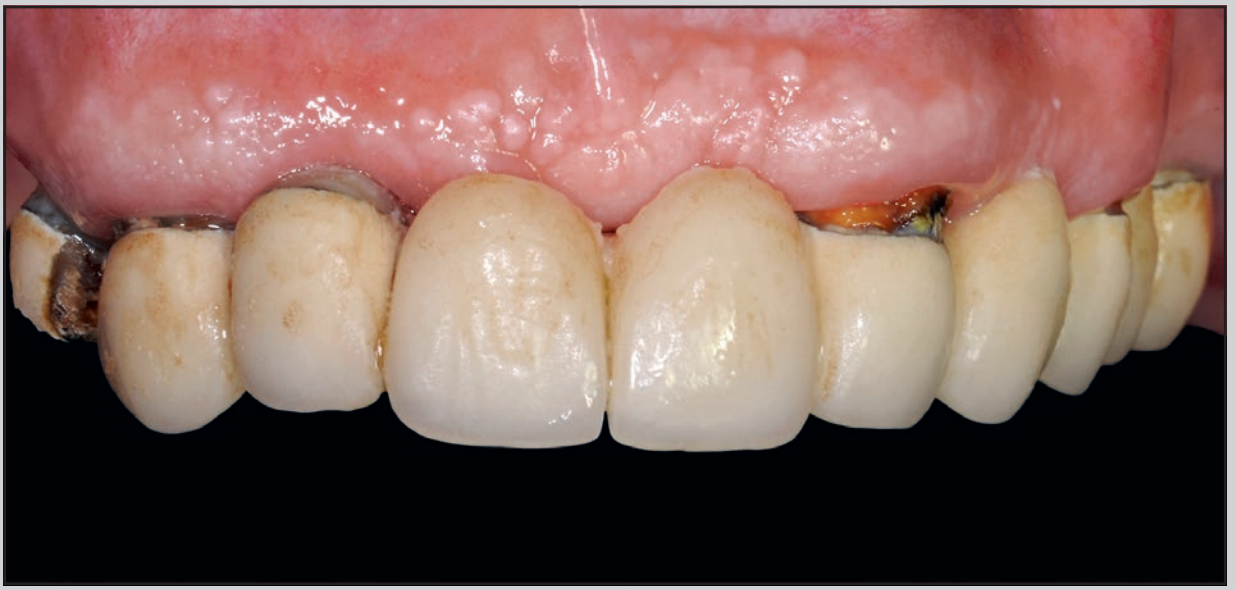

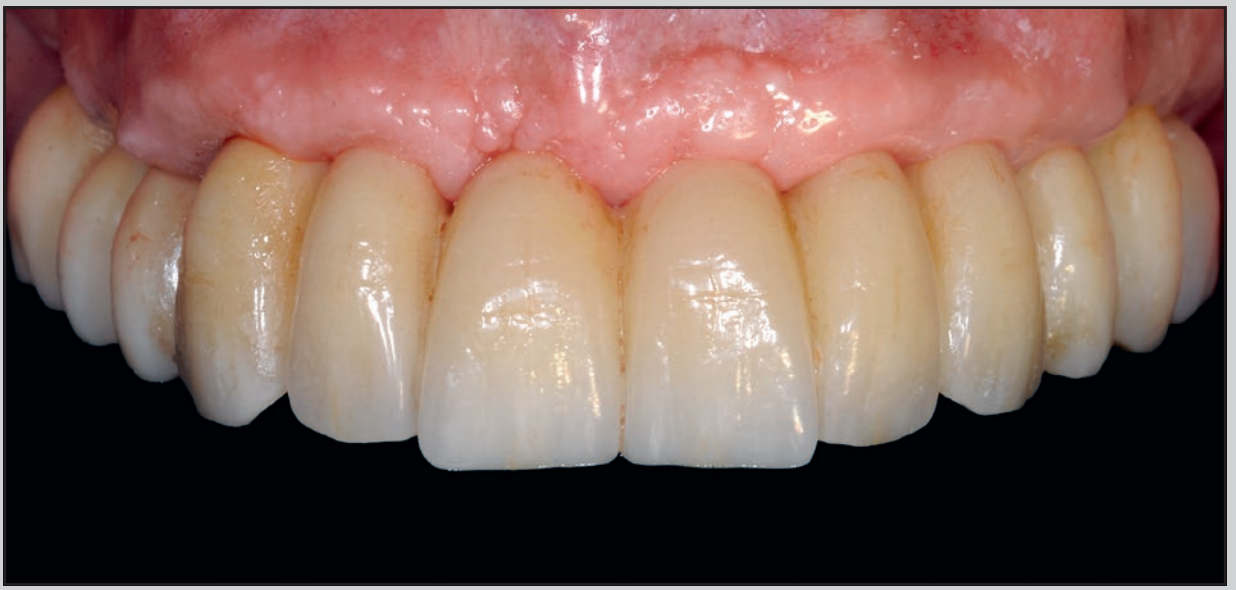

Implant Rehabilitation According to the Biologically Oriented Preparation Technique (BOPT): A Medium-Term Retrospective Study

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Clinical records of patients who underwent implant-supported rehabilitation according to the biologically oriented preparation technique (BOPT) principles were retrospectively analyzed. Records of 189 nonconsecutive patients who received 502 implants were reviewed. At the last follow-up visit (occurring on average 5.11 years after prosthesis delivery), 466 (92.8%) implants had a Gingival Index of 0, and 491 (97.8%) presented no bleeding on probing. Four hundred eighty-nine crowns on as many implants (97.4%) showed no sign of gingival recession. Technical complications occurred with 10 implants (2.0%) and 6 patients (3.2%). Biologic complications were detected with 14 implants (2.8%) and 6 patients (3.2%). When the BOPT approach is applied to rehabilitate patients using implant-supported prostheses, excellent medium-term results concerning soft tissue health may be achieved. Int J Periodontics Restorative Dent 2020;40:711–719. doi: 10.11607/prd.4408

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Submitted April 9, 2019; accepted June 20, 2019.

