

Evaluation of Peri-implant Tissue Stability and Patient Satisfaction After Immediate Implant Placement in the Esthetic Area: A 3-Year Follow-up of an Ongoing Prospective Study



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Horizontal and vertical reduction of the ridge has to be expected after tooth extraction. Immediate implant placement and provisionalization is a viable treatment option that can help to minimize those changes. Additionally, it can better meet a patient's expectations about the treatment, reducing time and invasiveness. The aim of this prospective study is to evaluate the stability of the hard and soft tissues surrounding single immediate implants placed in the esthetic zone, as well as evaluating patient satisfaction. A total of 16 implants were placed, and 15 could be evaluated at the 3-year follow-up. Radiographic and clinical data was recorded after this period. Some marginal bone level reduction was detected after 3 years but was not statistically significant. The soft tissues, measured at 3 points, showed stability and even better positions with respect to the day of the final restoration placement. Patient satisfaction was analyzed using the modified Oral Health Impact Profile questionnaire (OHIP-14), and high satisfaction values were reported. The implementation of a precise surgical and prosthetic protocol when an immediate implant is placed into a fresh extraction socket is likely to result in high survival and success rates combined with excellent patient satisfaction. After the 3-year follow-up, favorable results were present.

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A physiologic collapse of the alveolar bone after tooth loss is unavoidable.^{1,2} This collapse will result in a concavity in the buccal area of the ridge contour, which could lead to difficulties in ideal implant positioning or esthetic problems when implants are placed in the anterior area.³ In order to achieve more predictable ridge remodeling, delayed implant placement approaches have been proposed, which basically consist of a healing period between 6 to 8 weeks from tooth extraction to the reentry procedure for implant placement.⁴ The objective of such approach is to achieve enough soft tissue maturation to be able to cover by first intention the grafted area surrounding the implant.⁵ On the other hand, some immediate-treatment protocols after tooth extraction have been documented with the goal to minimize the quantity of volume loss and treatment time. Socket preservation or immediate implant therapy combined with regenerative procedures are presented in the literature as clinical procedures that could reach that aim.⁶ Regarding patient treatment expectations when a tooth has to be extracted and restored, immediate implant therapy seems to fulfil these demands, as the patient would be asking for the shortest, less invasive, and cheapest treatment.⁷ Patient-centered outcomes,

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like satisfaction with the treatment received, should be something important to be taken into consideration by clinicians, trying to apply treatments that can achieve better clinical results and obtaining the highest patient's satisfaction. Several satisfaction questionnaires have been proposed,⁸⁻¹⁰ and the Oral Health Impact Profile (OHIP) questionnaire¹¹ has been frequently documented. An adaptation (OHIP-14) of the original questionnaire was performed to make it simple for the patient, having in total 14 questions of the 49 original ones with 4 possible answers.¹⁰

Results published in the scientific literature applying immediate implants into fresh extraction sockets can have very different outcomes.¹² The long-term survival of immediate implants has been proven to be excellent, but there are some concerns about esthetic complications that could compromise the success of the treatment, like migration of the facial gingival tissues.¹³

The aim of this ongoing prospective study is to provide a comparative evaluation between 1- and 3-year follow-up data of immediate implants from a prospective, single-arm study, analyzing success rate, soft and hard tissue changes, as well as patient satisfaction.

Materials and Methods

Surgical Procedure

Fifteen patients received 16 single implants placed immediately after tooth extraction in the esthetic area

of the maxilla (second premolar to second premolar). The following inclusion criteria were applied:

- Healthy subjects between 20 and 75 years of age
- Patients with a hopeless single tooth in the anterior region (tooth 15 to tooth 25; FDI position)
- Intact socket walls after tooth extraction
- Absence of dehiscence in the most-coronal 4 mm of the buccal bone
- Patients with medium-thick soft tissue biotype
- Sufficient apical bone to allow adequate anchorage/primary stability of the implant (4 to 5 mm)

Patients who presented the following characteristics were excluded from the study:

- Presence of acute infection
- Damaged buccal bone wall after tooth extraction
- Impossibility to reach adequate implant primary stability in the native bone
- Surgical flap necessary to place the implant or to regenerate the bone
- Smoking more than 10 cigarettes per day
- Antitumor chemotherapy or radiotherapy in the previous year
- Unwillingness to sign the informed consent form

Teeth were extracted atraumatically using elevators and forceps.

