A 10-Year Evaluation of Implants Placed in Fresh Extraction Sockets: A Prospective Cohort Study

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Background: The placement of an implant into a fresh extraction socket has been identified as being a reliable technique allowing a reduction in the time needed for prosthetic rehabilitation. This treatment modality is widely reported in the scientific literature; however, the long-term outcomes and the need for guided bone regeneration (GBR) are still topics of debate. The aim of this prospective study was to evaluate the clinical and radiological findings from the 10-year follow-up of immediately placed implants, with and without the GBR procedure.

Materials and methods: 159 implants in 91 patients were included in this study; 101 implants required GBR procedure simultaneously with the placement. All implants were used to support a single crown restoration. The clinical/radiographic measurements were repeated each year up to the 10-year follow-up. At the 10-year follow-up visit, the Papilla Index and the apicocoronal location of midbuccal soft tissue positions were recorded.

Results: The 10-year cumulative success rate was 91.8% (87.9% in the non-GBR group and 94.1% in the GBR group). The clinical attachment level (CAL) measurements were stable throughout the study and 82% of the implants showed a marginal bone loss (MBL) between 0.6 and 1.5 mm at the 10-year visit; moreover, these two parameters did not show significant differences between the GBR and non-GBR groups. 70% of the implant sites showed acceptable outcomes in terms of interproximal papilla. The facial gingival level was more apical in the non-GBR group than in the GBR group ($P<0.05$).

Conclusions: The present prospective clinical study showed that implants placed in fresh extraction sockets had a high cumulative success rate, namely 91.8% after 10 years. No differences were detected in survival and success rate of implants either GBR procedures were performed or not. The CAL, MBL and marginal level of soft tissue measurements were stable throughout the 10-year evaluation.

KEY WORDS

immediate dental implants; prospective studies; aesthetic, dental; bone regenerations.

The placement of implants into fresh extraction sockets is defined as immediate placement. This procedure has been identified as being a reliable technique allowing a reduction in the time needed for prosthetic rehabilitation[1-2].

Although early studies demonstrated that implants placed in fresh extraction sockets may help to preserve the bone alveolar dimension[2-4], later studies performed in humans and experimental animals[5-6] demonstrated that such a technique was not capable of maintaining the alveolar bone crest in its original shape, after 3 or 4 months of healing. The clinical concern that arises from these studies is that

alteration in hard tissue following tooth extraction, may cause bone deficiencies in bone contours which eventually can compromise the aesthetic outcome of immediate implants.

Several approaches have been suggested to treat the gap around implants, in order to preserve or improve the dimension and contour of the ridge following tooth extraction and implant placement, including the use of various graft or filler materials[7, 8]. Some recent studies have demonstrated that the placement of bone substitutes into the gap between the implant and the buccal bone wall might modify the pattern of hard tissue modelling[9-11].

Recent systematic reviews including 'immediate implants'[1, 12] showed that the majority of included prospective and retrospective studies reported survival rate of over 95% in short to medium term follow-ups. Three retrospective studies, with a follow-up period longer than five years, reported a survival rate ranging from 95% to 100%. Four prospective studies with a 5-year follow-up period indicated survival rates which ranged from 90.4% to 94.9%; while Degidi et al.[13] using transmucosal implants with immediate restoration, and Botticelli et al.[14], on 18 submerged implants, reported survival rate of 92.5% and 100% respectively.

Moreover, it should be considered that mid-facial mucosa recession was reported to occur in a high percentage (40%) of immediate implants; this dimensional change was expected to have an adverse effect on aesthetic outcomes[5, 14, 15]. The findings that almost one-third of the immediate implants showed unsatisfactory aesthetic outcomes were associated with several factors such as the thickness of facial bone wall, tissue biotype and implant positioning within the extraction sockets[16, 17]. It should also be taken in consideration that most of the soft tissue changes, which are responsible for non-aesthetic outcomes, can continue after implant surgery even on a long-term basis[18]. There are still few studies that have evaluated the aesthetic outcomes using objective parameters.

The aim of the present 10-year prospective study was to evaluate the clinical and radiological long-term outcomes of implants placed in fresh extraction sockets, with or without augmentation procedures (GBR), supporting single crown restoration. A previous study reported data that had been collected over a 4-year time period[19].

