Lethal Photosensitization, Autogenous Bone, and e-PTFE Membrane for the Treatment of Peri-implantitis: Preliminary Results

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This clinical study reports on the results of a new method in the treatment of peri-implantitis. The surfaces of 24 plasma flame–sprayed cylindric implants in 17 patients who were diagnosed with peri-implantitis were decontaminated with a combination of toluidine blue (100 µg/mL) and laser irradiation at a wavelength of 906 nm. Bone defects were filled with autogenous bone using e-PTFE membranes for retention of the grafting material. Premature membrane exposure occurred in all patients after an average of 3 weeks (± 10 days), which required immediate removal of the exposed membrane in 1 patient. Since the soft tissue showed minimal signs of inflammation, the membranes were left in situ for another 6 weeks in all other patients. The mean radiographic peri-implant bone gain was 2 mm ± 1.90 mm after 9.5 months (maxilla 2.5 mm ± 2.38 mm; mandible 1.9 mm ± 1.87 mm). Two implants around which the initial bone defect had already reached the basket had to be removed after 10 months and 35 months, respectively, despite radiographic evidence of improvement of the peri-implant defect. The longer the membrane stayed in situ, the more bone was gained, as long as the membrane was covered by soft tissue (P = .01). However, the longer an exposed membrane was left in place, the smaller the resultant bone gain (P = .0001). Therefore, despite the absence of clinical signs of inflammation, exposed membranes should be removed immediately. The short-term results of this study corroborate the efficacy of the applied treatment method in prolonging the service time of dental implants involved with peri-implantitis. (Int J Oral Maxillofac Implants 2000; 15:374–382)

Key words: *autogenous bone, endosseous dental implantation, guided tissue regeneration, laser therapy*

The widespread use of implants in dentistry has led to an increasing number of implant failures, which, among other causes, may be the result of increased and progressive bone resorption following osseointegration in the presence of peri-implantitis. Peri-implantitis is assumed to result either from bacterial causes[1–3] or from occlusal overload.[4–7] Multiple efforts are currently being made to find the optimal treatment approach, among these guided bone regeneration (GBR)[8,9] with or without augmentation of grafting materials such as autogenous bone,[10] hydroxyapatite,[8,9] or demineralized freeze-dried bone.[8,9] Attempts have been made by Lang et al[11] and Spiekermann,[12] who proposed a classification of peri-implantitis depending on the clinical and radiographic morphology of the peri-implant defect, to propose guidelines for different treatment modalities. However, the clinical outcome on the basis of these treatment guidelines is still not clear.

Treatment methods should be directed toward eliminating the causes of peri-implantitis and re-establishing the original peri-implant conditions. Basically, 2 treatment methods exist: *resective* and *regenerative*. Resective implant treatment attempts to eliminate the etiologic factors and maintain

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optimal peri-implant conditions, mainly by cleaning the surfaces of the implants. A number of mechanical,[8,9] chemical,[13] and physical[14] methods have been described for decontamination. Decontamination with a soft laser following application of a photosensitizing substance (toluidine blue O) was tested on titanium platelets with different surface structures in an experimental study.[14] After treatment, single anaerobic bacteria were identified under the electron microscope, but smears indicated no further bacterial growth in cultures. Furthermore, this method proved to be effective in preliminary clinical results for decontamination of titanium plasma flame–sprayed implant surfaces.[15]

Regenerative treatment aims to reduce the peri-implant bone defect and to achieve reosseointegration. Surgical methods which have been described include GBR by means of resorbable[16] and non-resorbable membranes,[13,17–19] with or without grafting material. Examples of grafting materials are autogenous bone,[10,20] freeze-dried bone,[8,9] and hydroxyapatite,[8,9] among other bone substitutes. However, experimental[7,10,13,17,18,21–23] and clinical[19,20,24] studies investigating the regenerative treatment of peri-implantitis have been reported with controversial results. Guided bone regeneration without grafting material (non-resorbable membrane) has exhibited both positive[8–10,17,22,23] and negative[13,18,21] results in animal experiments. Augthun et al[19] were not able to treat peri-implantitis successfully by the use of GBR in a clinical study. Possible reasons for these diverse findings may be different defect morphologies and various decontamination methods used in vivo and in vitro.

