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Esthetic outcomes of immediate implant placements

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Abstract

Background: Single-rooted teeth deemed not restorable via conventional means may be candidates for implant placement at the time of tooth extraction. Immediate implant placements are believed to preserve soft and hard tissue form and contours, reduce the need for augmentation procedures, minimize surgical exposure of the patient, reduce treatment time and improve esthetic outcomes.

Method: This retrospective review analyzed the esthetic outcomes of 42 non-adjacent single-unit implant restorations completed using an immediate implant surgical placement protocol.

Results: The mean time in function was 18.9 months (range 6–50 months) and the majority of implants placed had a restorative platform diameter of 4.1 and 4.8 mm. A highly significant change in crown height due to marginal tissue recession of 0.9 $\pm$ 0.78 mm ($P = 0.000$) was recorded for all sites, with no difference seen between implant systems ($P = 0.837$). Thin tissue biotype showed slightly greater recession than thick tissue biotype (1 $\pm$ 0.9 vs. 0.7 $\pm$ 0.57 mm, respectively); however, this difference was not statistically significant ($P = 0.187$). Implants with a buccal shoulder position showed three times more recession than implants with a lingual shoulder position (1.8 $\pm$ 0.83 vs. 0.6 $\pm$ 0.55 mm, respectively) with the difference being highly statistically significant ($P = 0.000$).

Conclusions: Immediate implant placement requires very careful case selection and high surgical skill levels if esthetic outcomes are to be achieved. Long-term prospective studies on tissue stability and esthetic outcomes are needed.

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Osseointegration of dental implants to replace missing teeth is reported to occur with a predictable degree of success (Adell et al. 1990; Lekholm et al. 1994; Buser et al. 1997). In the esthetic zone, a key challenge for the restorative dentist is to provide patients with a crown and peri-implant mucosa that is in harmony with the adjacent teeth, thus restoring both function and esthetics. From a surgical perspective, the current concept is to plan for implants to be placed in a position to optimize the emergence profiles of the restoration, thereby achieving proper soft tissue form and symmetry (Belser et al. 1998). This 'restorative-driven' surgical concept is thought to be an important factor in achieving esthetic success.

There has been increasing interest in the placement of implants at the time of tooth removal. Implants placed in this manner, either with or without simultaneous restoration, are advocated to preserve soft tissue form and contour, preserve bone

dimensions, reduce the period of edentulism, reduce the overall treatment time and to optimize esthetic results (Lazzara 1989; Becker et al. 1998; Wheeler et al. 2000; Kan et al. 2003b). Despite the claims of esthetic advantages, few studies have reported on the esthetic outcomes of immediate implant placements (Kan et al. 2003b; Bianchi & Sanfilippo 2004). In addition, the definition of esthetic parameters in relation to successful single-tooth implant restorations is not well established in the dental literature. Several authors have attempted to quantify the esthetic parameters associated with implant restorations (Belser et al. 1998) and more recently parameters for evaluating implant restoration success have been proposed (Belser et al. 2004).

Achieving esthetic success is suggested to be dependent on ideal three-dimensional implant position (Buser et al. 2004), maintenance of adequate buccal bone over the implant buccal surface (Grunder et al. 2005) and tissue biotype (Kan et al. 2003a).

The aim of this retrospective study was to review the esthetic outcomes of single-tooth immediate implant placements and determine the factors that may influence these results.

Materials and methods

The clinical records of patients consecutively treated in a private specialist prosthodontic practice were examined, and patients were selected for inclusion in the study based on the following criteria:

(i) single-tooth replacement in the maxillary and mandibular anterior and premolar segments;
(ii) non-adjacent implant sites; and
(iii) availability of complete clinical records, including pre- and post-treatment study casts, radiographs and study models.

Cases were excluded if the patients did not return for review following restoration of the implants, or did not consent to their records being used in the analysis.