The health status of peri-implant soft tissues plays a pivotal role in ensuring both the functional and esthetic long-term success of implant-supported rehabilitations. Peri-implant recession is one of the most common short- and long-term soft tissue complications following fixed prosthetic rehabilitation[1,2] and is a determinant of the esthetic success of the restoration.[3] Predisposing factors are the lack of the integrity of the facial bone,[4,5] the limited peri-implant soft tissue thickness,[6] and the absence of an adequate band of keratinized mucosa,[7–9] as well as the orofacial malposition of the implant head.[10,11] Further causes may be iatrogenic, involving poor intrasurgical soft tissue management and errors in crown fabrication or delivery.[12] The biologically oriented preparation technique (BOPT) has been proposed as a method to prepare natural teeth to be rehabilitated, as opposed to the creation of a finish line.[13–15] BOPT has been shown to be effective in preserving the health status of peri-prosthetic soft tissues and in preventing gingival recessions.[16–17] Gingival tissues may be better guided to recover physiologic contours and achieve better soft tissue conditioning when no finishing lines are present and the position of the prosthetic margin is decided on the master model. BOPT, using the same principle, should also be

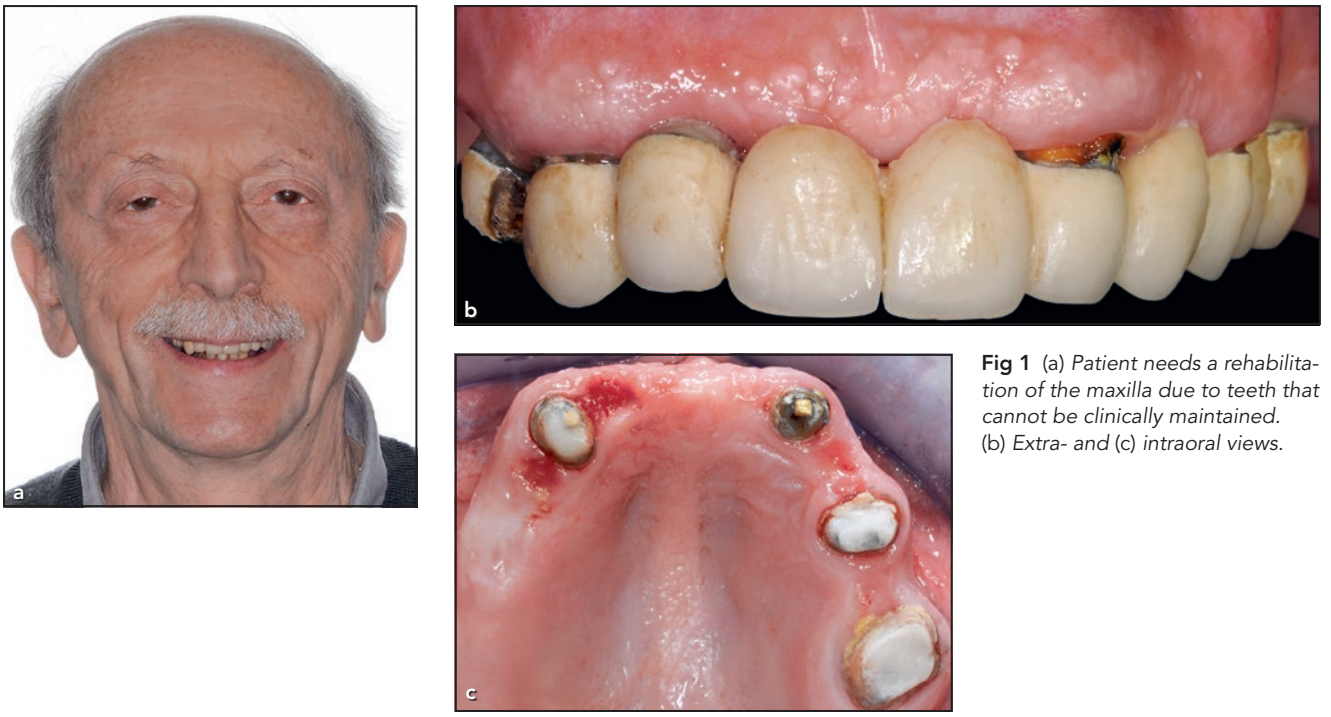

Fig 1 (a) *Patient needs a rehabilitation of the maxilla due to teeth that cannot be clinically maintained.* (b) *Extra- and* (c) *intraoral views.*

valid for implant-supported rehabilitations. Specifically, abutments designed without finish lines that position the implant crown margin subgingival yet coronal to the epithelial attachment should maintain physiologic gingival profiles.[17] This hypothesis was formulated by Cocchetto and Canullo,[18] who presented a rationale for the use of different abutment designs for different situations, as well as by Agustín-Panadero and Solá-Ruiz[19] and Solá-Ruiz et al.[20] Current evidence concerns only few cases with limited follow-up, and no study has focused on peri-implant soft tissue health.[20,21] The aim of the present retrospective study was to assess the frequency of esthetic and biologic complications of implant-supported rehabilitations carried out according to the BOPT principles over a medium 5-year follow-up period.