All the alveolar walls were intact before and after tooth extraction. Bone Level Roxolid SLActive implants (Institut Straumann) were inserted without making any incision. The gap created between the implant surface and the inner wall of the buccal alveolar bone was filled with alloplastic material (Vivoss, Straumann) (Figs 1a to 1c). No membranes or sutures were used.

Prosthetic Procedure

Provisional fixed bonded prosthesis or a removable provisional prosthesis was placed the same day of surgery. The type of temporary prosthesis was decided according to occlusal conditions. Lot of caution was taken in the design of the critical contour of the provisional restoration, trying to copy the extracted tooth contour. This achieved an optimal sealing of the socket, avoiding graft material contamination or migration to the oral cavity (Figs 1d to 1f). As no connective tissue graft was utilized, and based on Cardaropoli et al's findings on tissue maturation in tooth extraction sites,¹⁴ implants were exposed after a healing period of 6 to 10 weeks and impressions for a definitive crown were taken (Fig 1g). A customized zirconia abutment (CARES zirconia abutment, Institut Straumann) was manufactured. When the emergence of the screw was on the buccal or incisal surface, the customized abutment was screwed to the implant and a full ceramic crown was cemented using retraction cord to avoid subgingival cement extru-

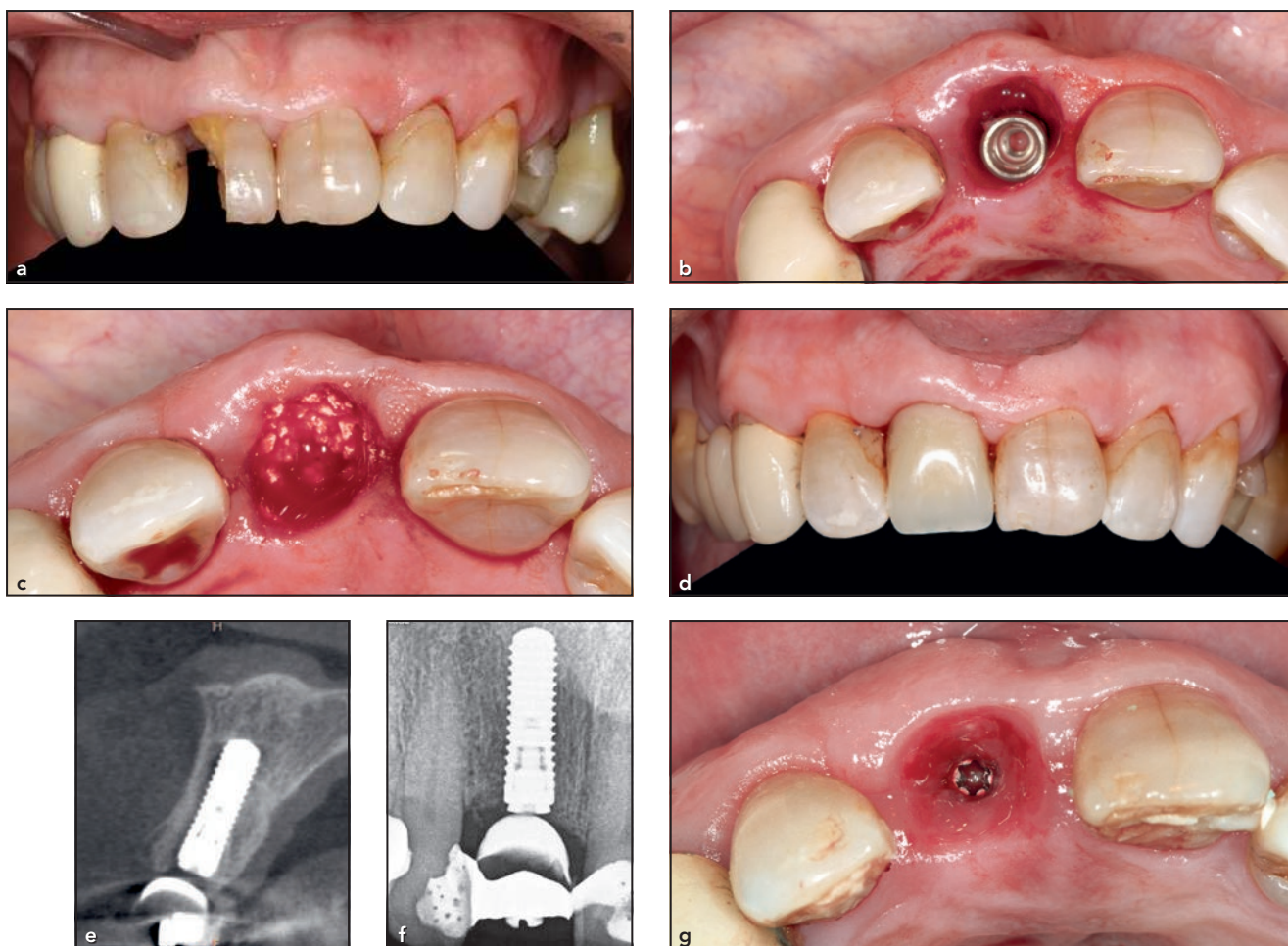


Fig 1 (a) Initial situation. (b) Atraumatic tooth extraction and flapless implant installation and (c) buccal gap filling with alloplastic material. (d) Immediate provisionalization with an adhesive prosthesis. (e and f) Radiographic views of the socket sealing. (g) Soft tissue healing after 10 weeks.