MATERIALS AND METHODS

This study was a 10-year prospective, non-randomized clinical study which was designed to evaluate the cumulative success rate (CSR) of implants placed immediately after tooth extraction.

Treatments were carried out between 1996 and 1999 at the Tirrenian Stomatologic Institute, Versilia Hospital, Lido di Camaiore, Italy; all surgical procedures were performed by the same experienced operator (UC).

The following criteria were used to select eligible patients:

- Age > 18 yrs
- Need for tooth extraction and immediate implant placement
- Presence of a 4 mm (at least) apical root apex, adequate quantity and quality of native bone to guarantee primary implant stability

Exclusion criteria from the study were:

- Systemic pathologies contraindicating oral surgical procedures
- Not previously treated periodontitis

- Low level of compliance and psychiatric illness (not collaborative patients)
- Uncontrolled diabetes
- Acute infection at the tooth site
- Heavy smoking (>10 cigarettes/day)

All patients received thorough explanations and had to complete a written informed consent form prior to being enrolled in the trial. This study was approved by the human subjects ethics board of Versilia Hospital and the study was conducted in accordance with the Helsinki Declaration of 1975. After the informed consent had been signed, all patients underwent at least one oral hygiene session prior to the surgical procedures in order to provide an oral environment more favourable to wound healing. Each case was accurately evaluated examining diagnostic casts to assess the inter-arch relationship; moreover, peri-apical and panoramic radiographs were taken, while the computed tomography examination was requested only if considered necessary.

All patients received prophylactic antibiotic therapy of 2g of amoxicillin (or clindamycin 600mg if allergic to penicillin) 1 hour before the extraction and implant placement procedures and continued to take the antibiotic postoperatively - 1g amoxicillin (or 300 mg clindamycin) twice a day for 5 days. All patients rinsed for 1 minute with chlorhexidine mouthwash 0.2% prior to the surgery (and twice a day for the following 3 weeks), and were treated under local anesthesia using lidocaine with adrenaline 1:50,000.

All the patients were treated with the same surgical technique consisting of a tooth extraction and simultaneous implant placement as previously reported[19]. In brief, a full-thickness flap was elevated and two releasing incisions were performed extending over the mucogingival junction so that the soft tissue primary closure could be achieved. Tooth extractions were carried out with or without elevators to minimise the trauma; great care was taken to maintain the integrity of the buccal bone wall. After extraction, the socket was carefully curetted and, subsequently, the implant bed was prepared according to the standard procedure with standard drills following the palatal bony wall as a guide with maximum use of the bone apical to the removed tooth. The longest possible implants were placed with the implant platform placed at the marginal level of the buccal wall. All the implants showed a good primary stability. A periodontal probe was used to verify the integrity of the bone walls and to measure the peri-implant bone defect. The presence of a bone defect/dehiscence and residual gap between the implant surface and the bone wall larger than 2mm required an augmentation procedure using a mixture of autogenous bone and corticocancellous porcine bone# in a 1:1 ratio. Subsequently, a reabsorbable membrane** was used to stabilize the graft. After releasing periosteal incisions, the flaps were closed achieving a complete soft tissue closure. Antibiotics, anti-inflammatory and clorexidine mouthwash were prescribed to all patients. No removable prostheses were allowed for the first 3 weeks. Sutures were then removed after one week and the patients were seen monthly for prophylaxis. The second stage surgery was performed 6 months after implant placement. The impressions were taken and the implants were restored with a single implant supported crown. The final prosthetic rehabilitations consisted of ceramo-metal crowns, cemented on screw-retained solid abutments. The occlusion on prosthesis was designed to minimize the occlusal forces onto the implant and to maximize force distribution to adjacent natural teeth.[20] All patients were partially edentulous and participated in a personally tailored supportive periodontal treatment (their follow-up visit ranged from 2 to 4 months) compressive of periodontal debritement, root plannig in site with PD > 5 mm and polishing. At these visits, the conditions of the soft tissues, the patient's discomfort and any prosthetic complications were evaluated. The overall level of oral hygiene was also evaluated and further instructions were given as needed. Lastly, once a year a clinical and radiographic evaluation was performed.

The following outcome measures were considered:

-Implant success rate: implants removed were considered failures. Implant stability was manually assessed every year without removing the prosthetic rehabilitation, since each implant received a single crown restoration. The cumulative success rate was evaluated for the entire 10-year follow-up period. An implant was classified as successful when it fulfilled the criteria as defined by Buser et al.[21].