Materials and Methods

Data Collection

Clinical records were selected among those of patients who presented to the clinical practices of the authors (F.G., M.D., A.P.) between January 2005 and January 2017 seeking implant-supported rehabilitation and were restored according to the BOPT approach. Being a retrospective study, approval from an ethical committee was not sought. Patients were included in the present retrospective study if they met the following criteria: *(1)* all abutments placed and the corresponding implant-abutment connections featured a shape and surface presenting no finishing lines, in accordance with the principles of the BOPT approach; *(2)* the patient was followed for at least 12 months after final prosthesis delivery; *(3)* age at the time of surgery was between 18 and 90 years; *(4)* the presence of partial or total edentulism; and *(5)* the lack of any systemic diseases. Patients were excluded if they were pregnant or heavy smokers (more than 10 cigarettes per day) and if they had osteoporosis, neoplasia, or psychiatric disease; had acute oral infections; had coagulation disorders; had a history of chemotherapy or radiotherapy in the head or neck region; were immunocompromised; were undergoing current bisphosphonate therapy; or were chronic alcohol or drug abusers.

Surgical and Implant Placement Protocols

After clinical examination and radiographic assessment using intraoral

radiographs and cone beam computed tomography when needed, surgery was performed as described below (Figs 1 and 2). Antibiotic prophylaxis (2 g amoxicillin-clavulanic acid; Augmentin, GlaxoSmithKline) was prescribed 1 hour before surgery and then every 12 hours for 8 to 10 days, and the patients were subjected to mouth rinses with chlorhexidine 0.2% (Corsodyl, GlaxoSmithKline) to be continued for 2 weeks after surgery. Naproxen sodium (500 mg; Synflex, Recordati) was prescribed 2 to 4 times a day for 7 days after surgery for pain, if needed.

The surgical area was anesthetized using articaine hydrochloride (40 mg/mL) with epinephrine 1:100,000 (Citocartin, Molteni). Full-thickness flaps were elevated, and implants were placed according to the manufacturer's instructions. Implants used in the present study (ExFeel, AnyRidge AnyOne, MegaGen) with abutments featuring appropriate conical shapes with no finish lines (Milling Abutment, MegaGen) facilitate rehabilitation according to the BOPT approach. Also, they are platform-switched[22] and have a conical connection to the implant platform.

After placing the healing abutments, flaps were sutured using nonresorbable 5-0/6-0 sutures that were removed after 10 days. Provisional prostheses were delivered within 24 hours (Fig 3) from surgery or after an average of 2 to 3 months. Soft tissue conditioning was achieved using the BOPT abutments (Figs 4 to 7). Depending upon individual patient needs, rehabilitation was definitively achieved using single crowns or fixed prostheses, following delayed loading protocols as defined by Aparicio and colleagues.[23] Radiographic assessment with intraoral radiographs was performed before surgery, at implant placement, at implant loading, and at least every 12 months thereafter.

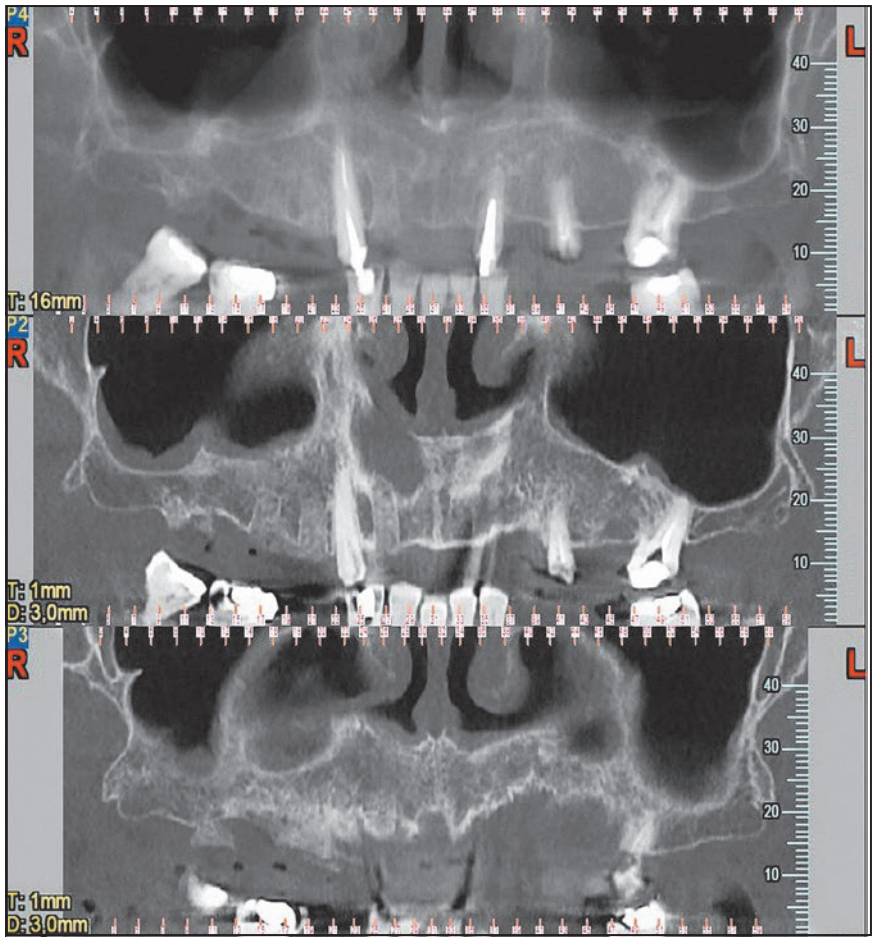

Fig 2 *Cone beam computed tomography scans of the maxilla were taken in order to plan dental implant insertion.*

Clinical Assessment

Clinical assessment was performed at baseline, prior to implant placement, and at each follow-up visit after implant placement. Data collected at follow-up visits were the absence/presence and type of technical complications (chipping, debonding, unscrewing, screw fracture) and biologic complications (mucositis or peri-implantitis).