Seven surgeons performed surgical aspects of implant treatment, with the restoration provided by a single prosthodontist (the first author). The patients were selected for placement of implants at the time of tooth extraction at the discretion of the surgeon. Implant placement at the time of tooth extraction was not performed if there was acute apical or coronal infection at the site of interest, or if primary stability was not achieved at the time of implant placement.

Following surgery, an interim removable partial prosthesis was inserted and adjusted to avoid pressure on the peri-implant tissue or implant's healing abutment. An integration time of between 3 and 4 months was allowed before commencing restoration of the implant, based upon the surgeon's recommendations. Implant restoration was completed between January 2000 and June 2004. A consistent restorative concept was maintained throughout the study. This concept was to achieve ideal crown morphology by developing a gradual transition in contour from the implant shoulder to the desired cervical position. Tissue conditioning with a provisional restoration was used to achieve the desired contour without excessive pressure on the labial peri-implant mucosa, and to establish stable tissue positions before final restoration in selected cases. Ridge-lap designs were avoided. Implant abutment selection was made indirectly on a working cast poured from an implant-level impression. Care was taken to minimize the need to modify the contra-lateral tooth crown morphology. The patients were reviewed at 3, 6 and 12 months during the first year, and annually thereafter to assess implant integration, peri-implant tissue health and occlusion.

Clinical data, digital photographs and/or 35 mm photographs taken at 1 : 1 magnification and study casts were evaluated for each patient at the final review appointment. Radiographic examination was undertaken at implant-level impression, delivery of the implant crown and review appointments. Non-standardized radiographs were obtained using a parallel long-cone radiographic technique and a film holder (Rinn Holder, Dentsply, UK). Change in crestal bone position on the proximal implant surfaces from crown delivery to final review appointment was determined radiographically using light box illumination and $\times$ 2.6 magnification. A magnification factor was established by comparing implant length on the radiograph with the actual implant length. The distance from the implant shoulder to the first point of contact of bone on the implant body was measured to the nearest 0.5 mm and the actual distance calculated.

The time in function for each restoration was calculated from the date of insertion to the date of the final review appointment. This time interval was used for all clinical and radiographic examinations.

On study casts and photographs, a horizontal reference line was established for each site where an implant was placed. The horizontal reference lines were determined as follows:

1. For maxillary central incisors implant sites – a line drawn between the incisal edges of the maxillary central incisors.
2. For maxillary lateral incisor implant sites – a line drawn between the incisal edges of the lateral incisors.
3. For maxillary canine implant sites – a line drawn between the cuspal tips of the maxillary canines.
4. For a maxillary and mandibular premolars – a line drawn between the cusp tips of the canine to the second premolar or first molar.

Where the reference incisal edges or cusp tips were obscured or where the crown of the tooth to be replaced was damaged or missing, the position of the reference point was estimated using the incisal edge of an adjacent tooth, taking into consideration the natural symmetry and cant for that individual. Care was taken to ensure that the same reference line was used for post-treatment measurements.

The following parameters were measured at 90° to the reference line to the nearest 0.5 mm:

T = distance between the horizontal reference line and the gingival zenith of the pre-treatment test tooth (initial crown height).
ΔT = change in distance from the horizontal reference line and the gingival zenith of the post-treatment implant restoration at the test site (change in crown height).
C = distance between the horizontal reference line and the gingival zenith of the contra-lateral (control) tooth.
DP = distance between the horizontal reference line and the tip of the papilla on the distal aspect of the test site.

MP = distance between the horizontal reference line and the tip of the papilla on the mesial aspect of the test site.

The interdental papilla volume following restoration was recorded based on the index proposed by Jemt (1997).

Index 0 = no papilla present.
Index 1 = less than one half the papilla height is present and a convex nature of the adjacent tissue nature is noted.
Index 2 = greater than half the height of the papilla is present but not to the full extent of the contact point. Papilla is not in complete harmony.
Index 3 = the papilla fills the entire proximal space and is in good harmony.
Index 4 = the papilla is hyperplastic.