-Any biological or prosthetic complications including presence or absence of pain, suppuration, loosening of the crown or abutment, fracture of the porcelain were recorded.

-Peri-implant marginal bone loss was evaluated on intra-oral radiographs; a periapical radiograph was taken in a standardized manner using the long-cone paralleling technique with a commercial holder ††. A silicon occlusal jig was used to standardize the angulations and position of the film in line with the x-ray beam in order to ensure radiographic reproducibility during the follow-up period.[12] The bone level was measured as the distance from the implant shoulder to the first crestal bone contact (SBC – Shoulder to Bone Crest), mesially and distally to the implant.

-Clinical attachment level (CAL) was measured with a periodontal probe at four sites for each implant from implant shoulder to the apical penetration of the probe[25].

-Aesthetic treatment evaluation. This evaluation was performed only once at the 10-year recall visit and therefore can be considered a cross sectional analysis 10 years after implant placement.

The apicocoronal location of midbuccal soft tissue positions were evaluated measuring the distance from a reference line which connected the cementoenamel junctions (CEJs) of the adjacent teeth. Furthermore, the interdental papilla volume, 10 years after implant placement, was recorded on the basis of the index proposed by Jemt[23]:

Index 0 = no papilla is present.

Index 1 = less than half the papilla height is present.

Index 2 = more than half the papilla height is present but not to the contact point. The papilla is not in harmony.

Index 3 = papilla fills the entire proximal space and is in good harmony.

The measurements were performed by the two examiners on the same day for each site; in case of absence of agreement between the examiners, a third evaluation was scheduled with the two examiners until a final decision was reached.

Statistical Analysis

Statistical analysis included descriptive statistics for all clinical and radiographic parameters were carried out during the entire follow-up period. The Kaplan-Meier survival curve (with a log-rank test at a 95% confidence level) was used for the evaluation and the comparison of cumulative success rate between implants with or without GBR. Implant clinical measurements were calculated by averaging the readings of each implant parameter for each patient, since the within-subject variation was much lower than among-subject variation. Subsequently, the means and medians were calculated among the means per patient at each study time point. The comparison within each group of implants (with GBR and without GBR) between the different time points was performed with dependent student-t test (statistically significant at a level of $\alpha = 0.05$). The A P value was set at < 0.05 with the Bonferroni corrections for multiple comparisons.

All the data was analysed using dedicated statistical software ‡‡.

RESULTS

One hundred and fifteen patients were considered eligible for the study. However, 17 patients could not be enrolled in the study for the following reasons: 7 patients declined to participate in the study; ten patients were excluded during the extraction procedure because the post extraction socket did not allow for the insertion of an immediate implant. As a result, a total of 98 patients were enrolled in the study. Moreover, during the follow-up examinations seven patients discontinued the study and were excluded, therefore 91 patients (55 females and 36 males with an age range from 23 y.o. to 75 y.o.) eventually completed the 10-year longitudinal study. The selected patients were treated for tooth extraction and simultaneous implant placement from 1996 to 1999. All the patients completed the 10-year follow-up visit. The main baseline procedure characteristics are presented in Table 1.

One hundred and fifty-nine implants with a sand-blasted/acid-etched surface§§ were placed immediately after tooth extraction. The reasons for tooth extraction were as follows: 37% tooth fracture, 34.5% caries and endodontic treatment failure, 13.3% periodontal disease and 15.2% root resorption. Fifty-eight implants, placed in 35 patients did not require any augmentation procedures; the remaining 101 implants, placed in 56 patients, were treated with augmentation procedures.

In total 13 implants failed in the 10-year evaluation. Two implants failed during the initial healing period and showed signs of peri-implant infection, probably due to bacterial contamination of the implant surface and/or recipient site and were considered early failures. Other three implants, which showed progressive bone loss after prosthetic rehabilitation, failed after one to two years of follow-up; two had received GBR procedures. The remaining 8 implants failed after 5 years of loading, due to loss of osteointegration, and of these only three received GBR procedures. The time of failure and location of failed implants are reported in Table 2.