Gingival recessions were categorized into four classes: absent; mild (< 1 mm); medium (≥ 1 mm and < 2 mm); and severe (≥ 2 mm). The Gingival Index (GI) according to Löe and Silness[24] and Löe[25] and the bleeding on probing (BOP) index[26] were also measured.

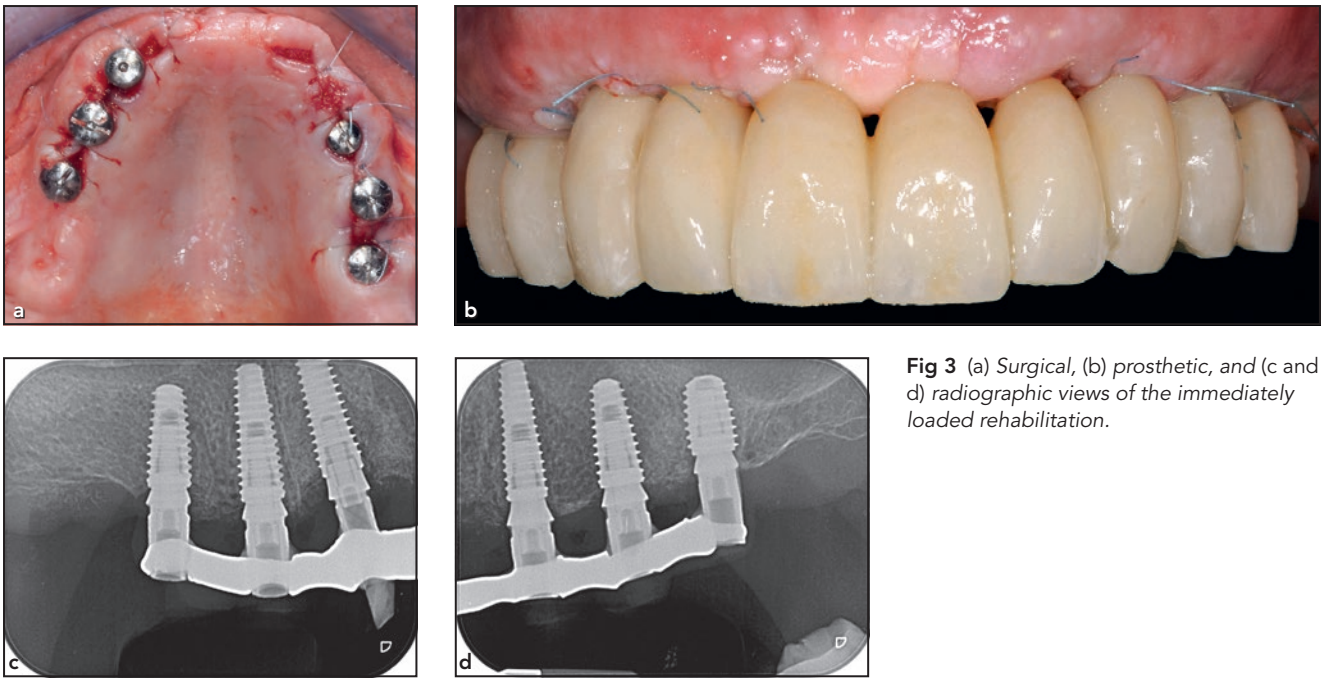

Fig 3 (a) *Surgical,* (b) *prosthetic, and* (c and d) *radiographic views of the immediately loaded rehabilitation.*

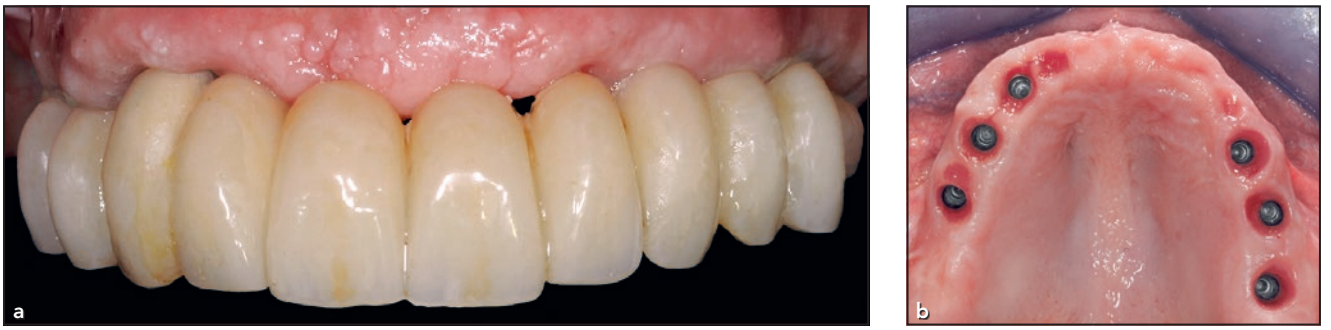

Fig 4 (a) *Frontal and* (b) *occlusal views of the provisional rehabilitation and soft tissues 6 months after surgery.*

Data Extraction

Data extracted from the clinical records were the patients' age, gender, and follow-up duration, as well as the crown retention (cemented or screw-retained), crown material (porcelain-fused-to-gold, porcelain-fused-to-zirconium, zirconia, gold resin, metal resin), and the set of clinical data collected at the last follow-up visit, as described in the previous paragraph.