A subjective esthetic score (SES) was developed to rate the esthetic outcome based on the vertical change in the mucosal margin position following restoration of the implant and tissue fullness. The outcome was scored as follows:

I = vertical buccal change was 0.5 mm or less and labial tissue fullness was in harmony with the adjacent teeth (Fig. 1a).
II = vertical buccal change was between 0.5 mm and 1 mm and the labial tissue fullness was in harmony.
III = vertical buccal change was between 1 and 1.5 mm or if the labial tissue appears deficient in contour.

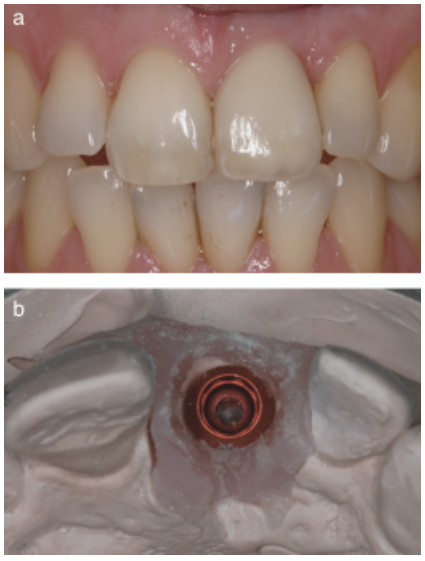

Fig. 1. (a, b) 21 Site: Straumann implant with subjective esthetic score rating 1 and buccolingual position B.

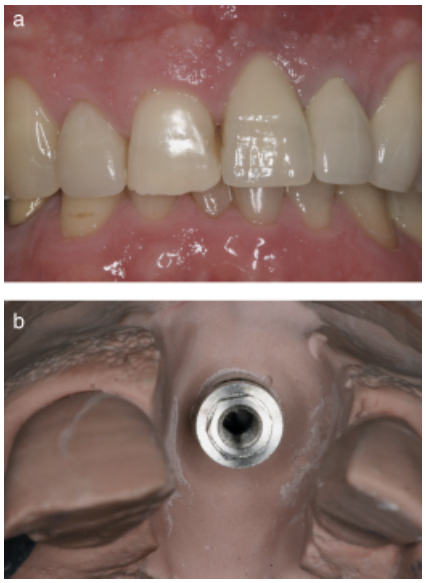

Fig. 2. (a, b) 21 Site: 3i implant with subjective esthetic score rating IV and buccolingual position A.

IV = vertical buccal change was greater than 1.5 mm and a deficiency in labial tissue contour was noted (Fig. 2a).

For determining the bucco-lingual implant position, a reference line was drawn between the cervical buccal position of the adjacent teeth following the line of the arch (Buser et al. 2004) and classified as follows:

Position A – the buccal edge of the implant shoulder was at or buccal to the reference line (Fig. 2b).
Position B – the buccal edge of the implant shoulder was lingual to the reference line (Fig. 1b).

Tissue biotype was assessed as being thick or thin based on the following criteria (Müller 2000):

(a) Thin tissue – a periodontal probe placed into the labial gingival sulcus could be seen through the gingival tissue; the tissue was assessed as being thin.
(b) Thick tissue – a periodontal probe tip was not visible; the tissue was assessed as being thick.

Implant failure was assessed according to the criteria presented by Lang et al. (2000).

Data analysis

Descriptive statistics, *t*-test and analysis of variance (ANOVA) models were used to test differences in means between crown height change and implant type, tissue biotype and implant position. All analyses were carried out using the statistical package Minitab Release 14 (Minitab Inc., State College, PA, USA).

Results

A total of 42 patients with 47 implant restorations, who fulfilled the inclusion criteria, were identified. Five patients presented with multiple non-adjacent implants. One implant was randomly selected from each of these patients for inclusion. A sample of 42 non-adjacent immediate implant sites was therefore available for analysis. The mean age of the patients at the time of implant placement was 47.9 ± 12.8 years, comprising 17 males and 25 females.

