

Case Series

A 5-year prospective study on single immediate implants in the aesthetic zone

Jan Cosyn^{1,2}, Aryan Eghbali²,
Alexander Hermans², Stijn Vervaeke¹,
Hugo De Bruyn^{1,3} and Roberto
Cleymaet²

¹Department of Periodontology and Oral Implantology, Faculty of Medicine and Health Sciences, Dental School, Ghent University, Ghent, Belgium; ²Oral Health Research Group (ORHE), Faculty of Medicine and Pharmacy, Vrije Universiteit Brussel (VUB), Brussels, Belgium; ³Department of Prosthodontics, Faculty of Odontology, Malmö University, Malmö, Sweden

Cosyn J, Eghbali A, Hermans A, Vervaeke S, De Bruyn H, Cleymaet R. A 5-year prospective study on single immediate implants in the aesthetic zone. *J Clin Periodontol* 2016; doi: 10.1111/jcpe.12571.

Abstract

Aim: There is a paucity of long-term data on soft tissue aesthetics of single immediate implants. The objective of this study was to evaluate the 5-year clinical and aesthetic outcome of this treatment concept.

Materials and methods: Twenty-two periodontally healthy patients (12 men, 10 women; mean age 50) with low risk for aesthetic complications (thick gingival biotype, intact buccal bone wall, both neighbouring teeth present) were consecutively treated with a single immediate implant in the aesthetic zone (15–25). Flapless surgery was performed and the gap between the implant and buccal bone wall was systematically filled with bovine bone particles. Implants were immediately non-functionally loaded with a screw-retained provisional crown. Cases demonstrating major alveolar process changes and/or advanced mid-facial recession (>1 mm) at 3 months were additionally treated with a connective tissue graft (CTG). Permanent crowns were installed at 6 months. The clinical and aesthetic results at 5 years were compared to those obtained at 1 year.

Results: Seventeen patients attended the 5-year re-assessment, of whom five had been treated with a CTG for early aesthetic complications. There was one early implant failure and one complication after 1 year (porcelain chipping). Mean marginal bone loss was 0.12 mm at 1 year and 0.19 mm at 5 years ($p = 0.595$) with the moment of implant installation as baseline. Papilla height increased between 1 and 5 years ($p \leq 0.007$), whereas mid-facial contour ($p = 0.005$) and alveolar process deficiency ($p = 0.008$) deteriorated. Mean mid-facial recession was on average 0.28 mm (SD 0.48) at 1 year and 0.53 mm (SD 0.53) at 5 years ($p = 0.072$) with the preoperative status as baseline. Three implants demonstrated advanced mid-facial recession (>1 mm) at 5 years. All three were in a central incisor position and none had been treated with a CTG. Thus, 8/17 implants showed aesthetic complications (five early and three late aesthetic complications). Implants in a lateral incisor position showed stable soft tissue levels. The pink aesthetic score was on average 12.15 at 1 year and 11.18 at 5 years ($p = 0.030$).

Conclusion: Single immediate implants showed high implant survival and limited marginal bone loss in the long term. However, mid-facial recession, mid-facial contour and alveolar process deficiency deteriorated after 1 year. With an

Key words: dental implant; immediate; long term; single tooth

Accepted for publication 22 April 2016

Conflict of interest and source of funding statement

Prof. Cosyn has a collaboration agreement with Nobel Biocare GöteborgSweden Prof. De Bruyn has collaboration agreements with Dentsply Implants (York, Pennsylvania, USA) and Southern Implants (Irene, South-Africa). The study was self-funded by the authors and their institutions. Nobel Biocare, Belgium, provided free materials to be used in the study

aesthetic complication rate of 8/17 in well-selected patients who had been treated by experienced clinicians, type I placement may not be recommended for daily practice.

Immediate implant treatment has always been an appealing concept for patients as it has the potential to instantly re-establish function and aesthetics. Also clinicians may benefit from this protocol classified as type I by Hämmerle et al. (2004), given a considerable reduction in chair time when compared to more conventional approaches.