Statistical Analyses and Units

Descriptive statistics concerning the patients' age, gender, follow-up duration, and complication rates were performed considering the patient as the statistical unit of analysis. Further descriptive analyses, including again the calculation of complication rates, were carried out considering implants as the statistical analysis unit. Descriptive statistics on implants were undertaken to describe the distribution of implants across the different positions in the two arches and to describe the distribution of materials used to fabricate crowns. Appropriate contingency tables were created and analyzed using Fisher exact test to investigate the correlation between crown material or retention (screw- or cement-retained) and the type of biologic and technical complications as well as to the distribution of recessions according to their severity.

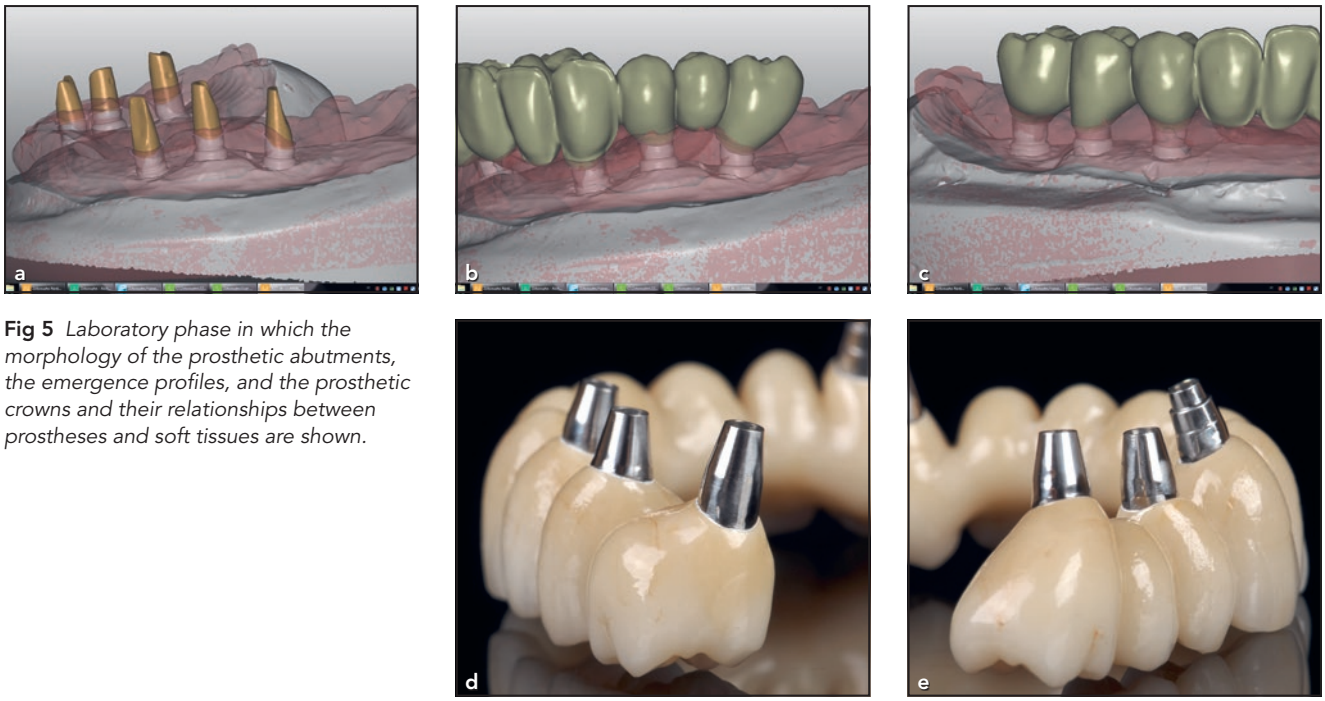

Fig 5 *Laboratory phase in which the morphology of the prosthetic abutments, the emergence profiles, and the prosthetic crowns and their relationships between prostheses and soft tissues are shown.*

