A Retrospective Periodontal Assessment of 137 Teeth After Featheredge Preparation and Gingittage

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The aim of this study was to retrospectively evaluate the periodontal response of periodontally healthy teeth prosthetically restored using a featheredge finish line preparation combined with a light rotary curettage (gingittage). A total of 137 restored teeth were included in the study. Mean follow-up time was 18.2 months (range: 6 to 60 months). Bleeding on probing was noted in 18% of cases, while the Plaque Index was found to be 11%. The probing depth in 99.4% of cases was ≤ 3 mm. In only 7 cases (5.1%), a slight restoration margin exposure was recorded. Although randomized controlled studies with longer follow-up are advocated, the present investigation seems to suggest that this protocol is a viable procedure.
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In fixed prosthodontics, the unsatisfactory appearance resulting from apical migration of the free gingival margin around definitive crowns is a major complication.[1] This can ultimately expose the crown-to-tooth interface and make the restoration unsuccessful, especially in the esthetic areas.

Soft tissue recession around crown margins has been extensively investigated, and a number of etiologic factors have been suggested, including excessively subgingival placement of the crown margin, iatrogenic soft tissue trauma during tooth preparation, aggressive and invasive gingival displacement procedures for the final impression, lack of marginal accuracy, horizontal overcontouring, and a thin and scalloped biotype.

Although scientific evidence for many of these factors is lacking, a relationship between marginal inaccuracy and soft tissue recession has been reported.[2] The finish line geometry (horizontal versus vertical) has often been held responsible for creating inaccuracy and thus tissue instability.[3] The cross-sectional configuration of the finish line for full-coverage restorations has been extensively investigated, yet it remains a controversial topic in prosthetic dentistry.[4,5] Various shapes have been described and advocated. Kuwata[6] formulated a classification of the finish line from

Fig 1 *Komet 6862D / 012 bur. This bur has the same reference markers as a periodontal probe, with the first black mark 1 mm from the tip.*

the point of view of the margin angle. He defined a margin angle between 0 and 30 degrees as a bevel, between 31 and 60 degrees as a chamfer, and between 61 and 90 degrees as a shoulder. A different and more practical system for classifying the geometry of the finish line was later proposed in which margins are broadly divided into two main classes: vertical and horizontal.[7] Among margin designs, dentists usually prefer horizontal, such as shoulders or chamfer, over vertical preparation, such as featheredge. This is most likely for practical reasons, including that horizontal preparations are distinct; are readily visible on the prepared tooth, impression, and die; give a neat margin on the relined provisional restoration; and should produce better seating for the restoration. Vertical preparations such as featheredge have been considered unsuitable for metal-ceramic or all-ceramic crowns because of poor marginal adaptation, horizontal overcontouring, and possible distortion of the cast during porcelain firing.[8] However, according to the literature, the vertical geometry rather than the horizontal has proven to reduce the marginal gap of the restoration and create a less irritating environment within the gingival sulcus.[9–11] Recent clinical studies have discussed the application of featheredge tooth preparation in different clinical situations.[12–14] The aim of this study is to retrospectively evaluate the periodontal response of prepared prosthetic teeth with a featheredge finish line combined with a rotary gingival curettage (gingittage).

Materials and Methods

The data collection was carried out between November 2015 and January 2016, and patients subjected to regular hygiene recall were enrolled. The inclusion criteria were as follows: *(1)* at least one restored periodontally healthy tooth treated according to the protocol; *(2)* American Society of Anesthesiologist (ASA)-1 or -2 classification; *(3)* aged > 18 years. Patients with disabling diseases and those on anticoagulant therapy were excluded.

Data were collected using a specific form before each session of programmed dental hygiene.

