 cases (62.2%), an incision into the mucosa was made before placing the implant in bone. The implant was mostly inserted using a torque of at least 45 Ncm (82.2%). In the two situations without primary implant stability, the torque was less than the recommended 32 Ncm (Table 1).

**Table 1: Distribution of implant torque and number of primary implant stability**

Torque	Number (torque)	Number (stability)
$\geq 32$ Ncm	87	88
$< 32$ Ncm	3	2

Implants in the maxilla were mostly placed in the region of incisors (n=31; 34.4%) and premolars (n=21; 23.3%). In the mandible, the first molars (n=17; 18.9%) were mainly replaced by a dental implant (Fig. 3 and 4). The length of the implant varied from 10.0 to 18.0 mm and the diameter from 3.3 to 6.0 mm.

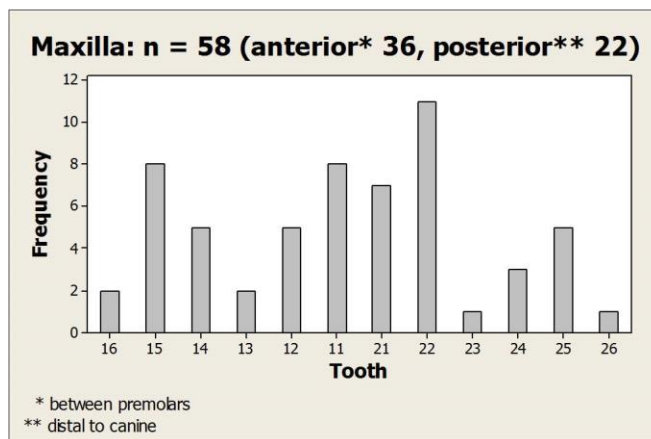


Fig. 3

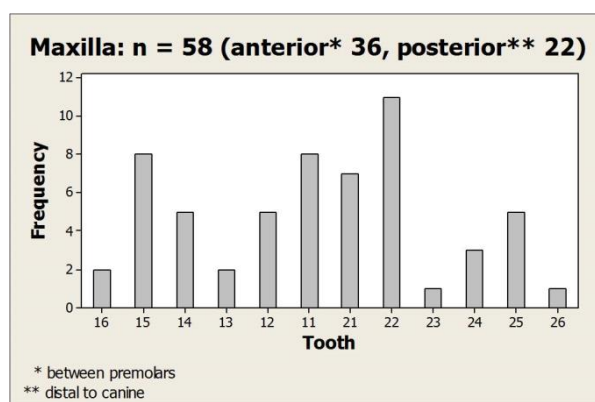


Fig. 4

Fig. 3, 4: Distribution and frequency of the location of implants (n = 90)

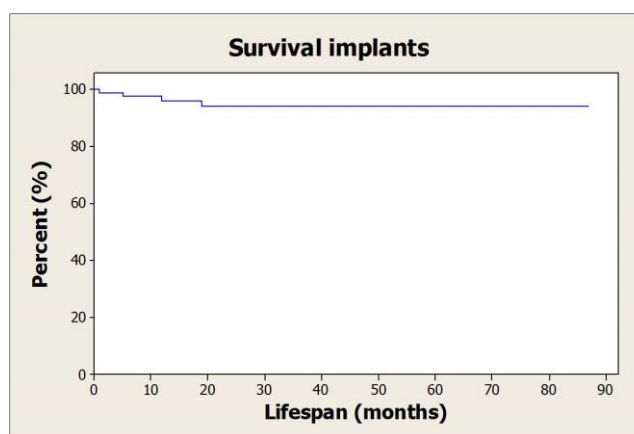


Fig. 5: Survival curve for the lifespan of implants (n=90) according to Kaplan-Meier. Mean survival time: 18.52 months (95% CI: 17.90-19.15)

Thirty-nine of the 90 implants were *Brånemark System®* implants (*Nobel Biocare AB, Göteborg, Sweden*), which were mostly (24) used in the mandible. Approximately 30% (27) of the *Brånemark System®*

implants were inserted in the posterior region. Table 2 shows that 25.6% (10) of the *Brånemark System®* implants had a length and a diameter of 10.0 x 5.0 mm. The length and diameter of the other 29 *Brånemark*

System® implants were: 10.0 X 3.75 (n=2), 10.0 X 4.0 (n=3), 11.5 X 3.75 (n=1), 11.5 X 3.75 (n=1), 11.5 X 3.75 (n=1), 11.5 X 3.75 (n=1), 11.5 X 3.75 (n=1), 11.5 X 4.0 (n=1), 11.5 X 5.0 (n=3), 13.0 X 3.3 (n=1), 13.0 X 3.75 (n=4), 13.0 X 4 (n=1), 13.0 X 5.0 (n=1), 15.0 X 3.3 (n=1), 15.0 X 3.75 (n=4), 15.0 X 5.0 (n=2), and 18.0 X 3.75 (n=1).