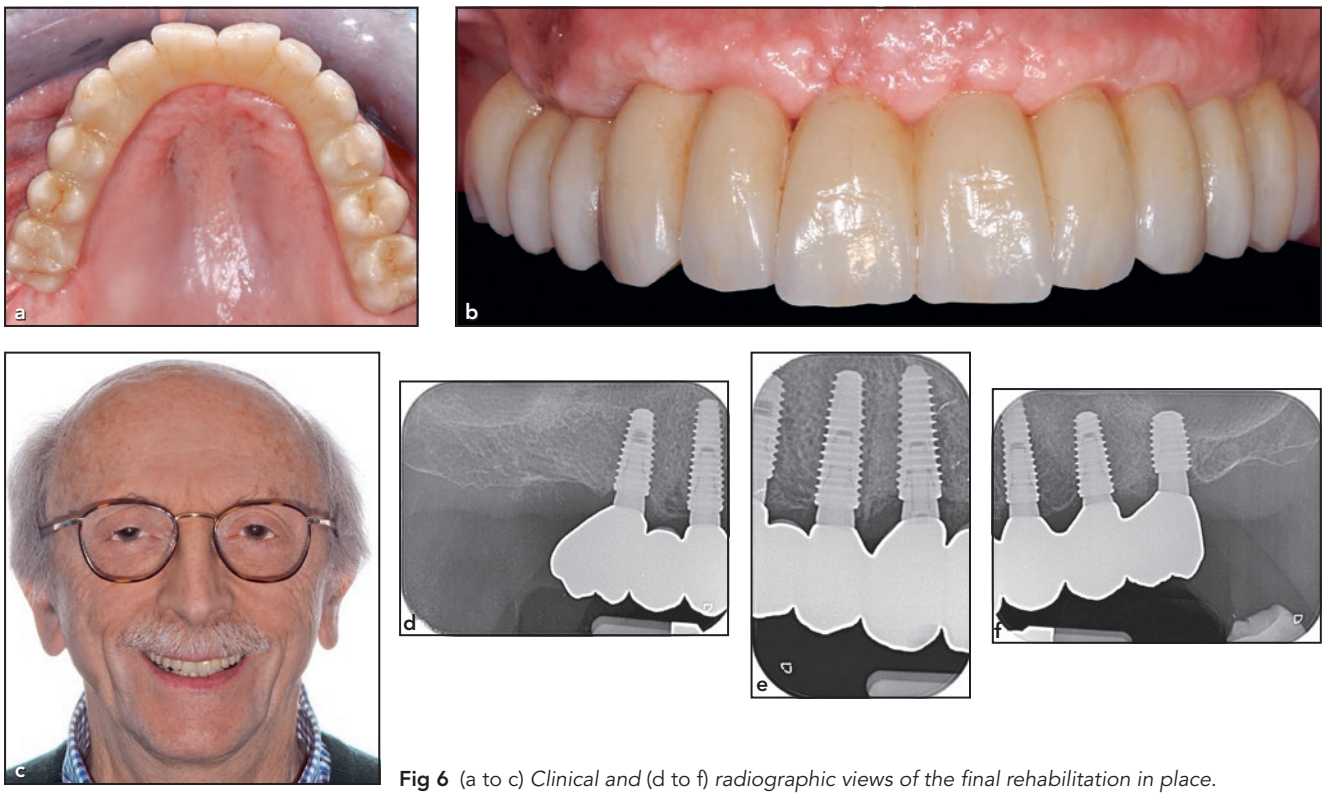

Fig 6 (a to c) *Clinical and* (d to f) *radiographic views of the final rehabilitation in place.*

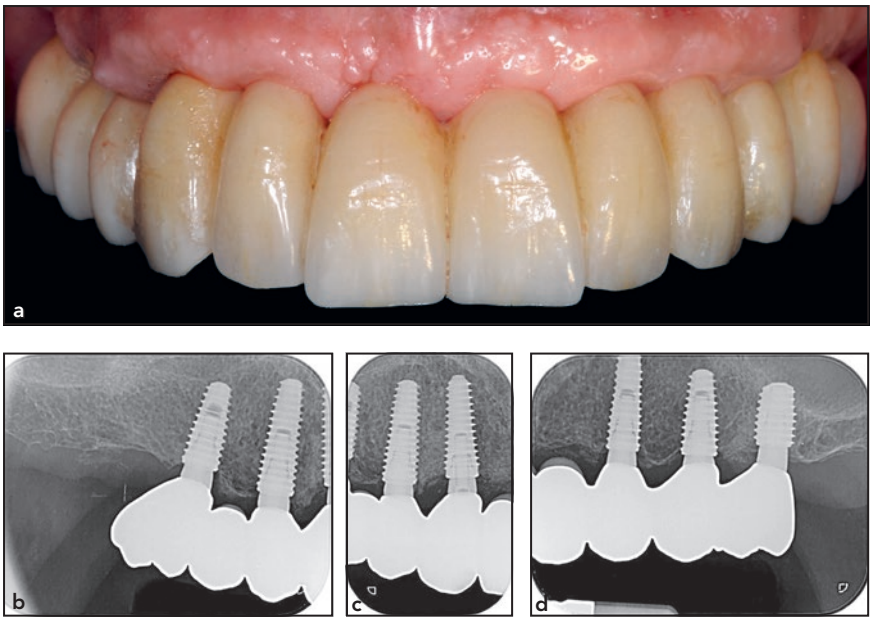

Fig 7 (a) *Clinical and* (b to d) *radiographic views of the maxillary rehabilitation at the 3-year follow-up.*

Fisher exact test was also used to investigate whether the distribution of biologic and technical complications, as well as that of recessions, was correlated to the arch the implant was placed in or to the tooth (incisor, canine, premolar, molar) being replaced.

To investigate whether the type of retention, as well as the crown material, had any effect on the GI and BOP indices, the corresponding datasets were compared using Mann-Whitney *U* test. To investigate if the GI and BOP indices differed in relation to the material the crowns were made of as well as to the tooth being replaced, the median values for each group were calculated and compared using Kruskal Wallis analysis of variance test followed by post-hoc Mann-Whitney *U* test. All data are provided as mean value ± standard deviation or median and interquartile range (IQR). Statistical analyses were carried out using standard statistic software programs (Excel, Microsoft; Origin 2018b, OriginLab).