Günay et al[10] found that filling of defects with autogenous bone without application of a membrane was inferior to GBR alone. Behneke et al,[20] on the other hand, achieved reduction of the defect by about 50% using autogenous bone grafts alone in a clinical study. No clinical or experimental studies have been reported on the combined use of GBR and autogenous bone. A few clinical studies that have been published investigating the treatment of peri-implantitis represent mainly case reports, and these have reported quite controversial findings.[16,19,24,25]

The aim of this clinical study was to examine the clinical efficacy of a treatment concept that combines implant decontamination by means of soft laser and GBR with autogenous bone grafts.

MATERIALS AND METHODS

This study included patients who had been treated with IMZ implants (Friatec, Mannheim, Germany) and who were diagnosed with peri-implantitis both clinically and radiographically. The peri-implant tissue was examined for signs of inflammation such as reddening, swelling, and secretion (based on the gingival index according to Löe and Silness[26]) as well as bleeding on probing.[27,28] Measurements of pocket depth were carried out mesially, buccally, distally, and lingually to the implant with a periodontal probe (Hu-Friedy, Chicago, IL). Morphology of the defect's mesial and distal depths was evaluated by means of orthopantomography and dental radiography. Indication for the treatment of peri-implantitis was defined as an infrabony pocket depth of more than 6 mm and progressive bone loss during the last year of observation. Furthermore, only patients who demonstrated a mainly narrow vertical bone defect were included[21,29]; patients with mainly horizontal bone loss were excluded. All operations were carried out by the same surgeon. All procedures to be performed were explained, and patients gave their written consent.

Surgical Procedure

The cervical aspect of the implant was circumscribed, the incision was extended into the vestibule mesially and distally, and a mucoperiosteal flap was raised. Granulation tissue within the bone crater was curretted with a sharp spoon. Following removal of the concrement, the implant surface was treated by means of toluidine blue O (100 µg/mL) (Toluidinblau O Zinkchlorid Dopplersalz, Merck KGaA, Vienna, Austria) for 1 minute. After the tissue was rinsed thoroughly with physiologic saline solution, soft laser light with a wavelength of 906 nm was applied buccally and lingually for 1 minute each.

The defect was filled with autogenous bone harvested with a trephine from adjacent areas or the chin region. If necessary, the bone defect was freshened by means of 1-mm drillings. The autogenous bone material was ground in a bone mill and condensed within the crater. A centrally perforated expanded polytetrafluoroethylene (e-PTFE) membrane (W. L. Gore, Flagstaff, AZ) was then placed over the defect. The head of the implant projected through the punched-out hole of the membrane, which was fixed buccally by titanium nails. The mesiostructure of the implant was removed and replaced by a cover screw. Finally, the mucosal flap was sutured back into position to submerge the treated implants. If necessary, this was done by mobilizing the mucoperiosteal flap.

Postoperatively, the patients were administered penicillin (Augmentin, SmithKline Beecham, Mayenne, France) orally for 5 days as well as antiphlogistic medication (Seractil, Gebro, Fieberbrunn, Austria). If possible, the suprastructure was

Table 1 No. of Patients (Implants), Listed Separately by Sex, Type of Dentition, and Location

	Female		Male		
Indication	Maxilla	Mandible	Maxilla	Mandible	Total
Total edentulism	1 (2)	4 (5)	0	1 (1)	6 (8)
Partial edentulism	1 (1)	7 (11)	0	3 (4)	11 (16)
Both groups	2 (3)	11 (16)	0	4 (5)	17 (24)

reconnected, avoiding the treated implant. Initially, all patients were recalled weekly; later they were seen at 2-week intervals. The membranes were scheduled for removal 3 months after placement. When premature membrane exposure occurred, the patient was instructed to rinse with chlorhexidine gluconate. If signs of soft tissue inflammation appeared, the membrane was removed immediately.