Restorative Procedures

All teeth analyzed in this study were prepared by the same operator (F.S.) according to standardized technical procedures. Tooth reduction started after the sulcus depth was measured. Sulcus probing may also provide important information regarding the tissue biotype and soft tissue thickness. The biotype was considered thin if the periodontal probe could be seen through the gingiva; otherwise, it was categorized as thick.[15] Simultaneous to tooth preparation, a rotary curettage of the gingival sulcus (gingittage) was performed. Such gingittage has already been described[16,17] as an expected consequence of the featheredge type of preparation. The preparation did not extend subgingivally deeper than 1 mm from the gingival margin regardless of the probing depth recorded at baseline so as to avoid any violation of the biologic width.[18,19] The depth of preparation could be easily controlled using specifically designed laser-marked burs (Komet 6862D / 012) (Fig 1). Such burs have the same reference markers as a periodontal probe, where the first black mark begins 1 mm from the tip and is readily visible throughout the entire preparation process. Therefore, the markers allow the operator to know the exact depth of the sulcus at all times. Once the tooth preparation was completed, allowing sufficient room for the restorative materials, a fine-grit diamond bur was used to refine the preparation and create a smooth surface with parallel walls and a featheredge design. The immediate temporary

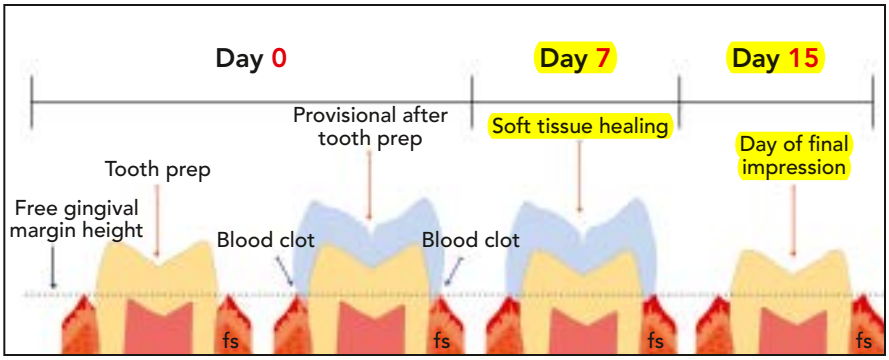

Fig 2 *Tooth preparation was always carried out by means of a laser-marked bur* (see Fig 1). *This allowed consistent placement of the end of the preparation 1 mm within the gingival sulcus. All teeth included in this study were prepared following the same strict protocol. At the end of tooth preparation, each tooth was checked visually and by probing the sulcus for a 1-mm subgingival finish line where the provisional was placed. At the time of final impression, on removal of the provisional, finish line position was checked again and no clinical changes in the gingival level were noticed. The stone dies prepared by the lab* (see Fig 12) *are evidence of this clinical observation. After 1 to 2 weeks, before the final restoration was cemented, margin positions were checked once again and were found to still be 1 mm subgingivally. It was finally assumed that throughout all steps of the procedures, from tooth preparation to final delivery, soft tissue margins remained at the same level.*

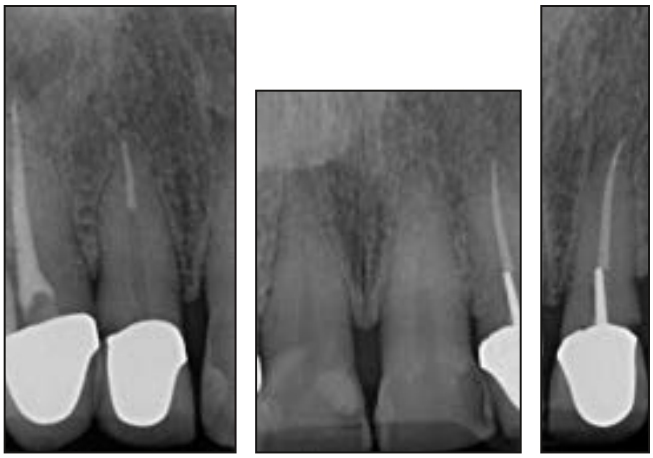

Fig 3 *Radiologic preoperative evaluation of a case. The esthetic area needed restoration due to ill-fitting crowns and caries.*

crown application with its convex profile prevented the soft tissue margin from collapsing on the prepared tooth surfaces. The margin of the provisional crown was always placed within 1 mm subgingivally. The gingittage led to blood clot formation and enhanced the healing response.[20,21]

None of the treated teeth had to be reprepared after the first appointment.