sion (Fig 2). In the cases where the screw emergence was on the occlusal or palatal surface, a full ceramic crown with an occlusal hole was cemented extraorally with RelyX Unicem (3M ESPE) and screwed both elements together to the implant (Fig 3).

Follow-up Evaluation

Patients were scheduled for follow-up once per year after insertion of the final crown. At these visits, clini-

cal and radiographic evaluations were performed.

Clinical Evaluation

Plaque Index and bleeding on probing were recorded. After 3 years of implant installation (T3) (Fig 2c), three vertical measurements from the occlusal plane to the mesial papilla, zenith, and distal papilla were performed with a periodontal probe for each site and compared to the same measurements taken at

1 year (T2) (Fig 4). These distances describe the stability or migration of the soft tissues surrounding the implant-supported restoration from the final crown insertion (T1) to the 3-year follow-up (T3). When the difference between the T2 and T3 measurements resulted in a negative value, this corresponded to a coronal advance of the soft tissues. Statistical significance was assessed by using nonparametric Brunner-Langer test.

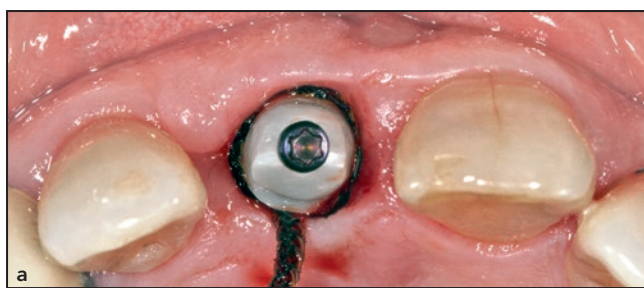


Fig 2 (a) Definitive crown cementation and (b) initial situation after final cementation. (c) Facial view at the 3-year follow-up.



Fig 3 (a) The definitive full-ceramic crown cemented on the zirconia customized abutment and (b) screw-retained at the mandibular left second premolar site.