The dimensions of the defect were measured mesially, buccally, distally, and lingually at both the first and second surgical procedures. The last follow-up radiograph, obtained using the paralleling technique for each patient, was used to evaluate the treatment result. Peri-implant bone loss was assessed by taking into account the magnification factor, which was calculated on the basis of the known implant length.

Statistical Analysis

For statistical analysis, the mean values and standard deviations of the bone defect, pretreatment as well as posttreatment, were calculated using the SAS program package (SAS, Cary, NC). Statistical significance of defect reduction was determined by Wilcoxon's signed rank test. For further statistical analysis, the mean values of the mesial and distal bone defect were used. Correlation analysis with Spearman's correlation coefficient was carried out for bone defect, period of membrane application, time until membrane exposure, and period between membrane removal and follow-up radiography.

Statistical analysis was carried out for:

- The maxilla and the mandible, both together and separately. (Further statistical analysis of maxillary results was not possible, because of the small number of treated implants.)
- All implants, as well as only 1 implant per patient.

Where there was more than 1 treated implant per patient, the value of the second implant was excluded from evaluation, and only 1 implant per patient, chosen at random, was considered in the calculation. *P* values less than .05 were considered statistically significant.

RESULTS

The study included 17 patients with a total of 24 IMZ implants. Three implants in 2 patients were located in the maxilla, and 21 implants in 15 patients were located in the mandible (Table 1). Five completely edentulous patients wore bar-retained overdentures and 1 patient wore an implant-supported prosthesis. Of the 11 partially edentulous patients, 5 were treated with a fixed implant-supported prosthesis and 6 wore a tooth/implant-supported prosthesis. Exact implant locations are provided in Table 2.

Following uneventful primary wound healing, exposure of the membrane occurred in all patients after a mean of 3 weeks (± 10 days) postoperatively (Figs 1a to 1e). For 23 implants in 16 patients, the exposed membrane was left in place another 6 weeks on average because of healthy soft tissue conditions (Table 3). In only 1 patient was it necessary to remove the membrane immediately as a result of suppuration.

At the start of treatment, the mean defect depth was 5.5 mm ± 2.0 mm (maxilla 7.2 mm ± 2.18 mm; mandible 5.3 mm ± 1.90 mm). The radiographically measured mean bone gain was 2 mm ± 1.9 mm (36.4%) and was statistically significant ($P = .0001$) (maxilla 2.5 mm ± 2.38 mm, 34.7%; mandible 1.9 mm ± 1.87 mm, 35.8%; $P = .0001$) (Figs 2a and 2b). Twenty-one implants showed reduction of the bone defect after a mean observation period of 9.5 months. Only 2 implants exhibited bone resorption of 0.5 mm each, while the defect depth remained unchanged in 1 implant. At the time of membrane removal, the mean bone gain was 1.2 mm ± 1.7 mm (21.8% gain; $P = .036$) in 13 patients with a total of 17 implants. In 4 patients with 7 implants, it was not possible to assess these data (Table 4).

The total period of membrane application (exposed and unexposed) and especially the duration of the exposed membranes remaining in situ, which amounted to 70% of the total application period on average, had a statistically significant negative effect on bone growth (total time, $r = –0.62$, $P = .001$; time in situ for exposed membranes, $r = –0.78$; $P = .0001$).