Results

Records were analyzed for 189 nonconsecutive patients (94 men and 95 women) with a mean age of 59.6 ± 13.4 years (range: 24 to 87 years), who received 502 implants. All patients completed the healing period following implant placement with no complications. Average follow-up time was 5.11 ± 3.12 years (range: 1 to 13 years). Distribution of crowns according to their retention type, materials, and position in the two arches are provided in Appendix Table 1 (all Appendix Tables can be found in the online version of this article at quintpub.com/journals). At the last follow-up visit, 466 (92.8%) implants had a GI of 0 and 491 (97.8%) presented with no BOP (Appendix Table 2). Four hundred eighty-nine crowns on as many implants (97.4%) showed no signs of gingival recession: Gingival recessions deeper than 2 mm involved 2 crowns (0.4%); those less than 2 mm but at least 1 mm deep concerned 9 crowns (1.8%); while those whose depth was smaller than 1 mm involved 2 crowns (0.4%). Technical complications concerned 10 implants (2.0%) and 6 patients (3.2%). Chipping concerned 4 implants (0.8%); debonding involved 3 implants (0.6%); unscrewing involved 2 implants (0.4%); and screw breakage concerned 1 implant (0.2.%). Biologic complications concerned 14 implants (2.8%) and 6 patients (3.2%). Mucositis concerned 12 implants (2.4%), while peri-implantitis involved 1 implant (0.4%).

Type of Retention

The type of crown retention had no effect on the distribution of biologic (P = .51) nor technical complications (P = .11). The distribution of recessions according to their severity and the kind of crown retention is shown in Appendix Table 3. Cemented crowns were associated to a significantly greater (P = .001) number of recessions than screw-retained ones. GI had median and IQR of 0 both for cemented (minimum 0, maximum 2) and screw-retained crowns (minimum 0, maximum 3), with no significant differences be-

tween the two retention types (P = .19). Median BOP was also found to be 0 (minimum 0, maximum 1; IQR = 0) for both retention types, with no significant difference (P = .43).

Crown Material

The crown material did not significantly affect the distribution of biologic complications (P = .07) or technical complications (P = .62). It was also found to have no effect on the distribution of recessions according to their severity (P = .62). The different materials did not significantly affect either GI (P = .52) or BOP (P = .63).

Arches

The position of the implant in the two arches did not significantly affect the distribution of biologic (P = .53) or technical complications (P = .17), nor the recession severity (P = .26). Median GI was 0 both for the mandible (minimum 0, maximum 3; IQR = 0) and maxilla (minimum 0, maximum 2; IQR = 0), the difference not being significant (P = .88). Median BOP was also 0 for both the mandible (minimum 0, maximum 1; IQR = 0) and maxilla (minimum 0, maximum 1; IQR = 0), with an insignificant difference (P = .49).

Implant Position

Implant position had no significant effect on the distribution of biologic complications (P = .17). Conversely, distribution of technical complications and severity of recession were found to be dependent on the implant position (Appendix Table 4). Technical complications had a greater incidence in canine teeth (P = .02). A significantly greater incidence of recessions was observed in incisors than at other positions (P < .001).

The median GI was 0 and all positions had an IQR of 0 (minimum–maximum: 0–2 for incisors; 0–0 for canines; 0–2 for premolars; 0–3 for molars) with no significant differences among or between teeth (P > .05 in all cases). BOP had a median and IQR of 0 for all tooth types (0–1 for incisors; 0–0 for canines, 0–1 for premolars; 0–1 for molars), but a significantly different distribution for incisors compared to molars and premolars, with more cases showing a BOP score greater than 0 (P > .05 in both cases).

Discussion

Results of the present study show that when implant-supported prostheses are prepared and delivered according to the BOPT principles, medium-term complications are few and mild, and excellent soft tissue health is maintained over time. Incidence data concerning peri-implant soft tissue recessions are few and inconsistent, ranging from 0% to 64%, and limited to short follow-up periods (1 year).[12,27–29] The medium-term incidence of recessions observed in the present study is low and compares rather favorably with such figures. This suggests that performing implant-supported fixed prosthesis restorations according to the BOPT approach is effective in preventing soft tissue recessions on a medium-term basis. The observation that the rates of mucositis and peri-implantitis were markedly lower than those currently reported in literature[30,31] further supports this conclusion. Additionally, technical complications occurred at a rate that was lower than that reported for fixed prosthesis rehabilitations over a similar follow-up period.[30–32] These observations further support the conclusion that the very same principles that make BOPT effective when natural teeth are concerned apply to implants. Here, the absence of a finishing line on the abutment and the consequent subgingival position of the implant crown margin, yet coronal to the epithelial attachment, may allow the growth of a thicker band of marginal keratinized mucosa, which has a position that is more coronal than when using an abutment having a different shape and a finishing line. The thicker keratinized mucosa may be pivotal in preventing bacterial contamination and the consequent chronic inflammation that leads to gingival recession. Also, it may provide greater protection against mechanical trauma. Further, removal of excess cement, a possible cause of chronic inflammation, is much easier when the abutment presents no shoulder or finishing lines. Such design also allows placing the crown a certain distance from the implant platform, again facilitating the removal of excess cement.

Results of the present study show that utilizing the BOPT ap-

proach can effectively achieve dimensional stability of peri-implant soft tissues, as the incidence of recessions was as low as 2.6%. Cemented prostheses were still associated with a higher gingival recession rate, possibly because of their known, poorer biologic performance in comparison to screw-retained ones,[33] but were not associated with a health decay of peri-implant soft tissues. In some clinical conditions, as when the implant is moved slightly buccally, a cemented prosthesis allows for correcting the misalignment between the prosthetic and implant axes. This condition is usually associated with thinner soft tissues, which, in turn, favor gingival recessions.[6] The association the present authors observed between cemented prostheses and gingival recessions may therefore be due to several concomitant factors other than the use of cemented prostheses alone. The greater incidence of recessions involving incisors may be ascribed to the reduced thickness of hard and soft tissue that is usually observed in the anterior sectors of the arches.