Fig 4 Clinical measurement in millimeters at the (a) mesial papilla, (b) zenith, and (c) distal papilla.

Radiographic Evaluation

Marginal bone level (MBL) changes were evaluated comparing the 1-year and 3-year standardized periapical digital radiographs (Kodak RVG 6200, Carestream Dental). MBL was considered as the distance between the implant shoulder and the first visible bone-to-implant contact. The measurements were done at the mesial and distal aspects after image magnification of 150% using an image analysis program (ImageJ, version 1.51, National Institutes of Health) (Fig 5) as described by Buser et al.¹⁵

Patient Satisfaction Evaluation

Two weeks after having finished the treatment, patients were asked to fill out the OHIP-14 questionnaire to show their degree of satisfaction with the treatment received. A small OHIP-14 number is related to high patient satisfaction. In the worst possible situation, the score could reach a maximum of 56 points.

Results

Descriptive Analysis

One patient passed away before the 1-year follow-up, and 14 of the 15 implants placed could be reevaluated at the 1- and 3-year follow-ups. The mean follow-up time for the implants was 39 months, ranging from 32 months to 53 months. At 3 years, all implants remained osseointegrated and in function, resulting

in an implant survival rate of 100%. Details about patient demographics and treatment are shown in Table 1.

Clinical Results

All patients showed adequate Plaque Index scores and an absence of bleeding on probing. For the soft tissue evaluation, comparison of the three vertical clinical measurements at T2 and T3 showed minor variations. The vertical soft tissue remodeling ranged from 0.5 mm to -1 mm (Table 2).

The average value was highest for the mesial papilla, where a soft tissue migration of 0.14 ± 0.57 mm (mean $\pm$ SD) was detected ($P = .740$). At this point, soft tissue had changed by -0.29 ± 0.32 mm between T1 and T2 ($P = .002$). Overall, a soft tissue gain of -0.14 ± 0.50 mm between T1 and T3 was observed ($P = .162$). In the zenith, an improvement of the soft tissue of 0.11 ± 0.45 mm was encountered between T2 and T3 ($P = .067$). Between T1

and T2, a change of -0.14 ± 0.36 mm had been reported for the soft tissue ($P = .083$). Overall, a soft tissue gain of -0.25 ± 0.58 mm between T1 and T3 was observed ($P = .01$). At the distal papilla, the exact same values were encountered between T2 and T3 (0.11 ± 0.45 mm; $P = .061$). Between T1 and T2, a difference of -0.21 ± 0.43 mm was seen ($P = .086$). Overall, a soft tissue gain of -0.32 ± 0.54 mm between T1 and T3 was observed ($P = .010$).

Radiographic Results

The radiographic measurements at T2 and T3 are shown in Table 3. At the mesial aspect, MBL was 0.18 ± 0.48 mm after 1 year and 0.35 ± 0.59 mm after 3 years. In the distal aspect, MBL was 0.26 ± 0.54 mm after 1 year and 0.40 ± 0.80 mm after 3 years. Therefore, MBL increased during this period of 3 years, 0.17 ± 0.53 mm mesially ($P = .073$) and 0.14 ± 0.31 mm distally ($P = .060$) but was not statistically significant.