Table 2 Treated Implant Location, Prosthetic Treatment, and Opposing Arch

Patient no.	Patient	Location	Prosthetic treatment	Opposing arch
1	G.C.	Maxillary left second molar	Tooth implant/supported prosthesis	Natural dentition
2	K.J.	Maxillary right first and second molars	Bar-retained overdenture	Tooth/supported prosthesis
3	B.A.	Mandibular right first molar	Implant-supported prosthesis	Natural dentition
4	H.I.	Mandibular left second premolar and first molar	Tooth/implant-supported prosthesis	Natural dentition
5	H.L.	Mandibular left first and second molars	Tooth/implant-supported prosthesis	Natural dentition
6	K.R.	Mandibular left first molar	Implant-supported prosthesis	Natural dentition
7	K.-W.C.	Mandibular right first and second molars	Implant-supported prosthesis	Natural dentition
8	M.A.	Mandibular left first and second molars	Implant-supported prosthesis	Natural dentition
9	N.G.	Mandibular left second premolar	Tooth/implant-supported prosthesis	Fixed partial denture
10	O.G.	Mandibular right first molar	Tooth/implant-supported prosthesis	Natural dentition
11	P.I.	Mandibular right first premolar and first molar	Implant-supported prosthesis	Natural dentition
12	P.-T.S.	Mandibular right second premolar	Implant-supported prosthesis	Implant-supported prosthesis
13	P.H.	Mandibular right first premolar	Bar-retained overdenture	Partial denture
14	P.M.	Mandibular right lateral incisor and first premolar	Bar-retained overdenture	Bar-retained overdenture
15	Sch.H.	Mandibular right lateral incisor	Bar-retained overdenture	Complete denture
16	St.C.	Mandibular left first molar	Tooth/implant-supported prosthesis	Natural dentition
17	W.M.	Mandibular right lateral incisor	Bar-retained overdenture	Complete denture

The longer the exposed membrane was left in place, the smaller the reduction of the bony defect. If the membrane was covered by soft tissue for a long period of time, a statistically significant positive effect on bone growth was seen at the time of membrane removal ($r = 0.68$, $P = .01$). Rather, a slight decrease in the peri-implant bone crater was observed between the removal of the membrane and the last follow-up radiograph ($r = –0.29$, $P = .17$). When the calculations were carried out by taking into account only 1 implant to avoid possible false significant influences, no change in results was obtained.

Two patients showed an unfavorable starting situation because the bone defect had already reached the basket. Despite initial clinical and radiographic improvement, both implants had to be removed after 10 months and 35 months, respectively (Table 4).

DISCUSSION

The present study reports on a treatment modality for peri-implantitis that combines implant decontamination by means of soft laser and a photosensitizing substance with GBR. Application of toluidine blue O in humans was possible since no carcinogenic potential was seen in the experimental design[30] and toluidine blue O is widely used in local,[31] oral,[32] and parenteral[33] diagnosis and treatment. Nonresorbable membranes were used for GBR, and defects were additionally filled with autogenous bone grafts. The success of treatment was evaluated at the time of membrane removal with a periodontal probe and thereafter by means of radiography. No further clinical parameters were assessed, since radiography is the only generally accepted reliable diagnostic tool for peri-implantitis.[6,34] Horizontal defects were not included in this study.[21,29]

Contrary to other studies, which have utilized mechanical[8,9] or chemical[13] measures for decontamination of the implant surface, a combination of laser and a photosensitizing substance was used in this study. In experimental evaluations,[14] this method has been shown to be effective in decontaminating smooth machine-polished, plasma flame–sprayed, and hydroxyapatite-coated titanium surfaces of *Actinobacillus actinomycetemcomitans*, *Porphyromonas gingivalis*, and *Prevotella intermedia*. The advantage of this method is the lack of any surface alteration.[14]

The applied treatment concept was shown to be very effective in the treatment of peri-implantitis in both maxillae and mandibles. A mean reduction in the bone defect of 2 mm was achieved. In only 3 of 24 implants did the defect either remain unchanged (1 implant) or increase by 0.5 mm (2 implants). Since to the author's knowledge no clinical or experimental studies investigating the treatment of peri-implantitis by means of autogenous bone and GBR have been published, a direct comparison with other findings was not possible.