At 1 to 2 weeks after tooth preparation, a final impression was taken. The impression could be taken using a conventional material, such as polyether or silicone, or digitally, through an intraoral scanning device (Bluecam Sirona Dental Systems), after placing either single (000) or double (00 + 000) retraction cord (Ultrapak Clean Cut, Ultradent). The restorative material for the final crowns was indifferently selected among metal-ceramic, zirconium oxide, and lithium disilicate following only the esthetic requirements and/or mechanical properties required by the case. The definitive restoration margins were visually tested and assessed by probing the sulcus to be sure they were located 1 mm subgingivally.

Final cementation was performed a few days after the impression with the corresponding cementation system selected according to the guidelines present in the literature.[22]

Therefore, complete healing of the newly formed tissue took place around a definitive ceramic restoration, which had a smoother surface and better-defined contours and was more accurate in terms of precision compared to the temporary crown.

Figures 2 to 21 illustrate two cases that describe the above technique.

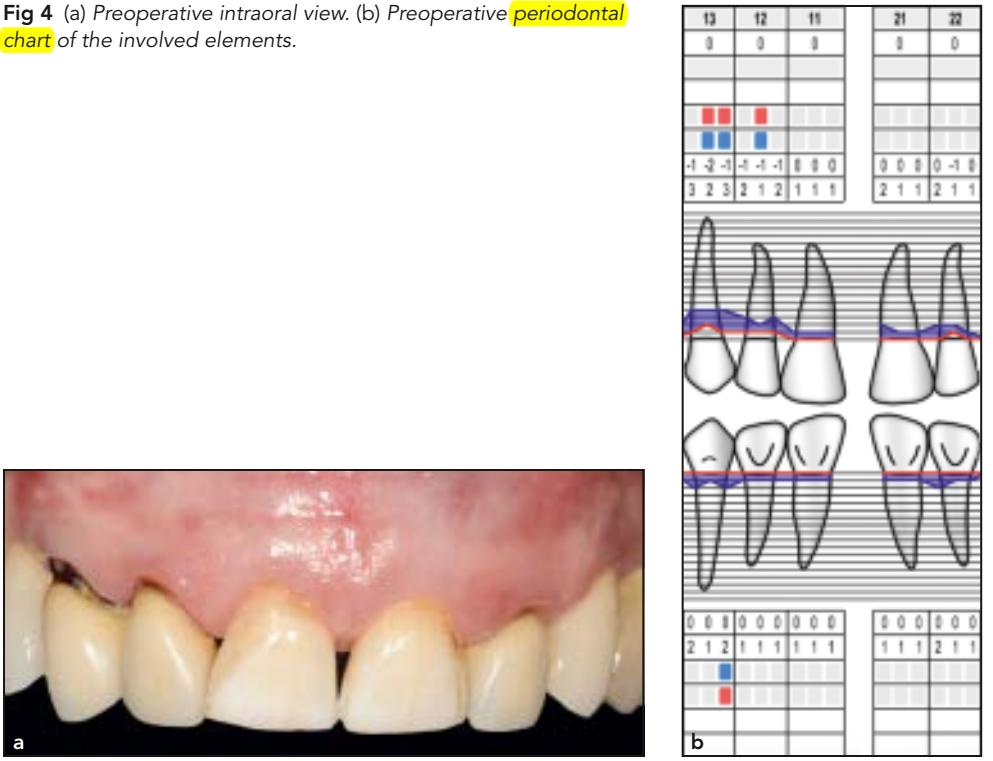

Fig 4 (a) *Preoperative intraoral view.* (b) *Preoperative periodontal chart of the involved elements.*

Fig 5 *Teeth preparation.*

Fig 6 *Application of the provisional prosthesis.*

Examined Variables

The following primary variables (at tooth level) were analyzed: keratinized mucosa, probing depth (at six points per tooth), tissue recession (meaning the distance between the restoration and the gingival margin), bleeding on probing (BoP), and presence of plaque (at six sites per tooth).