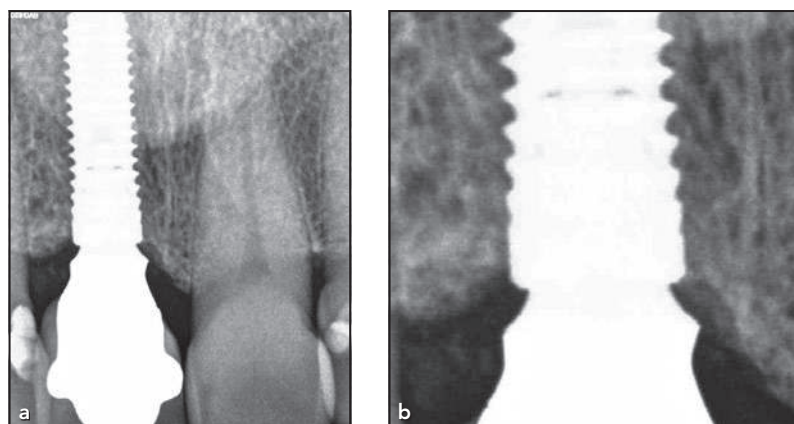


Fig 5 Periapical radiograph (a) at a standard magnification and (b) at $\times 150$ magnification for marginal bone level measurement.

Table 1 Patient Demographics and Treatment Characteristics

Implant	Age, y	Sex	Smoker	MH	Position (FDI)	AP	Diameter, mm	Length, mm	PP	DP	Time, d
1	60	F	No	No	22	No	3.3	12	Maryland	S	91
2	64	M	No	No	12	No	3.3	12	Maryland	S	85
3	32	F	Yes	No	14	No	4.1	12	Maryland	S	113
4	49	F	Yes	No	15	No	4.1	10	Maryland	S	71
5	49	F	Yes	No	25	No	4.1	12	Maryland	S	71
6	59	M	No	No	25	No	4.1	12	Maryland	S	95
7	64	F	No	No	11	No	4.1	14	Maryland	C	105
8	45	M	Yes	No	24	No	4.1	12	Maryland	S	117
9	64	F	No	No	23	No	4.1	12	Removable	C	89
10	54	F	No	No	25	No	4.1	10	Maryland	S	119
11	64	M	No	No	12	Yes	3.3	12	Maryland	C	95
12	66	F	No	No	25	No	4.1	12	Maryland	S	85
13	67	F	No	No	15	No	4.1	10	Removable	S	98
14	33	F	No	No	25	No	4.1	14	Maryland	S	71
15	57	F	No	No	22	No	3.3	12	Maryland	S	101
16	54	F	Yes	No	14	Yes	4.1	10	Maryland	S	87

MH = medical history; AP = previous apical pathology; PP = provisional prosthesis; DP = definitive prosthesis; S = screwed; C = cemented. Smokers consumed < 10 cigarettes per day. The "Time" column pertains to time of definitive restoration delivery.

Patients' Satisfaction Results

All patients completed the OHIP-14 questionnaire. Figure 6 summarizes the patients' answers. Difficulties with diet intake was mentioned by 73.3% of the patients. It was also common to experience some alteration of pronunciation (46.7%) and experience worrying (26.7%) or nervousness (33.3%).

Discussion

It has been reported by human histologic studies that osseointegration of implants placed in fresh extraction sockets is comparable to the implants installed in healed

ridges.^{16,17} One goal of immediate implant protocols is minimizing the dimensional changes after tooth extraction and consequently achieving stable peri-implant hard and soft tissue architectures.^{18,19} Such protocols take into account different aspects, such as correct 3D implant position, geometry of the implant, presence of buccal bone, filling the gap between implant neck and buccal bone with a biomaterial, and provisionalization.²⁰ These aspects need to be respected in order to minimize ridge collapse, as demonstrated in recent studies by Tarnow et al²¹ and Degidi et al.²² It is important to fill the gap with a bone substitute biomaterial and seal the socket entrance with an immedi-

ate provisional crown following the emergence profile of the extracted tooth.²³ In the present study, a temporary tooth (adhesive or removable) was carefully adapted to seal the socket, containing the alloplastic biomaterial and preserving soft tissue architecture.