The remaining 146 implants fulfilled the success criteria, and the 10-year CSR for all immediate implant was 91.8%. The CSR for implants which did not receive augmentation procedures (non-GBR group) was 87.9% while for implants which had received augmentation (GBR group) it was 94.1%; Figure 1. shows details on the success rate of the 2 groups. There were no statistically significant differences between the two groups for the early or late implant failure rate over 10 years ($P>0.05$). All implants showed stable CAL measurements throughout the study (Table 3). The comparisons between GBR group versus non-GBR group were made for each time interval (Table 3); the mean clinical attachment level did not show any statistically significant difference ($P>0.05$) between the 2 groups at any recall visit. The mean CAL measurements in the non-GBR group ranged between 2.40mm and 2.86mm during the time interval from implant placement to the 10-year follow-up evaluation; whereas the range of clinical attachment level was between 2.28mm and 2.96 in the GBR group (Figure 2).

The mean marginal bone loss throughout all time points of the study was reported in Table 4. The largest estimated marginal bone loss occurred between the 1-year and 3-year recall visit. Subsequently, clinically non-significant marginal bone loss occurred. Lastly, at the 10-year recall visit 51% of the implant sites showed a marginal bone loss of between 0.6mm and 1.0mm, 31% of the implant sites showed a bone loss between 1.1mm and 1.5mm, whereas only 2% of the implant sites showed a marginal bone loss between 1.6mm and 2.0mm.

After 10 years the mean midbuccal soft tissue margin position for implants placed in fresh extraction sockets was 0.9±0.5 mm, apical to the reference line which connected the facial gingival level of adjacent natural teeth. A soft tissue position apical to the reference line will be reported as negative values; positive values will be considered as a soft tissue position coronal to the reference line. The facial gingival level was more apical in the non-GBR group (-1.1 ± 0.7mm) than in the GBR group (-0.7 ± 0.4 mm), the difference resulted in being statistically significant (P value < 0.05). No

differences were observed with regard to the soft tissue position at the interdental spaces. Changes in the mesial and distal papilla position showed that 27% of the implant sites had less than half the papilla height both mesially and distally. 57% of the sites had more than half the papilla height without a full extent to the contact point; 13% of the implant sites had interproximal papillae which were in good harmony (filling the entire proximal space) and 3% of the implant sites presented complete absence of the papilla.

All implants in the study supported a single ceramo-metal restoration; no implant was part of a fixed bridge or was connected to a natural tooth. The prosthetic rehabilitation was functional and in good condition throughout the 10-year period. There was no fracture of the abutments and/or prosthetic screws. Two crowns needed replacing due to chipping of the ceramic. Nine implants showed screw loosening and required crown removal and screw replacement.

DISCUSSION

The present prospective clinical study showed that implants placed in fresh extraction sockets had a high cumulative success rate, namely 91.8%, at the 10-year follow-up. Implant placement in fresh extraction sockets has been thoroughly documented and discussed in the literature, and consensus statements and recommendations have been drawn up [12, 16], even though a lack of long-term studies was highlighted. To the author's knowledge, this is the first prospective study completed over 10 years on 159 implants placed in fresh extraction sockets. The results of the present study were slightly less positive than those reported by Schwartz-Arad et al.[24] (95% over 4 to 7 years) and by Huys [25] (96.6% over 7 to 10 years) where grafting materials were used without barrier membranes. On the other hand, the findings from this study were similar to those reported by Polizzi et al. [26] (90.4% at 5 years) and Becker et al. [27] (94.9% at 5 years) using GBR procedures. This study showed that immediate implants guarantee as many reliable long-term results as implants placed in healed site[28, 29]; this observation was also supported by several comparative studies with medium term follow-ups[30].

Implant failures were observed during three different periods: before prosthetic rehabilitation, after the first year of occlusal loading or on a long term basis. Out of 13 failures 8 were in a premolar position. This finding was probably coincidental, even though it would have suggested a clustering effect to be the cause of failure.

The marginal bone loss was considered another primary clinical parameter in our study; overall, a crestal bone changes ranging from 0.6 to 1.5 mm was observed in 82% of experimental implants after 10 years. Based on the criteria for implant success proposed by Albrektsson et al.[31], bone resorption of 2.8 mm was considered physiological; therefore, in the present study 100% of survival implants may be considered successful. These findings were in agreement with several other studies showing that implants placed in fresh extraction sockets had an acceptable marginal bone stability [14]. In this regard, it should be taken into account that marginal bone remodelling is a biological phenomenon which is influenced by several factors such as macro- and microgeometry of the implant neck and implant-abutment connection[32- 34]. The implant system used in this study had a machined implant neck, an internal abutment connection and no switching platform interface.