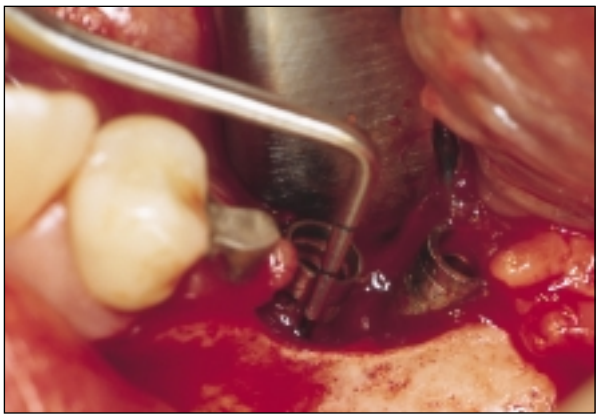

Fig 1a Intraoperative view after removal of soft tissue exposing a crater-like peri-implant defect. The periodontal probe is placed in the buccal aspect.

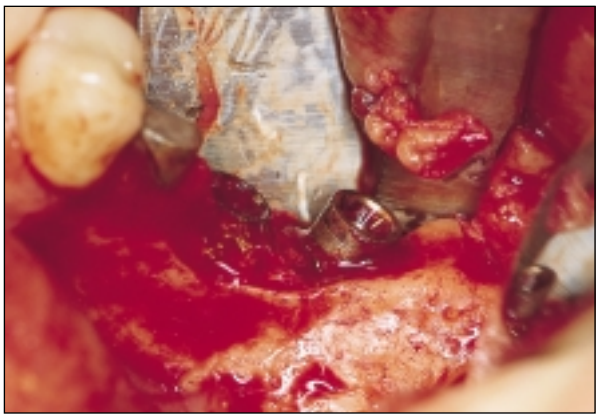

Fig 1b The peri-implant defect is filled with autogenous bone harvested from the posterior region of the mandible.

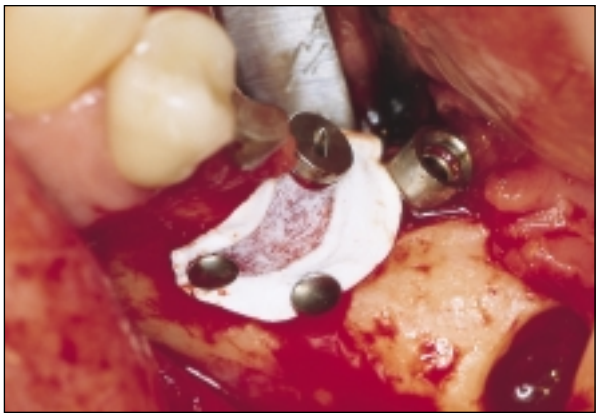

Fig 1c A centrally perforated e-PTFE membrane is placed over the defect without covering the head of the implant.

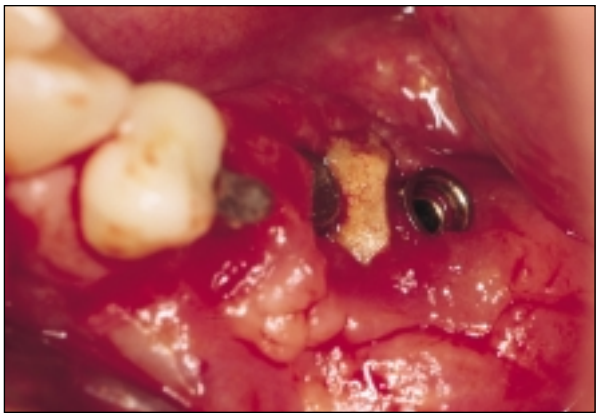

Fig 1d Partly exposed membrane 45 days after placement.