Secondary variables were full-mouth plaque score (FMPS) and full-mouth bleeding score (FMBS) of the patient, periodontal biotype, type of restorative material, and prosthesis complications such as loss of vitality of the element, presence of caries, chipping/fracture, and loss of retention.

Statistical Analysis

Differences in the outcome variables between patients with different biotypes were evaluated. Pearson's chi-square was used for recession incidence, and unpaired Student *t* test was used for other variables (Plaque Index, BoP, FMPS, and FMBS). $P = .05$ was considered the significance threshold.

Fig 7 (left) *Tissue healing at 2-week follow-up.*

Fig 8 (below) *Impression after 2 weeks.*

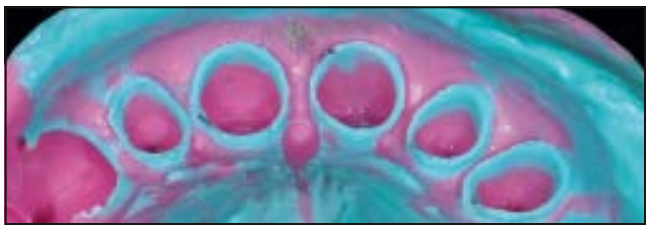

Fig 9 (above) *Intraoral view of the final case with zirconia-based porcelain delivered.*

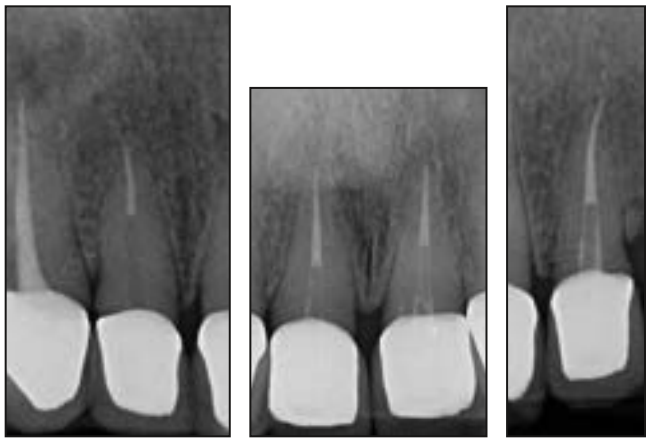

Fig 10 (right) *Final case: radiologic evaluation.*

Fig 11 *Final case: 6-month follow-up*

Fig 12 *The dental technician drew two lines on the dies: the coronal line is the gingival margin, and the second line is 1 mm below, where the finish line is placed.*

Fig 13 *Second case: preoperative view. The patient presented with broken and ill-fitting restorations on central and lateral incisors.*

Fig 14 *The old restorations were removed, teeth were reprepared following the protocol, and heat-cured temporary prostheses were temporarily cemented.*

Fig 15 *The temporary prosthesis after 2 weeks, at the time of final impression.*