The placement of an implant immediately after tooth extraction is often associated with a residual bone defect between the implant neck and the residual bone walls. Moreover, the placement of an implant into a fresh extraction socket failed to maintain the alveolar bone crest in its original shape. This demonstrated that such procedure did not influence the tissue alterations which naturally occurred after tooth extraction [5-7]. In the present clinical study, buccal bone defects and presence of marginal gaps larger than 2 mm were treated with augmentation procedures. The implants sites which required

augmentation received a grafting material (autogenous bone and corticocancellous porcine bone in a 1:1 ratio) in combination with a resorbable membrane. The use of barrier membranes could be affected by some clinical complications[2]. In this study, 10 patients who were treated with GBR procedure showed some minor complications during the healing phase, according to the outcomes which were previously reported[19]. Nonetheless, no implant failed for this reason alone.

The findings from this 10-year long-term study showed that were no differences in survival and success rate of implants either GBR procedures were performed or not. The distribution was not balanced between the groups with and without GBR and there was no randomization of treatment due to the anatomical condition of the extraction site. This means that GBR procedures were performed for implants which showed peri-implant bone defects, according to the parameters reported in the Materials and Methods section. Marginal bone changes after tooth extraction may cause insufficient bone thickness that may not be favourable especially in the long-term and thus should be supplemented by possible guided bone regeneration [35, 36].

All the successful implants had a stable clinical attachment level during the study; similar CAL values were found for both GBR and non-GBR implants. After the initial loss of attachment during the first 3 years, there was a fluctuation of the CAL values. These changes were probably related to limitations of the probing procedure (according to the probing method, measurements were rounded up to the nearest millimetre) more than with a true clinical attachment gain and loss.

All implants in this study were evaluated for their aesthetic outcomes according to an evaluation of the apicocoronal position of the facial and proximal soft tissue margins. The facial gingival level showed a mean recession of 0.9mm, a statistically significant difference was observed between GBR treated and non-GBR treated implants; they showed an apical displacement of facial gingiva of 0.7mm and 1.1mm respectively. Moreover, the papilla index showed that 57% of the experimental sites had more than half interproximal papilla without a full extent to the contact point; 13% of the experimental sites showed a complete interproximal papilla with a good harmony and only 3% of the sites showed a complete absence of interproximal papilla. With regard to the aesthetic outcomes it should be considered that the surgical treatments were carried out between 1997 and 1999 using the best available procedure at that time. The key factor applied during implant placement was to obtain good primary implant stability. The implants were placed toward the palatal aspect of the socket, the gap between buccal bone and implant surface was grafted when the horizontal defect dimension was higher than 2mm or in presence of dehiscence, and the mucoperiosteal flap was displaced to obtain a primary soft tissue closure.

Nowadays, it is well known that the surgical technique has a vital influence on the final aesthetic outcome for implants placed in extraction sockets [37, 38]. The absence of bone and/or soft tissue grafting on the facial aspect of the immediate implants could cause a soft tissue collapse, which can be responsible for some negative aesthetic effects [6, 39-40]. Therefore, a contour augmentation seems to be strongly recommended in postextraction sites [41-43]; moreover, the surgical procedure is usually performed without raising a flap[44] and placing a subepithelial connective tissue graft on the facial aspect [45]. This has been shown to enhance aesthetics and decrease gingival recession [46].

In addition, it should be noted that contour augmentation is strictly dependent on the characteristic of the biomaterial used. The soft tissues at the facial level need to be supported by a buccal bone wall with sufficient height and thickness. The use of non-resorbable biomaterials seems to optimize the augmentation volume at the implant surgery and to maintain on the long-term the augmented bone volume at the facial level due to the low substitution rate of these fillers[47-50]. It should be kept in mind that all the improved knowledge above reported was developed during the last 5-6 years, even if their

validity has not yet fully demonstrated their application during placement in fresh extraction sockets seems to be strongly recommended. Therefore, the findings from this study need to be interpreted with caution since the surgical technique performed at the beginning of the study wouldn't be performed nowadays. Despite this observation, the present study has provided some valuable information.