Seven surgical colleagues (two oral and maxillofacial surgeons and five periodontists) performed the surgical aspects of implant therapy. All implants were installed at the time of tooth removal and no implant was restored at the time of implant placement. Healing was uneventful in all cases and all implants integrated successfully. Two implant systems were identified; these were Straumann implants (Straumann Dental Implant System, Waldenberg, Switzerland) and 3i implants (Implant Innovations, Palm Beach Gardens, FL, USA). The choice of systems selected for each patient was based on the surgical and prosthodontist pre-operative site assessment.

No implant failures were noted during the observation time period. Implants at two sites (both 3i Implant Innovations) elicited tenderness on removal of the healing abutments. Restoration of these implants was delayed for a further 3 months, after which time restorative procedures and delivery of the final crowns were completed without further complications.

The distributions of implants, platform diameters and tooth sites by implant system are presented in Table 1. The mean time in function was 18.9 months, with no statistically significant differences between implant systems. The majority of implants placed had a restorative platform diameter of 4.1 and 4.8 mm.

The initial crown height of the control teeth was 10.1 ± 1.22 mm. A small but significant increase in crown height of

Table 1. **Implant platform diameter and site, and time in function – by implant system**

Implant system	*N*	Time in function (months)*	Restorative platform diameter (mm)					Implant site				
			3.5	4.1	4.8	5	6.5	Maxillary central	Maxillary lateral	Maxillary canine	Maxillary premolar	Mandibular premolar
3i	17	16.2 (10.1)	–	14	–	3	–	11	4	2	0	0
Straumann	25	20.7 (11.5)	4	–	20	–	1	12	5	3	4	1
All	42	18.9 (11)	4	14	20	3	1	23	9	5	4	1

*Mean ± SD.

Table 2. **Initial crown height (*T*) and change in crown height (Δ*T*) at test implant sites by implant system, biotype and implant shoulder position**

	N	Initial crown height in mm – implant site (*T*)*	Change in crown height in mm – implant site (Δ*T*)*
All sites	42	10 (1.08)	0.9 (0.79)†
System			
3i	17	9.9 (1.06)	0.9 (0.83)
Straumann	25	10 (1.11)	0.9 (0.77)
		P = 0.774	*P* = 0.837
Biotype			
Thin	24	10.3 (0.97)	1 (0.90)
Thick	18	9.7 (1.15)	0.7 (0.57)
		P = 0.082	*P* = 0.187
Shoulder position			
A (buccal)	10	9.6 (1.02)	1.8 (0.83)
B (lingual)	32	10.1 (1.08)	0.6 (0.55)
		P = 0.181	*P* = 0.000

*Mean ± SD.

†Significant change between baseline and re-examination for all sites (*P* = 0.000).

Table 3. **Frequency of sites with buccal tissue recession <1 and ≥ 1 mm by tissue biotype and implant shoulder position**

	No. of sites			
	Thin biotype (*n* = 24)		Thick biotype (*n* = 18)	
Implants shoulder position	Buccal	Lingual	Buccal	Lingual
Recession <1 mm	1	12	1	11
Recession ≥ 1 mm	6	5	2	4
Total	7	17	3	15

control teeth amounting to 0.1 ± 0.37 mm ($P = 0.026$) was noted at the end of the observation period. The changes in crown height between implant systems and tissue biotype were not statistically significant.

Table 2 shows the changes in crown height at the test implant sites by implant system, tissue biotype and implant shoulder position. A highly significant change in crown height due to a marginal tissue recession of 0.9 ± 0.78 mm ($P = 0.000$) was recorded for all sites, with no difference seen between implant systems ($P = 0.837$). The thin tissue biotype showed slightly greater recession than the thick tissue biotype (1 ± 0.9 vs. 0.7 ± 0.57 mm, respectively); however, this difference was not statistically significant ($P = 0.187$). Implants with shoulder position A (buccal) showed three times more recession than implants with shoulder position B (lingual) (1.8 ± 0.83 mm vs. 0.6 ± 0.55 mm, respectively), with the difference being highly statistically significant ($P = 0.000$).