Fig 16 *Prepared teeth the day of final impression.*

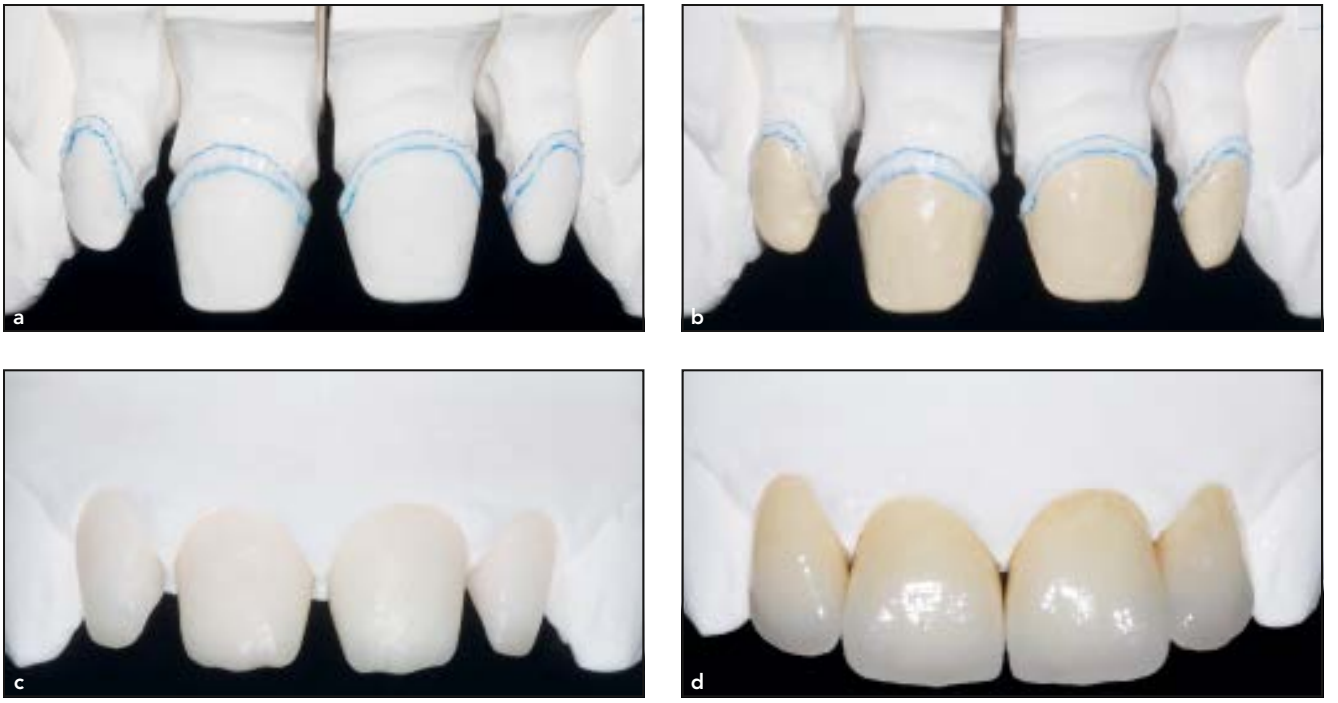

Fig 17 (a) *Ditching of the master cast.* (b) *Application of the dice spacer up to the first blue line.* (c) *Pressed lithium disilicate copings.* (d) *Veneered lithium disilicate final restorations on the master cast.*

Results

A total of 21 patients (15 women and 6 men) with a mean age of 59.9 years (range: 36 to 84 years) were finally included in the study. General features of the study sample are reported in Table 1. FMPS and FMBS were recorded before the dental hygiene sessions and found to be 17.71% and 17.23%, respectively, on a patient basis; 55% of teeth had a thick periodontal biotype. The 137 rehabilitated teeth included in the analysis had a mean follow-up of 18.20 months (range: 6 to 60 months) and were divided into three groups based on restorative material: 50% metal ceramic, 27% zirconia, and 23% lithium disilicate. The distribution of tooth type is described in Table 2. The keratinized gingiva was on average 2.09 mm. The analysis of treated teeth and