Although short- and mid-term immediate implant placement studies show promising results, long-term studies have different outcomes.^{13,24–26}

These differences in the outcomes of similar immediate implant protocols need further investigation. For instance, a description of the geometry and dimensions of the used implants are lacking in some of the previously mentioned studies. In the publication by Evans and

Chen, the unsuccessful results were related to wider implant platforms (4.8 mm) and implants shifted to the buccal compartment of the socket.²⁶ Only in the study of Cooper et al²⁴ was the implant diameter reported. In their study, out of the 55 implants placed in fresh extraction sockets, 25 implants were 5 mm in diameter. This information is missing in studies by Cosyn et al²⁵ and Kan et al¹³ but would be useful to understand these aforementioned differences, since implant diameter seems to play an important role in the appearance of unpleasant facial tissue recession.²⁶ The implant diameters used in the present study were 4.1 or 3.3 mm, and great care was always taken to install the implant in the palatal compartment of the socket. Caneva et al²⁷ concluded that reducing the diameter of the implant and shifting the position of implant into a more palatal or lingual position would increase the distance between the vestibular gingival margin and the implant prosthetic interface, consequently reducing the appearance of facial recession.

In the present study, favorable radiologic results were present after the 3-year follow-up. The MBL values obtained are comparable to the ones reported by Testori et al²⁸ or Buser et al, using the same implant system.¹⁵

When analyzing the clinical values obtained at the two periods measured (between T1–T2 and T1–T3) in the present investigation, a decline of the mesial papilla was detected after 1 year, but after 3 years, the papilla was in a better position with respect to the day of

Table 2 Differences of Measurements in the Mesial Papilla, Gingival Zenith, and Distal Papilla Between T2 and T3

Implant	M, mm	GZ, mm	D, mm
1	1	0	0
2	1	–0.5	0
3	0	–0.5	0
4	0	–1	–0.5
5	0	0	0
6	0	1	0
7	0.5	0	–0.5
8	–	–	–
9	0.5	0	0.5
10	0.5	0	0.5
11	0.5	0	0.5
12	–0.5	0	–1
13	0	0	0
14	–0.5	0	–0.5
15	–1	–0.5	–0.5
Average	0.14 ± 0.57	–0.11 ± 0.45	–0.11 ± 0.45

T2 = 1-year follow-up; T3 = 3-year follow-up; M = mesial papilla; GZ = gingival zenith; D = distal papilla.

Differences were calculated by subtracting T2 measurements from T3 measurements.

Table 3 Radiographic Measurements on Standardized Periapical Radiographs at Mesial and Distal Aspects at T2 and T3

Implant	MT2, mm	DT2, mm	MT3, mm	DT3, mm
1	0.80	1.47	0.70	2.32
2	0	0	0	0
3	0	0.68	0.78	1.56
4	0	0	0	0
5	0	0	0	0
6	0	0	0	0
7	0	0	0	0
8	0	1.90	–	–
9	0	0	0	0
10	1.68	1.46	1.92	1.66
11	0	0	0	0
12	0	0	1.11	0
13	0	0	0	0
14	0	0	0	0
15	0	0	0.33	0
Average	0.18 ± 0.48	0.26 ± 0.54	0.35 ± 0.59	0.40 ± 0.80

T2 = 1-year follow-up; T3 = 3-year follow-up; MT2 = mesial measurement at T2; DT2 = distal measurement at T2; MT3 = mesial measurement at T3; DT3 = distal measurement at T3.