Replace® Select Tapered implants (Nobel Biocare AB, Göteborg, Sweden) were used in 56.6% (51) of all cases. There was a preference of using a Replace® Select implant in the anterior region, instead of the Brånemark System® implants (see Table 2). Twenty-two of the 51 Replace® Select implants (43.1%) had a length and a diameter of 16.0 x 4.3 mm and 10 (19.6%) had a length and a diameter of 13.0 x 4.3 mm. The length and diameter of the other 19 Replace® Select implants were: 10.0 X 4.3 (n=2), 10.0 X 5.0 (n=1), 13.0 X 5.0 (n=1), 14.0 X 4.5 (n=1), 16.0 X 3.5 (n=6), 16.0 X 5.0 (n=4), 16.0 X 6.0 (n=1), and 18.0 X 4.3 (n=3).

In summary, Replace® Select implants were mostly used in the maxilla. In the anterior area, a length of 16.0 mm was frequently used, while in the posterior region, a length of 13.0 mm was used. On the other hand, Brånemark System® implants were mostly used in the mandible, with implants having a length of 10.0 mm being applied. According to the Fisher Exact Test, there was a significant difference between the implant systems and the position of the implants ( $p < 0.05$ , Table 2).

**Table 2: Distribution of the Brånemark System® implants and Replace® Select implants, according to region**

	Brånemark (n= 39)	Replace® Select (n=51)	P*
<i>Region</i>			
Mandible	24 (26.7%)	8 (8.8%)	0.00
Maxilla	15 (16.7%)	43 (47.8%)	
Total	39 (43.4%)	51 (56.6%)	
Anterior	12 (13.4%)	28 (31.1%)	0.03
Posterior	27 (30.0%)	23 (25.5%)	
Total	39 (43.4%)	51 (56.6%)	

\*Fisher Exact Test;  $P < 0.05$

During the evaluation period, three implants (3.3%) were lost after 1, 12 and 19 months, respectively, and one implant (1.1%) lost its occlusal screw after 5 months following surgery. The remaining 86 implants were still in situ at the time of screening the patient charts. Fig. 5 illustrates the survival curve according to the Kaplan Meier test.

Several characteristics in relation to failure and success are presented in Table 3. The Fisher Exact Test demonstrated no association between failure and these parameters, with the exception of 'parafunction' ( $p < 0.05$ ).

Age, smoking and alcohol use did not influence the success of the implants in this study and the implant of only one patient with diabetes was lost. However, bruxism and/or clenching seems like a risk factor; as all patients whose implant failed presented a parafunction.

**Table 3: Distribution of success of failure, dependent on patient, surgery, implant and restorative characteristics**

	No failure (n= 86)	Failure (n=4)	P*
<i>Patient characteristics</i>			
Smoking	15 (17.4%)	0 (0%)	0.60
Alcohol use	11 (12.8%)	0 (0%)	1.00
Diabetes	5 (5.8%)	1 (25%)	0.24
Parafunction	33 (38.4%)	4 (100%)	0.03
<i>Surgery characteristics</i>			
Bone level < 12 mm	17 (19.8%)	1 (25%)	1.00
Bone augmentation	4 (4.7%)	0 (0%)	1.00
Incision	32 (37.2%)	2 (50%)	1.00
Torque < 32 Ncm	11 (12.8%)	1 (25%)	1.00
No primary stability	1 (1.2%)	1 (25%)	0.09
Bone quality ≤ 2	73 (84.9%)	2 (50%)	0.13
<i>Implant characteristics</i>			
Brånemark	36 (41.9%)	3 (75%)	0.31
Replace	50	1	
Mandible	29 (33.7%)	2 (50%)	0.61
Maxilla	57	2	
Left	40 (46.5%)	3 (75%)	0.35
Right	46	1	
Anterior	38 (44.2%)	2 (50%)	0.35
Posterior	48	2	
<i>Restorative characteristics</i>			
Ceramic crown	4	1	0.21
Metal ceramic crown	82 (95.3%)	3 (75%)	
Contact during lateral movements	38 (44.2%)	2 (50%)	1.00

\*Fisher Exact Test

In the cases where the implant was lost (n=3), the bone level was more than 12 mm. In these cases, the quality of the bone could be described as a thick layer of compact cortical bone that surrounded a core of dense trabecular bone (quality type 2), or a thin layer of compact cortical bone that surrounded a core of dense trabecular bone of favorable strength (quality type 3). In one case of failure, the implant had no primary stability, possibly due to a torque of less than 32 Ncm, which is the minimum torque recommended in the literature.

Three implants out of 39 Brånemark System® implants (7.7%) failed and one of the 51 Replace® Select (2%) implants failed. The implants which were

lost were all inserted in the maxilla. Two of the failed implants replaced an anterior tooth and one a posterior tooth. These implants had a length and diameter of 13.0x3.75 mm (Brånemark) or 16.0x3.5 mm (Replace® Select). The Brånemark System® implant which lost the occlusal screw was inserted in the mandible in the posterior region. Its length and diameter was 11.5x5.0 mm.

Three failed implants (94.4%) had metal-ceramic crowns. The other implant had an allceramic crown. The anterior crowns did not make contact during lateral movements of the mandible. Loss of the occlusal screw occurred with a metal-ceramic crown.