Fig 18 *Lithium disilicate final restoration physiologic emergence profile.*

Fig 19 *Final restorations on the day of cementation.*

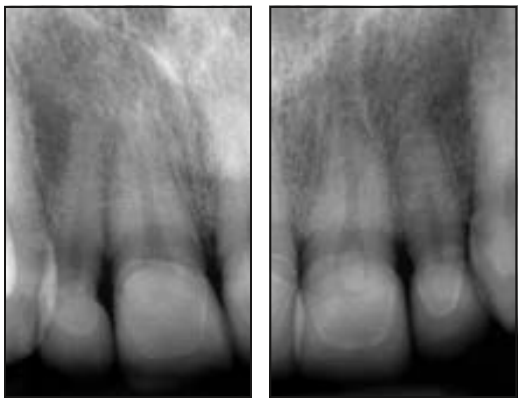

Fig 20 *Radiographic control after cementation.*

Table 1 Main Characteristics of the Study Sample

Teeth (n)	137
Mean follow-up (mo)	18.2 (range: 6–60)
Depth of finishing line	1.0 mm (controlled with a marked bur)
FMBS (%)	17.71
FMPS (%)	17.23
BoP (%)	18
Plaque index (%)	11
Keratinized tissue (mm)	2.09
Soft tissue recession (%)	5.1 (7 teeth out of 137)
PD < 3 mm (%)	99.4 (all teeth probed at 6 points)

FMBS = full-mouth bleeding score; FMPS = full-mouth plaque score; BoP = bleeding on probing; PD = pocket probing depth.

Fig 21 *Final restoration at 2-year follow-up.*

Table 2 Restored Teeth Distribution (FDI)

Tooth site	17	16	15	14	13	12	11	21	22	23	24	25	26	27
n	4	2	4	9	9	12	8	8	8	9	9	4	5	3
n	2	6	5	1	3	2	2	2	2	2	5	6	3	2
Tooth site	47	46	45	44	43	42	41	31	32	33	34	35	36	37

periodontal indexes shows that the BoP was 18%, while the Plaque Index (PI) was 11% on a tooth basis. In 52% of the treated teeth, no bleeding was noted, and in 65.6% no plaque was present. In 99.4% of the cases, probing depth, carried out at 6 points per tooth, was ≤ 3 mm, while in the remaining 0.6% it was 4 mm. Soft tissue recession (considered as crown margin exposure) occurred in 5.1% of the cases, or 7 restored teeth of 137. Of these, two occurred in the same patient, who also showed significant teeth abrasion due to an aggressive brushing technique. Taking into account the periodontal biotype, there were no statistically significant differences in terms of recession incidence (P = .22), BoP (P = .97), or PI (P = .09). Finally, only two prosthetic complications occurred: loss of retention and caries infiltration.

Discussion

Soft tissue recession around crown margins has always been a major concern in restorative dentistry. Many etiologic factors have been suggested, though few have been scientifically demonstrated to be responsible.[2] The tooth preparation design may significantly influence soft tissue behavior, namely the accuracy with which different design types guarantee the final restoration.

The proposed protocol allows proper management of the subgingival portion of the restoration. The laser-marked bur allows minimization of the trauma to the connective tissue.

Many in vitro and in vivo studies have demonstrated that the feather-edge preparation shows the least marginal discrepancy compared to other preparation designs.[4,9–11]

Furthermore, a smaller gap will cause less extrusion of cement that would be in direct contact with the sensitive gingival sulcus environment.

The gingittage or rotary curettage of the soft tissue wall of the gingival sulcus, which is central to the present protocol, has been described in the literature[16] and further developed by Ingraham et al[17] with the purpose of removing a limited amount of soft tissue from the lateral sulcus wall while a chamfer finish line was simultaneously prepared on the tooth structure.[17] The suitability of the gingiva for this procedure is determined by three factors: an absence of BoP, a sulcus depth of < 3 mm, and adequate keratinized tissue height.[17] Several studies have been carried out to compare the clinical efficacy and wound healing of rotary curettage with more conventional techniques for soft tissue displacement before the final impression. Kamansky et al[23] reported fewer changes in gingival height with rotary curettage than with lateral gingival displacement using retraction cords. Ingraham et al[17] reported slight differences in tissue healing after testing three different soft tissue displacement techniques: rotary gingival curettage, pressure packing cord, and electrosurgery.