CONCLUSION

In conclusion, the outcomes presented in this study demonstrated that immediate implants with or without GBR procedures used to support single crown restorations, was a predictable treatment modality. The long-term data indicated that patients treated with implant placed in fresh extraction sockets did not seem to show compromised aesthetic outcomes, and that immediate implants were associated with a radiological and clinical stability of the peri-implant tissues. Furthermore, it should be taken into consideration that the surgical skills such as implant positioning within the extraction socket, soft tissue management and augmentation procedures might play a fundamental role in maintaining favourable contour of the facial tissues to support aesthetically acceptable implant-supported restorations. The hypothesis that augmentation procedures can be recommended in order to sustain the peri-implant tissues seems to be reliable, even if prospective randomized clinical trials would be necessary to validate and to accept it as routine in dental practices.

Finally, the high success rate observed in this study should be attributed to several factors, such as:

1) A strict oral hygiene regimen. It is well documented that the quality of the supportive therapy and the control of periimplant inflammation are of decisive importance for the long-term success of implant supported restorations.

2) Even if no general consensus exists on the role of overloading in the potential biomechanical complication around implants, all the restoration were single crown and careful attention was paid to prosthetic design, emergence profile and occlusal scheme. As a result, no major prosthetic complication occurred.

3) Lastly, all surgical procedures were performed by the same expert operator.

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CONFLICT OF INTEREST

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Figure 1.

Kaplan-Meier survival curves of GBR and no GBR implants.

Figure 2.

Mean Clinical Attachment Level (CAL) of implants: total, with and without GBR during the follow-up period.

Table 1. Implant location and treatment.

	Maxilla	Mandible	Total
Incisor	22 (13)*	27 (15)	49 (28)
Canine	14 (4)	19 (10)	33 (14)
Premolar	30 (4)	47 (31)	77 (35)
Total	66 (21)	93 (56)	159 (77)
*Number in parentheses indicate number of site receiving GBR			

Table 2. Time of failure and location of failed implants.

Implant	**Time of failure (months)**	**LOCATION**		**GBR**
		Maxilla	**Mandible**	
1	1		Premolar	NO
2	3	Canine		YES
3	13		Premolar	YES
4	18	Premolar		NO
5	19		Incisor	YES
6	60	Premolar		NO
7	65	Premolar		NO
8	70		Premolar	NO
9	90		Premolar	YES
10	90	Incisor		YES
11	100		Incisor	NO
12	100		Incisor	YES
13	100	Premolar		NO

Table 3. Mean Clinical Attachment Level (CAL) of all successful implant during the follow-up period.

CAL measurement (mm) – Successful Implants										
	1 yr	**2 yrs**	**3 yrs**	**4 yrs**	**5 yrs**	**6 yrs**	**7 yrs**	**8 yrs**	**9 yrs**	**10 yrs**
Mean	2.34	2.66	2.74	2.80	2.76	2.63	2.76	2.76	2.46	2.56
SD	0.63	0.45	0.56	0.48	0.73	0.61	0.63	0.53	0.63	0.73
Min	1.25	1.50	1.50	1.50	1.50	1.25	1.75	1.25	1.50	1.50
Max	3.75	3.75	3.75	4.00	3.75	3.75	3.50	3.50	3.75	3.50
Median	2.50	2.75	3.00	3.00	2.75	2.50	3.00	2.75	2.75	2.75
CAL measurement (mm) - Implants without GBR										
	1 yr	**2 yrs**	**3 yrs**	**4 yrs**	**5 yrs**	**6 yrs**	**7 yrs**	**8 yrs**	**9 yrs**	**10 yrs**
Mean	2.40	2.77	2.59	2.69	2.86	2.60	2.70	2.66	2.60	2.69
SD	0.60	0.65	0.65	0.40	0.40	0.65	0.45	0.45	0.67	0.47
Min	1.50	1.50	1.50	1.50	1.50	1.25	1.50	1.25	1.25	1.50
Max	3.75	3.75	3.75	3.75	3.75	3.75	3.50	3.50	3.75	3.50
Median	2.50	2.75	2.75	3.00	2.75	2.75	3.00	2.75	2.75	2.75
CAL measurement (mm) - Implants with GBR										
	1 yr	**2 yrs**	**3 yrs**	**4 yrs**	**5 yrs**	**6 yrs**	**7 yrs**	**8 yrs**	**9 yrs**	**10 yrs**
Mean	2.28	2.55	2.89	2.96	2.66	2.66	2.82	2.86	2.32	2.43
SD	0.63	0.65	0.41	0.67	0.75	0.67	0.73	0.67	0.45	0.75
Min	1.25	1.50	1.50	1.50	1.50	1.50	1.75	1.50	1.50	1.25
Max	3.50	3.75	3.75	4.00	3.75	3.75	3.75	3.50	3.50	3.50
Median	2.50	2.75	3.00	3.00	2.75	2.75	3.00	2.75	2.75	2.75