Buccal tissue recession of 1 mm or greater was seen at 17 out of 42 (40.5%) sites (Table 3). Sites with thin tissue biotype had a higher frequency of recession of 1 mm or greater compared with thick sites (11/24 or 45.8% of thin sites vs. 6/18 or 33.3% of thick sites). Furthermore, at sites where implants shoulders were buccally positioned, a recession of 1 mm or greater was observed at six out of seven (85.7%) of thin biotype sites, and two out of three (66.7%) of thick biotype sites. Thin tissue biotype sites demonstrated a greater proportion of high value recession scores compared with thick tissue biotype sites (Fig. 3).

Table 4 shows papilla height changes and radiographic bone-level changes. A small but highly significant loss of height of 0.5 mm was found at the mesial ($P = 0.000$) and distal ($P = 0.001$) papilla of the implants. The difference between implant systems was not significant. With respect to the radiographic crestal bone changes, 3i implants showed significantly less crestal bone change compared with Straumann implants (0.3 vs. 0.9 mm, respectively; $P < 0.05$).

The SES revealed that 82% of the implant restorations were satisfactory (score I or II), with <1 mm of buccal recession and normal labial tissue contour (Table 5). Nine percent of cases demonstrated buccal recession between 1 and 1.5 mm

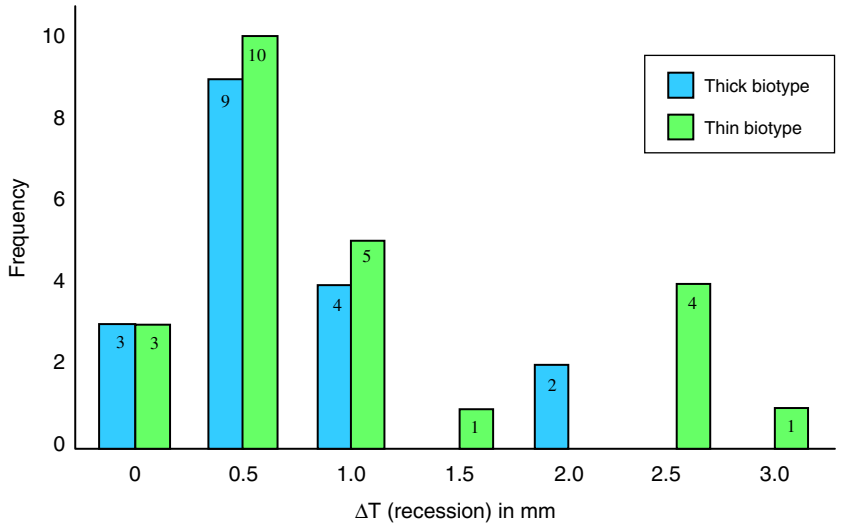

Fig. 3. Frequency table of change in crown height *T* in mm (marginal tissue recession) by tissue biotype.

***Table 4.* Radiographic bone level change, and change in mesial and distal papilla height by implant system**

System	*N*	Change in papilla height (mm)*		Change in radiographic bone level (mm)*	
		(MP) mesial	(DP) distal	Mesial	Distal
3i	17	0.5 (0.37)	0.3 (0.5)	1.3 (0.67)	1.3 (0.8)
Straumann	25	0.5 (0.61)	0.7 (1.21)	1.9 (0.71)	1.9 (0.68)
		P = 0.861	*P = 0.199*	*P = 0.015*	*P = 0.019*
All sites	42	0.5 (0.52)	0.5 (1.00)	1.7 (0.74)	1.7 (0.77)
		P = 0.000	*P = 0.001*		

*Mean ± SD.

***Table 5.* Subjective esthetic score (SES) of esthetic soft tissue outcomes**

	SES of esthetic outcome			
	I	II	III	IV
Criteria	Recession 0–0.5 mm with harmonious buccal tissue fullness	Recession 0.5–1 mm with harmonious buccal tissue fullness	Recession 1–1.5 mm and/or buccal tissue deficient in volume	Recession >1.5 mm and/or buccal tissue deficient in volume
N	23	11	4	4

(score III) and the remaining 9% of sites showed recession of greater than 1.5 mm (score IV).