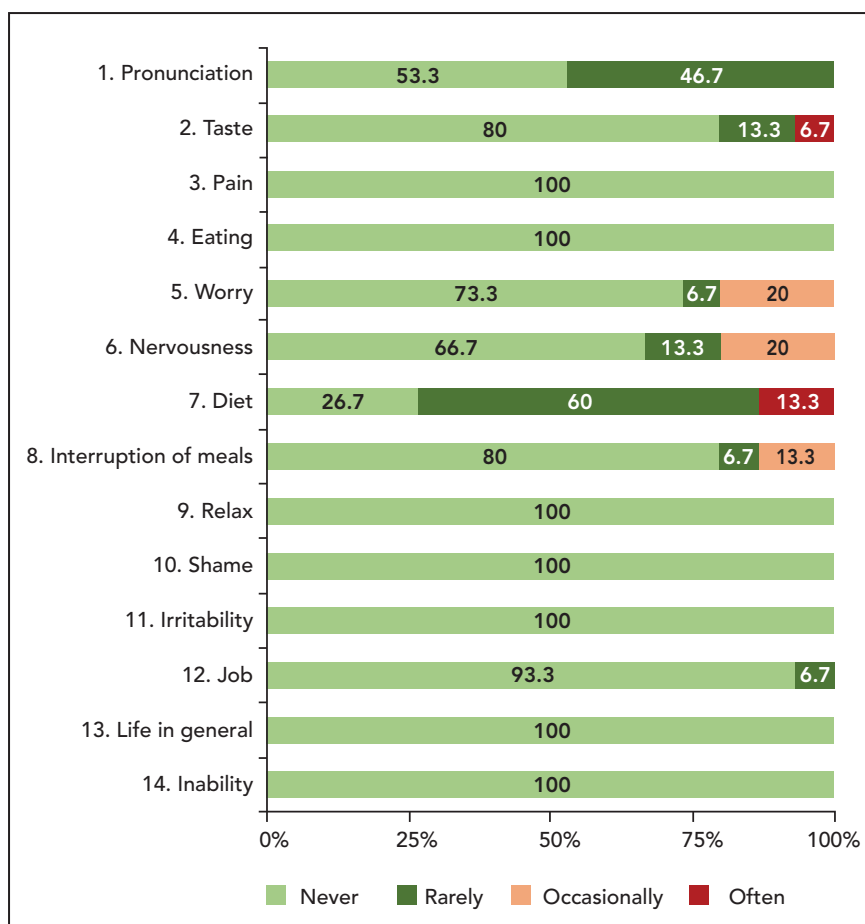


Fig 6 Percentage distribution of patient satisfaction responses to the OHIP-14 questions (summarized).

final restoration. Between T2–T3, a stable situation was found. The overall difference between T1–T3 measurements has to be interpreted as maintenance of the mesial papilla during the 3 years. The results obtained at the zenith and the distal papilla suggest that there has been a significant improvement between the day of final restoration and 3 years after.

Regarding patient satisfaction, few questionnaires are published in the field of dentistry, and their use is scarce. Schropp et al in 2003⁸ used the visual analog scale (VAS) to conclude that the group of patients

undergoing immediate implant treatment were significantly more satisfied than patients undergoing treatment with early implant placement. The satisfaction questionnaire used in the present study is the OHIP-14. This questionnaire is one of the most frequently used, offering greater standardization in comparison to the VAS questionnaire.⁹ According to the results of the present study, the authors can confirm that treatment with immediate implants (with flapless surgery and with immediate provisional restoration) results in high patient satisfaction. The average value obtained after answering

the OHIP-14 questionnaire (3.2 out of a maximum of 56) represents 5.7% of the points needed to indicate the worst possible outcome, which can be interpreted as a 94.3% general satisfaction on a scale of 0% to 100%.

These results are similar to those concluded by Esposito et al,⁷ who applied the VAS questionnaire. In more detail, several questions with a generally higher frequency of burden for the patients were identified: worrying or nervousness, and to a lesser extent the alteration of diet and the interruption of meals.

One of the main limitations of this study is the small patient sample. This study was performed in the clinical setting of the principal investigator (A.B.P.). Longer-term results and a larger sample size would contribute to strengthen the results of this investigation.

Conclusions

The application of an accurate surgical and prosthetic protocol when placing immediate implants in fresh extraction sockets in the esthetic zone may result in high survival and success rates and excellent patient satisfaction. After the 3-year follow-up, favorable results were present.

For a better understanding and to achieve stable and predictable esthetic results, new studies should include all information related to the characteristics of the immediate implants used, the clinical protocols applied, and the 3D evaluation of the buccal bone after a minimum 5-year follow-up period.

Acknowledgments

The authors declare no conflicts of interest.

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