While the concept of applying the BOPT approach to an implant-supported restoration is not new, the present work is the first providing a medium-term analysis of peri-implant tissue health on a relatively large number of implants, indicating that BOPT preserves it on a medium-term basis. Yet, the low rate of biologic and technical complications and the satisfactory results observed in this investigation concerning peri-implant recessions should be regarded as the result of multiple factors and should not be ascribed to the use of the BOPT technique only. Such factors include *(1)* implants being placed by expert implant surgeons who carefully followed all precepts of prosthetically driven implantology; and *(2)* the design characteristics of the implants and abutments being placed, including the conical connection and platform-switching design.[34,35]

Results of the present study should not be generalized. They must be regarded as valid only for the specific type of implant and abutment being used, as they may have been influenced by their design. It is reasonable to expect that different implant and abutment types, even when designed according to the BOPT principles, may perform differently. Further studies should be aimed to investigate how different designs may affect the medium- and long-term performance and safety of different systems.

Limitations of the present study include the fact it was retrospective in nature and was carried out on a relatively small number of patients. Further investigations including prospective, long-term randomized trials, even comparing non-BOPT and BOPT rehabilitations, should be carried out to get a more in-depth knowledge of the risks and benefits of this rehabilitation approach.

Conclusions

Patients rehabilitated using implant-supported prostheses prepared and delivered according to the principles of BOPT show no significant complications on a medium-term basis (average: 5 years; range: 1 to 13 years), and their soft tissues maintain an excellent health status. BOPT implant-supported rehabilitation seems to be a viable approach to guarantee stability of soft tissue health over time following implant-supported rehabilitation. More in-depth investigation on the BOPT approach should be warranted.

Acknowledgments

The authors declare no conflicts of interest.

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Appendix

Appendix Table 1 Distribution of Crowns According to Their Retention Type, Materials, and Position in the Two Arches

	Maxillary crowns (n = 315)										Mandibular crowns (n = 187)									
	Screw-retained (n = 190)					Cemented (n= 125)					Screw-retained (n = 140)					Cemented (n = 47)				
	PFG	PFZ	Z	GR	MR	PFG	PFZ	Z	GR	MR	PFG	PFZ	Z	GR	MR	PFG	PFZ	Z	GR	MR
Incisor (n = 32)	5	4	2	–	2	14	4	–	–	–	–	1	–	–	–	–	–	–	–	–
Canine (n = 28)	5	3	2	–	1	9	7	–	–	–	–	–	1	–	–	–	–	–	–	–
Premolar (n = 211)	30	26	31	1	4	42	14	1	–	–	12	13	17	–	–	15	4	1	–	–
Molar (n = 231)	26	17	30	–	1	28	3	3	–	–	42	17	37	–	–	24	2	1	–	–
Total (N = 502)	66	50	65	1	8	93	28	4	–	–	54	31	55	–	–	39	6	2	–	–

PFG = porcelain-fused-to-gold; PFZ = porcelain-fused-to-zirconium; Z = zirconia; GR = gold resin; MR = metal resin.

Appendix Table 2 Gingival Index and Bleeding on Probing at the Last Follow-up Visit

GI					BOP		
Score					Score		
0	1	2	3	Total	0	1	Total
466 (92.8)	27 (5.4)	8 (1.6)	1 (0.2)	502 (100)	491 (97.8)	11 (2.2)	502 (100)

GI = Gingival Index; BOP = bleeding on probing.
Values are shown as no. of implants (percentage).

Appendix Table 3 Distribution of Severity of Gingival Recessions in Relation to Crown Retention

Crown type	None	Mild	Moderate	Severe	Total recessions
Cemented, n (%)	161 (93.6)	1 (0.6)	8 (4.7)	2 (1.2)	11 (6.5%)
Screw-retained, n (%)	328 (99.4)	1 (0.3)	1 (0.3)	0	2 (0.6%)
Total, n	489	2	9	2	13

Appendix Table 4 Distribution of Technical Complications and Recession Severity According to the Position of the Replaced Tooth

	Technical complications						Recession severity				
	None	Chipping	Debonding	Screw breakage	Unscrewing	Total complications	None	Mild	Moderate	Severe	Total recessions
Canine	25 (89.3)	2 (7.1)	1 (3.6)	0 (0)	0 (0)	3 (10.7)	26 (92.9)	0 (0)	2 (7.1)	0 (0)	2 (7.1)
Incisor	32 (100.0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	27 (84.4)	1 (3.1)	2 (6.3)	2 (6.3)	5 (15.6)
Premolar	208 (98.6)	1 (0.5)	1 (0.5)	1 (0.5)	0 (0)	3 (1.5)	207 (98.1)	0 (0)	4 (1.9)	0 (0)	4 (1.9)
Molar	227 (98.3)	1 (0.4)	1 (0.4)	0 (0)	2 (0.8)	4 (1.6)	229 (99.1)	1 (0.4)	1 (0.4)	0 (0)	2 (0.8)
Total	492 (98.0)	4 (0.8)	3 (0.6)	1 (0.2)	2 (0.4)	10 (2.0)	489 (97.4)	2 (0.4)	9 (1.8)	2 (0.4)	13 (2.6)

Values are shown as no. of implants (percentage).