Prosthesis outcomes

Twelve cement-retained and 35 screw-retained crowns were issued. These were all constructed from porcelain fused to gold alloy. Six crowns were occlusal or palatal screw retained and 29 were transversal screw retained. In seven cases, the contra-lateral tooth was modified. Two were modified with direct resin restoration. In five cases, the contra-lateral tooth was crowned. The contra-lateral tooth was absent for comparison in one case.

During the observation period, two porcelain fractures were recorded involving one cement-retained implant crown in the upper premolar position and one transversal screw-retained crown in the upper cuspid position. Both were smoothed and polished mechanically. No other prosthetic complications were recorded.

One 3i implant located in the upper central incisor developed a buccal fistula from the crown/implant interface at 12 months. This was a transversal screw-retained crown, which used a silicone (GC Fit Checker, GC Corp., Kasugai, Aichi, Japan) space filler between the implant abutment and crown. The crown was removed and chlorhexidine (Perioguard 0.5%, Colgate, Sydney, Australia) irrigation was performed. The crown was replaced using temporary luting cement (Tempbond NE unidose, sdsKerr, Romulus, MI, USA) to seal inside the crown. The fistula resolved and did not recur.

Discussion

The results of the present study confirm that implants placed into extraction sockets may be expected to integrate with a high degree of predictability (Mayfield 1999; Chen et al. 2004). No differences were seen between the two implant systems used. It was interesting to note that the two implants that elicited tenderness on removal of the healing abutments (3i, Implant Innovations) were subsequently restored uneventfully by delaying restoration by a further 3 months. This suggests that the rate of osseointegration in extraction sockets may vary depending upon the conditions of the socket, the wound-healing potential of the individual and the surface characteristics of the implant used. Several studies have reported that implants initially exhibiting signs of tenderness on application of torque may integrate successfully when additional healing time is provided (Roccuzzo et al. 2001; Cochran et al. 2002; Salvi et al. 2004).

Although successful integration of immediate implants has been widely reported, soft tissue esthetic outcomes have not been well documented. In the present study, recession of the labial marginal mucosa of 0.9 ± 0.7 mm was found as a mean for all sites. This was similar to a report of 35 immediately placed threaded hydroxyapatite-coated implants in which a mean 0.55 ± 0.53 mm of recession was observed 12 months after restoration of the implants (Kan et al. 2003b). Recession of the marginal mucosa has also been reported in studies of implants placed in healed sites (Grunder et al. 2000; Small & Tarnow 2000; Oates et al. 2002; Priest 2003). These studies reported marginal mucosal recession ranging from 0.06 to 1 mm, with

most of the recession occurring within the first 3 months following delivery of the implant restoration (Bengazi et al. 1996).

Several factors have been proposed as being important in determining the stability of the peri-implant marginal mucosa, including implant shoulder position in a bucco-lingual and apico-coronal plane (Garber 1995; Kois 2001; Buser et al. 2004) and tissue biotype (Kois 2001; Kan et al. 2003a).

In relation to the optimal bucco-lingual position, Buser et al. (2004) recommended that the implant shoulder should be placed 1–2 mm lingual to the emergence of the adjacent teeth to ensure maintenance of an adequate width of buccal bone and stable mucosa over the buccal implant surface. This recommendation is supported by the findings of the present study in which the bucco-lingual position of the implant shoulder was found to be a highly significant factor in determining the degree of buccal marginal tissue recession. Implants with a shoulder position at or buccal to a line drawn between the cervical margins of adjacent teeth demonstrated three times more recession than implants with a shoulder position lingual to this line (1.8 vs. 0.6 mm; $P = 0.000$).