## Discussion

In the present retrospective study, 90 implants supporting single crowns were placed according to a standardized one-stage surgical procedure and loaded by a provisional crown within 24 hours. The mean survival time was 18.5 months. Three implants (3.3%) of the 90 evaluated implants were lost after 1, 12 and 19 months respectively, and one implant (1.1%) lost its occlusal screw 5 months after insertion.

Many studies have illustrated that immediate loading of single-tooth implants is successful.<sup>(3-13)</sup> The success rate found in short-term (maximum up to 5 years) studies is generally higher than 85.7%.<sup>(3-13)</sup> Therefore, the survival rate in this current study (95.6%) is in agreement with the results of other investigations.

This present study evaluated Brånemark System® implants and Replace® Select implants. The Brånemark System® implant has been frequently investigated. There are several studies on Brånemark System® implants, with success rates between 85.7 and 100% after at least 1 year in function. In 2005, Djanrajani and Al-Rafee evaluated 16 immediately loaded implants and 123 delayed loaded implants. The implant systems of Brånemark, 3i, Calcitek Sulzer, and Steri-Oss were used. Two immediately loaded implants and five delayed loaded implants were lost. All of the lost implants were Brånemark.<sup>(11)</sup> In the current study, three of 39 Brånemark System® implants failed, resulting in a success rate of the Brånemark System® of 92.3%. In comparison with other studies using Brånemark System® implants, the success rate of this current research corresponds with those of other studies. The success rate of the Replace® Select implants was found to be 98%.

Some studies<sup>(5,7)</sup> have strict inclusion criteria, such as non-smokers, non-bruxisers, patients with a certain quantity and quality of bone, with a stable occlusion and a with high primary implant stability. These factors may play a role in the success rate of such studies, because the exclusion criteria can involve risk factors for the survival of implants and negatively influence the survival and success rate.

Precautions had to be taken against overload of the implant. Contacts in intercuspal position (ICP) and during lateral movements of the mandible were avoided in the present study, and postoperatively, the patient was instructed to have a soft diet and to avoid placing food on or near the implant for a period of six weeks. However, it is never known to the dentist whether the patient follows this advice. Hence, there is a chance that the pursued forces on the implant are too high and the implant is overloaded. A consequence of this overload can be that osseointegration is not achieved. In 1995, Block and Kent described conclusions of two investigations about premature loading. Those authors were persuaded that loading during the healing phase leads to implant motion, which can result in bone resorption and fibrous encapsulation by inhibiting new bone formation.<sup>(20)</sup>

Especially when the implant is loaded during the healing period, adequate primary stability is essential. In order to have primary stability, the implant must be inserted using a torque of at least 32 Ncm.<sup>(4)</sup> In this present study, two of 90 implants, which did not have primary stability, were inserted in the bone with a torque of less than 32 Ncm. One of them was lost. In 2002, Andersen et al. reported that implant stability varied according to the jaw and bone type. Immediate loading in the maxilla was associated with a higher risk than in the mandible, because of the trabecular nature of the bone.<sup>(6)</sup> Bischof et al. had the same conclusion.<sup>(21)</sup> According to this current research, there is no significant difference for primary stability between immediately and delayed loaded implants. The only factors which were found to affect primary stability were jaw and bone type. The current authors described that the implant stability in the mandible was higher and that those implants were more stable than the implants in the maxilla, with implants inserted into type I bone have more stability than when placed in type III bone.<sup>(21)</sup> Type I bone differs from type III in that type I contains a thicker layer of cortical bone than type III. The amount of cortical bone is important for increasing the osseointegration and stability of implants. It is possible that type III bone cannot give the implant enough stability to achieve osseointegration. The results in this current study correspond with these studies of Andersen et al. and Bischof et al.<sup>(3,21)</sup> The lost implants in this current study were all inserted into the maxilla. Two of these failed implants were placed in type III bone and one in type II bone.

Diabetes, smoking, alcohol consumption and parafunction were mentioned in this current study to be potential risk factors for implant failures. However, the four patients whose implant failed did not smoke nor use alcohol at all, and only one patient was a controlled diabetic. Despite the presence of parafunction, implants were still placed in the patient, because all provisional crowns were made completely out of any occlusal contact. However, all implants which failed were

involved in parafunction. Due to the excessive loading during the parafunction, the implant or the occlusal screw can be lost. Due to the low failure rate, the causes of these failures are speculative. However, parafunction seems to be a risk factor, because all four failed implants were in patients with a parafunction, such as bruxism and/or clenching.

The results of this present study have to be interpreted with caution. Based on these results, it is not possible to give predictions in general. There were only four failures, so it is impossible to determine if a certain factor is influential of the success rate of implants in general.

### Conclusion

This retrospective study on the success of immediate loading implants supporting single crowns yielded a survival rate of 95.6% (mean follow-up time: 25.7 months). Due to the small number of failures (4.4%), no definite conclusions can be drawn concerning the risk factors of success for the single-tooth implants, but parafunction seemed to play a major role. However, this study illustrates that immediate loading of single-tooth implants is successful, and that it is a reliable treatment option for replacing missing natural teeth to restore esthetics and function.

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