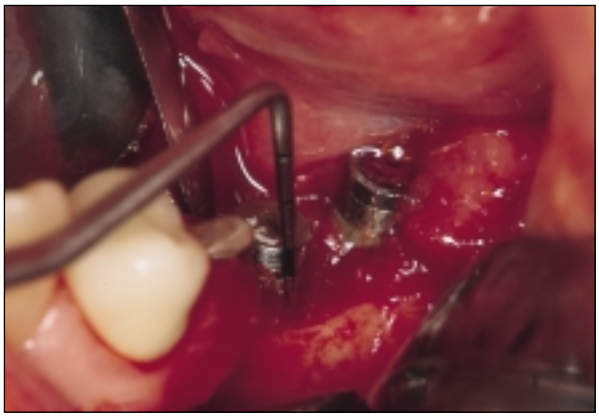

Fig 1e Intraoperative view immediately after membrane removal. The periodontal probe is placed at the same point as in Fig 1a.

Table 3 Duration of Membrane Application

				No. of days membrane in situ		
Patient no.	Initials	Sex	Location	Total	Placement to exposure	Exposure to removal
1	G.C.	F	Maxilla	39	39	0
2	K.J.	F	Maxilla	63	9	54
			Maxilla	63	9	54
3	B.A.	M	Mandible	64	23	41
4	H.I.	F	Mandible	65	45	20
			Mandible	65	45	20
5	H.L.	F	Mandible	23	18	5
			Mandible	23	18	5
6	K.R.	F	Mandible	35	26	9
7	K.-W.C.	F	Mandible	37	16	21
			Mandible	37	16	21
8	M.A.	M	Mandible	107	22	85
			Mandible	107	22	85
9	N.G.	F	Mandible	65	10	55
10	O.G.	F	Mandible	25	8	17
11	P.I.	F	Mandible	98	22	76
			Mandible	98	22	76
12	P.-T.S.	F	Mandible	70	14	56
13	P.H.	F	Mandible	15	13	2
14	P.M.	F	Mandible	117	20	97
			Mandible	117	20	97
15	Sch.H.	F	Mandible	37	20	17
16	St.C.	M	Mandible	57	25	32
17	W.M.	M	Mandible	130	25	105
Mean ± SD				66.3 ± 34.3	21.4 ± 10.0	44.9 ± 34.3

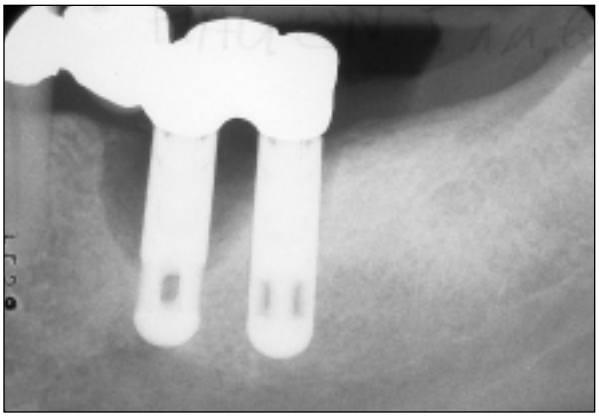

Fig 2a Preoperative radiograph of the same patient shown in Figs 1a to 1e.

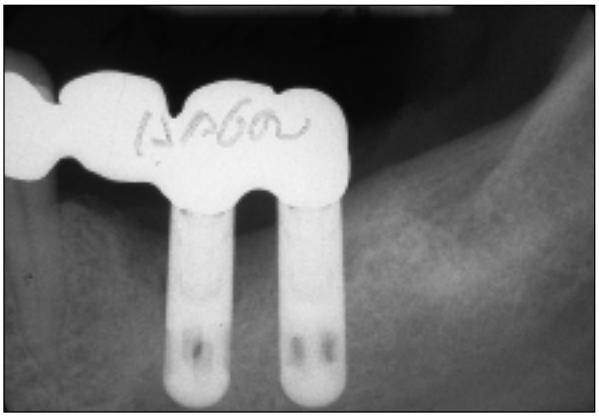

Fig 2b Radiographic examination 4 months after surgery.