The apico-coronal position or depth of implant placement may also be an important factor in determining the stability of the peri-implant mucosa (Garber 1995; Kois 2001; Buser et al. 2004). Experimental studies have shown that the peri-implant mucosa heals with the establishment of a mucosal attachment or biologic width of 3–4 mm (Berglundh et al. 1991). The dimensions are similar between different implant systems (Abrahamsson et al. 1996) and remain stable over time (Cochran et al. 1997). In a recent clinical study, Kan et al. (2003a) used sounding of the crestal bone through the peri-implant sulcus to demonstrate a mean mid-facial peri-implant mucosal height of 3.63 ± 0.91 mm, verifying that a biologic dimension exists within a relatively narrow range. In clinical practice, immediate implants are placed with the shoulder of the implant at or slightly apical to the buccal marginal bone crest (Lazzara 1989; Becker et al. 1991; Cochran & Douglas 1993), representing a distance of 3–4 mm from the buccal gingival margin. During the healing period, the buccal crestal bone undergoes resorptive and modeling changes characterized by a combination of bone fill within the original peri-implant defect, resorption of the buccal plate of bone of approximately 50% of the original width and approximately 1 mm loss of crestal bone height (Gher et al. 1994; Botticelli et al. 2004; Araujo & Lindhe 2005; Araujo et al. 2005; Chen et al. 2005). Clinical studies have shown that in relation to the implant shoulder, the most coronal contact between the bone and implant is 1.5–2 mm in externally hexed implant systems with a turned surface (Ericsson et al. 1994) and 2.5 mm for the standard plus collar in the Straumann implant system (Hanggi et al. 2005). Thus, following wound healing and resorptive/modeling changes to the crestal bone, the supracrestal mucosal attachment may range from 4.5 to 6.5 mm, which exceeds the normal biologic width. This situation may be unstable and may predispose the mucosa to recession (Hermann et al. 2001).

Gingival biotype, a term used to describe the thickness of the gingiva in a bucco-lingual dimension, has been classified as being either thick or thin (Seibert & Lindhe 1989; Muller et al. 2000). A morphological relationship has been described between the crown form of the natural tooth and gingival biotype. Long narrow crown forms are associated with thin tissue biotypes and short wide crown forms are associated with thick tissue biotypes (Olsson et al. 1993; Muller & Eger 1997). Recently, it has been suggested that tissue biotype may be a determinant of soft tissue esthetic outcomes with dental implants (Kois 2001). Differences between tissue biotypes were reported in a clinical report in which the peri-implant mucosa dimensions were greater than 4 mm in thick biotype sites compared with dimensions of 3 mm and less in thin biotype sites (Kan et al. 2003a). In the present study, although thin biotype sites showed greater recession than thick biotype sites (mean 1 vs. 0.7 mm), the differences were not statistically significant. Furthermore, when considering the frequency of marginal tissue recession, it was noted that this occurred at both thin and thick biotype sites. This would suggest that a thick biotype alone does not confer resistance to marginal tissue recession. However, sites with thin tissue biotype had a higher frequency of recession of 1 mm or greater compared with thick sites (45.8% vs. 33.3%, respectively) with a mean recession of 1.8 ± 0.82 mm (range 1–3 mm) and 1.3 ± 0.52 mm (range 1–2 mm), respectively. Sites with thin tissue biotype should therefore be regarded as having a greater risk of marginal tissue recession when compared with thick sites, particularly if the implants are buccally positioned (85.7% for thin vs. 66.7%). Although the over-riding determinant of recession appears to be the bucco-lingual shoulder position of the implant, nine out of 32 (28.1%) sites in which the implants were lingually positioned also demonstrated a recession of 1 mm or greater. Thus, other factors may play an important modifying role, including operator variables such as surgical and restorative techniques and technical skills, and patient variables such as the pre-treatment condition of the buccal plate, soft tissue volumetric deficiencies and wound-healing potential.