Table 4. Distribution of implants [Number of implants; (%)] with regard to crestal bone contact in relation to the implant shoulder (SBC) during the different time points of the study.

mm	**1 yr**	**2 yrs**	**3 yrs**	**4 yrs**	**5 yrs**	**6 yrs**	**7 yrs**	**8 yrs**	**9 yrs**	**10 yrs**
0	69 (44)	50 (33)	30 (20)	10 (7)	5 (3)	5 (3)	-	-	-	-
0.1-0.5	43 (27)	55 (36)	53 (34)	67 (43)	43 (28)	40 (27)	39 (25)	37 (25)	30 (20)	24 (16)
0.6-1.0	45 (29)	47 (31)	47 (31)	53 (34)	58 (38)	59 (39)	65 (43)	63 (42)	71 (48)	75 (51)
1.1-1.5	-	2 (0)	23 (15)	20 (13)	36 (23)	39 (26)	43 (29)	45 (30)	43 (30)	45 (31)
1.6-2	-	-	1 (0)	4 (3)	11 (8)	8 (5)	4 (3)	4 (3)	2 (2)	2 (2)

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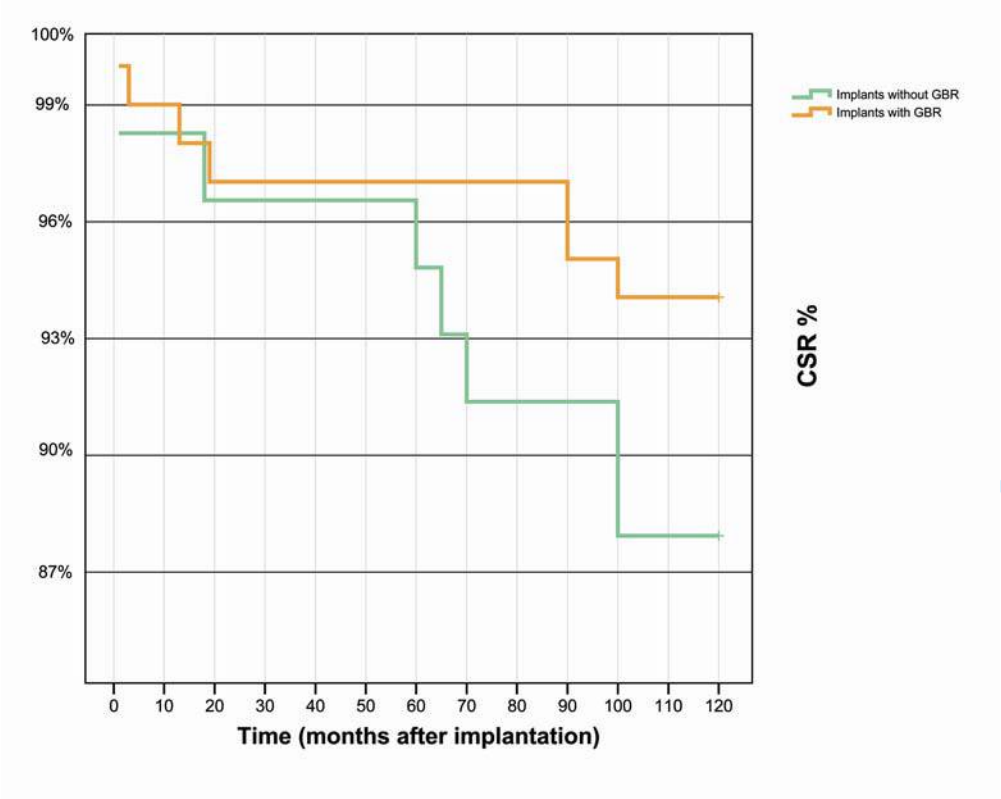

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