Another key element of the suggested protocol is the shape of the crown contour. The contour of the artificial crowns is a widely discussed topic.[20] Overcontouring has been frequently considered a detrimental anomaly in crown construction, leading to tissue inflammation and periodontal problems.[25] The crown contour has two major components: the emergence profile (EP) and the cervical contour (CC). The term EP was first proposed by Stein and Kuwata,[26] and the EP has been defined as "the contour of a tooth or restoration, such as a crown on a natural tooth or dental implant abutment, as it relates to the adjacent tissues."[27] In contrast, the CC is neither flat nor concave, but convex. It corresponds to the cementoenamel junction (CEJ) bulk and was first described by Wheeler,[28] who referred to it as a curvature that should always be recreated in artificial crowns. Declaring that it should be physiologic, he added that it has the important role of "holding the surrounding tissues into tension and health." The CC is the subgingival cervical start related to the profile and is different from the EP. The latter is straight and flat, while the former is convex. The amount of this convexity can be measured through the emergence angle (EA), the angle formed by the junction of a line through the long axis of the tooth and a tangent drawn coronal to the tooth as it emerges from the sulcus[29] (Fig 10). In the past, anecdotal information has been used to assign a value to the EA.[30] However, a more recent study has reported on measurement of this angle on natural human teeth with a scientific protocol.[29] The authors, using a three-dimensional radiologic assessment, measured this angle on 148 maxillary anterior

teeth. Central incisors showed an average angle of 15 degrees, lateral incisors had an angle of 12 degrees, and the average canine angle was 11 degrees. The same authors measured the EP, which is located coronal to the CC and emerges from the gingival margin, reporting that it is definitely flat.

Every time the CEJ is lost, this anatomical landmark should be artificially recreated with a physiologic angle that supports the surrounding soft tissue. This should not be seen as an overcontour but as an artificially recreated CEJ. This physiologically convex area must be reproduced, and it will increase the bulk of the restorative material in the cervical third. This also allows the use of any kind of restorative material, including metal-ceramic, lithium disilicate,[12] or zirconium oxide.[31]

Artificial crowns on a vertical margin have been used over the years, especially in cases of periodontally involved teeth where the featheredge was the only resource, as it was impossible to prepare a shoulder or a chamfer at root level.[32] A recent publication demonstrated the effectiveness of this therapy with 20 years follow-up.[33]

The retrospective study presented in this paper, although it included a small number of patients, shows that teeth restored with this protocol do not suffer from any periodontal disease. All periodontal indices were measured before the regular hygiene recall; therefore, we can assume a standard situation was registered. Second BoP and PI of the restored teeth are in accordance with FMPS and FMBS, meaning that there is no difference between the restored teeth and the rest of the patients' dentition. Also with regard to the probing depth (carried out at 6 points per tooth), 99.4% of the cases fell within the physiologic limits. The use of a standardized clinical protocol and dedicated instruments allowed correct crown margin positioning, respecting the biologic width and achieving a good soft tissue response. The presence of an adequate band of keratinized gingiva, which was about 2 mm, was definitely a favorable factor and has undoubtedly contributed to the stability of the result.

Conclusions

Although further studies are needed with a larger number of patients and a longer follow-up, the present study suggests that the application of a precise protocol that involves the use of featheredge and gingittage is respectful of the supporting periodontal tissues. The absence of signs of periodontal inflammation around prosthetic crowns is a tangible sign of tissues responding positively to this operational protocol (or approach), which gives the clinician more freedom to change the form and esthetics of the restoration, shortens and simplifies the laboratory phases, and provides greater tissue stability in the midterm.

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