The form and symmetry of the implant–tooth papilla may also contribute to the final esthetic outcome of the single-tooth implant restoration. The mesio-distal width of the crown is defined by the mesial and distal interdental papilla in the cervical zone and the contact points coronally (Reikie 1993, 1995). The cervical position of the contact point with the adjacent teeth, and maintenance of bone on the adjacent teeth and crestally around the dental implant is understood to influence the presence of interdental papillae regeneration (Choquet et al. 2001). If papilla loss necessitates that the contact point be located too far apically in order to close proximal spaces, the restoration may be esthetically compromised due to asymmetry. This is particularly relevant with highly scalloped tissue form and a tapering tooth contour. An index for assessing the size and contour of the interdental papillae adjacent to implant restorations is proposed by Jemt and has reported spontaneous papilla regeneration to occur irrespective of the use of provisional restorations in almost 60% of the cases (Jemt 1997, 1999). Priest reported that complete papillary infill was observed in 75% of the cases and papillary regeneration occurred in 83.9% of the cases (Priest 2003). The present study found the mean mesial and distal papilla height to be

within 0.5 mm of the pre-operative position and good papilla volumes were reported. Only a small number of cases used tissue conditioning using a provisional restoration, which is in agreement with other studies outlined above.

At esthetically sensitive sites, the goal of soft tissue management is to minimize marginal tissue recession. The frequency of sites with a buccal recession of 1 mm or greater (40.5%) as reported in the present study falls short of this goal. Only six out of 42 (14.3%) sites demonstrated no tissue recession. However, it should be noted that patient-based assessments of implant esthetic outcomes are less critical than operator-based assessments (Chang et al. 1999). In the present study, despite the frequency of recession observed, 39 patients expressed satisfaction with the final esthetic outcome.

Conclusions

Within the scope of this study, the following conclusions may be drawn:

1. Following restoration of immediate implants, a high incidence and statistically significant recession of the buccal marginal mucosa (0.9 ± 0.78 mm) occurred after a mean observation period of 19.9 months. A recession of 1 mm or more occurred at 40.5% of sites; only 14.3% of the sites demonstrated no recession.
2. Implants that were positioned with the shoulder at or buccal to a line between the cervical margins of adjacent teeth showed three times more recession than sites with implants placed lingual to this line (1.8 ± 0.83 vs. 0.6 ± 0.55 mm; $P = 0.000$).
3. Recession was observed at both thin and thick biotype sites. However, recession at thin biotype sites tended to be of a greater magnitude.
4. There was minimal change to the height of the mesial and distal papillae (mean 0.5 mm).

Further studies are required to evaluate other operator- and patient-related factors that may affect the stability of the peri-implant mucosa.

要旨
従来の方法では修復不能に思われる単根歯は、抜歯時にインプラント埋入の候補となる場合がある。即時インプラント埋入は、軟組織、硬組織の形態と輪郭を温存し、増生術の必要性を減らし、患者にとって外科侵襲度を最低限にとどめ、治療期間を減らし、審美的結果を改善すると考えられている。本後ろ向き研究は、即時インプラント埋入のプロトコールに従って治療した 42 個の非連結、単独インプラント修復物の審美的結果を分析した。平均機能期間は 18.9 ヶ月（６～５０ヶ月）であり、大半のインプラントは補綴用プラットフォームの直径が 4.1mm と 4.8mm であった。全ての部位において、0.9±0.78mm の辺縁組織の退縮のためにクラウンの高径に有意な変化が記録されたが（P=0.000）、インプラント・システム間の有意差は認められなかった（P=0.837）。軟組織が薄いバイオタイプは軟組織が厚いバイオタイプよりも、退縮がやや多かった（各々1.0±0.9mm 対 0.7±0.57mm）。しかしこれは、統計学的有意差ではなかった（P=0.187）。ショルダー位置が頬側寄りであったインプラントは、ショルダー位置が舌側寄りのインプラントよりも退縮の量が３倍多く（各々1.8±0.83mm 対 0.6±0.55mm）、これは顕著な統計学的有意差であった（P＝0.000）。
即時インプラント埋入によって審美的な結果を達成するには、きわめて慎重な症例選択と高度の外科手技の技術が必要である。軟組織の安定性と審美的結果に関する長期の前向き試験が必要とされる。

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