Table 4 Mean Defect Depth at the Start of Treatment and Changes in Depth at the Time of Membrane Removal and at the Evaluation of Treatment Success

		Mean defect depth (mm)			Mean change in defect depth (mm)		Mean change in defect depth (%)		
Patient no./Sex	Location	Initial	Membrane removal	Follow-up radiograph	Membrane removal	Follow-up radiograph	Membrane removal	Follow-up radiograph	Implant failure
1/F	Maxilla	9.00	6.00	4.00	3.00	5.00	33.3	55.6	
2/F	Maxilla	7.75	8.25	5.50	–0.50	2.25	–6.5	29.0	
	Maxilla	4.75	5.75	4.50	–1.00	0.25	–21.0	5.3	
3/M	Mandible	7.00	6.00	6.25	1.00	0.75	14.3	10.7	
4/F	Mandible	8.25	4.50	1.00	3.75	7.25	45.5	87.9	
	Mandible	2.50	2.25	0.00	0.25	2.50	10.0	100	
5/F	Mandible	8.25	6.00	4.50	2.25	3.75	27.3	45.5	
	Mandible	5.75	5.50	3.25	0.25	2.50	4.3	43.5	
6/F	Mandible	6.75	3.75	2.50	3.00	4.25	44.4	68.0	
7/F	Mandible	5.25	N/A	4.50	N/A	0.75	N/A	14.3	Failure
	Mandible	5.25	N/A	3.50	N/A	1.75	N/A	33.3	
8/M	Mandible	2.00	N/A	1.25	N/A	0.75	N/A	37.5	
	Mandible	3.50	N/A	4.00	N/A	–0.50	N/A	–14.3	
9/F	Mandible	6.75	4.25	4.00	2.50	2.75	37.0	40.7	
10/F	Mandible	5.25	N/A	3.25	N/A	2.00	N/A	38.1	Failure
11/F	Mandible	4.50	4.75	5.00	–0.25	–0.50	–5.6	11.1	
	Mandible	2.00	2.25	2.00	–0.25	0.00	–12.5	0.0	
12/F	Mandible	5.50	4.75	5.00	0.75	0.50	13.6	9.1	
13/F	Mandible	8.00	5.00	4.50	3.00	3.50	37.5	43.8	
14/F	Mandible	4.00	3.00	3.50	1.00	0.50	25.0	12.5	
	Mandible	3.50	1.75	3.25	1.75	0.25	50.0	7.1	
15/F	Mandible	5.50	N/A	2.00	N/A	3.50	N/A	63.6	
16/M	Mandible	5.25	N/A	3.25	N/A	2.00	N/A	38.1	
17/M	Mandible	6.50	6.00	5.00	0.50	1.50	7.7	23.1	
Mean ± SD		5.50 ± 2.00	4.70 ± 1.70	3.60 ± 1.90	1.20 ± 1.70	2.00 ± 1.90	21.8	36.4	

N/A = could not be assessed.

Comparable bone gains were achieved by means of GBR without the additional use of grafting material in animal experiments carried out by Wetzel et al[23] (2.6 mm ± 0.69 mm), Hürzeler et al[9] (2.5 mm ± 0.3 mm), Singh et al[22] (2.13 mm), and Persson et al[13] (1.48 mm ± 0.24 mm). On the other hand, this method resulted in bone loss in an experimental study carried out by Grunder et al[21] (–0.1 mm ± 0.1 mm), as well as a clinical study conducted by Augthun et al[19] (–0.8 mm). Slightly better results than in the present study were achieved by Hürzeler et al[9] (3.0 mm ± 0.5 mm), who used GBR and additional filling of the defect with freeze-dried bone in dogs 5 months postoperatively. Behneke et al[20] carried out a clinical study using autogenous block grafts for reconstruction of peri-implant defects. They achieved a reduction in defect depth of 3.7 mm on average, but only 7 implants were taken into account.

Differences in treatment outcome between the maxilla and the mandible, which differ in both bone quality and blood supply, were not observed in the present study. This seems to be related to the small number of maxillary implants (n = 3) included. The above-average gain in the maxilla (2.5 mm) can thus be attributed to the fact that single values had a strong impact on the outcome.

In situations of advanced bone defects, where the basket is at least partially exposed, the method used does not seem to be suitable.[23] The implants of both patients who had shown such conditions had to be removed, despite a radiographic decrease in the bone defect.

The optimum period of membrane application is still unclear and has been discussed with controversy. Recommended application periods range from 4 weeks[18,21] to 6 months.[24,35] Although the membranes did not remain covered for more than 45 days in any patient examined in this study, bone gains were achieved. A remarkable finding of this study was that all patients showed premature exposure of the membrane.

The longer the membrane remained covered by soft tissue, thus not coming into contact with the oral flora, the greater was the bone gain. Thus it can be assumed that the membrane exerts a positive influence on bone growth as long as it stays submerged. This positive effect was also observed in a number of case reports[24,36–39] and experimental studies,[10] where a clear

bone gain was observed after a sufficiently long period of membrane application. Furthermore, it was found that bone gains lessened the longer the exposed membrane stayed in situ. In support of these findings, Jovanovic et al[17] and Augthun et al[19] also observed a negative effect of exposed membranes on bone growth.

Obviously microorganisms were capable of penetrating the membrane, despite the absence of clinically evident inflammation and antimicrobial measures, and thus the peri-implant inflammatory process was maintained or reinduced. An exposed membrane is colonized mainly by periodontal pathogenic microorganisms (eg, *P gingivalis*, *Streptococcus spp*, *Actinomyces spp)*,[40–43] which subsequently colonize the peri-implant tissue beneath the membrane, either by direct penetration of the porous e-PTFE membrane[43] or by invasion through the non–bacteria-proof gap around the implant. Although a superficial lack of soft tissue inflammation was achieved by means of local anti-inflammatory measures, it apparently was not possible to prevent a reinduction of the peri-implant inflammatory process in deep layers, which resulted in an adverse effect on bone growth.

Membrane exposure is reported frequently when non-resorbable membranes are used for the treatment of peri-implantitis.[10,17,19,21,23] The reasons for this increased rate of complication are unknown. A possible way to exclude the risk of membrane exposure is to not use membranes at all. However, this would also mean giving up possible favorable effects. Two experimental studies came to the conclusion that the filling of defects with a bone substitute (hydroxyapatite, demineralized freeze-dried bone)[8,9] or autogenous bone[10] alone is clearly inferior to GBR. Another way to reduce the rate of complication is possibly by using resorbable membranes. However, it is not known if similar effects would be observed, as in the case of unexposed nonresorbable membranes. It can be assumed that membranes serve their purpose within a relative short period of time. Thus it seems that the minimum period of membrane application of 6 months postulated by one author[31] need not necessarily be observed, or should only be observed if membrane healing occurs without any complications. According to the findings of this study, the membrane should be removed immediately in case of exposure, even if no clinical signs of inflammation are visible.

CONCLUSION

The following conclusions can be drawn from the results of this study:

- Photosensitizing treatment and augmentation by means of autogenous bone grafts and the membrane technique resulted in a significant reduction of the peri-implant bone defect.
- This treatment concept was shown to be successful in both maxillae and mandibles.
- An exposed membrane should be removed immediately, even if there are no signs of soft tissue inflammation.

Consideration should be given to the determination of whether or not a modified decontamination method would help avoid premature exposure of the membrane and possibly have an additional favorable effect on the treatment results. Furthermore, it should be examined whether resorbable membranes are preferable to non-resorbable ones, and whether the treatment outcome could be improved by not using a membrane at all. The use of a photodynamic treatment in combination with soft laser, autogenous bone grafts, and membrane placement facilitates partial restoration or vertical peri-implant bone defects around plasma spray–coated cylindric implants. It remains to be seen whether this method will also yield favorable long-term results.

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