About a decade ago, pre-clinical and clinical studies demonstrated that post-extraction bone re-modelling cannot be avoided by the installation of an implant into a fresh extraction socket (Botticelli et al. 2004, Araújo et al. 2005). From then on, the scientific community has been focusing more on the aesthetic outcome of immediate implant treatment. Clinical studies have indicated high risk of advanced mid-facial recession (>1 mm) following type I placement in case of an incomplete buccal bone wall (Kan et al. 2007) and in patients with a thin-scalloped gingival biotype (Chen et al. 2009, Kan et al. 2011). Recent systematic reviews also pointed to the importance of such diagnostic aspects for a predictable outcome of immediate implant treatment (De Rouck et al. 2008b, Cosyn et al. 2012, Chen & Buser 2014, Khzam et al. 2015). In addition, flapless surgery (Raes et al. 2011), a correct three-dimensional implant position (Evans & Chen 2008, Chen et al. 2009, Lin et al. 2014), connective tissue grafting (Bianchi & Sanfilippo 2004, Rungcharassaeng et al. 2012, Yoshino et al. 2014) and immediate provisionalization (De Rouck et al. 2009a) seem to enhance mid-facial soft tissue levels following type I placement.

As described in a recent systematic review, single immediate implants may demonstrate a favourable outcome in terms of soft tissue stability and aesthetics following proper case selection and meticulous treatment, at least in the short term (Cosyn et al. 2012). To the best of our knowledge, however, only four

clinical studies have been published with long-term follow-up (≥ 5 years) (Mura 2012, de Carvalho et al. 2013, Cooper et al. 2014, Ross et al. 2014). Of those, only one provided changes in mucosal margins (Cooper et al. 2014) and none reported aesthetic outcomes based on a composite index. Clearly, there is a paucity of long-term clinical studies on type I placement with details on soft tissue alterations and aesthetics. This information is of key importance given the fact that immediate implant treatment is widely performed in contemporary practice.

The objective of this prospective study was to evaluate the 5-year outcome of single immediate implants in the aesthetic zone in well-selected patients with a low risk for aesthetic complications.

Materials and Methods

Patient selection

Patients were selected in a private practice between January 2009 and April 2010 to participate in a prospective case series. The 1-year results of this patient cohort have been published previously (Cosyn et al. 2013).

Inclusion criteria were as follows:

- 1 at least 18 years old;
- 2 good oral hygiene defined as full-mouth plaque score $\leq 25\%$ (O'Leary et al. 1972);
- 3 presence of a single failing tooth in the anterior maxilla (15–25) with both neighbouring teeth present;
- 4 no mucosal defects in reference to adjacent and contra-lateral teeth;
- 5 thick gingival biotype based on the lack of transparency of a periodontal probe through the gingival margin when probing the buccal sulcus of the failing tooth (De Rouck et al. 2009b);
- 6 adequate bone height apically to the alveolus of the failing tooth (≥ 5 mm) to ensure a minimal implant insertion torque of 35 Ncm;
- 7 signed informed consent.

Exclusion criteria were as follows:

- 1 systemic diseases;
- 2 smoking;
- 3 bruxism, lack of posterior occlusion;
- 4 periodontal disease or history of periodontal disease;
- 5 presence of active infection (pus, fistula) around the failing tooth;
- 6 incomplete buccal bone wall after extraction of the failing tooth.

The study was conducted in accordance with the Helsinki declaration of 1975 as revised in 2000 and the protocol was approved by the ethical committee of the university hospital in Brussels (UZ Brussel).

Surgical procedures and provisional restoration

Implant surgery was preceded by antibiotic therapy (Amoxicillin 1,000 mg twice a day for 4 days and started the day before) and oral disinfection (Corsodyl®; GlaxoSmithKline, Genval, Belgium). Teeth scheduled for immediate replacement were removed without flap elevation using periostomes. Immediate implant placement (NobelActive®; Nobel Biocare, Göteborg, Sweden) was performed paying special attention to an optimal three-dimensional positioning as described by Buser et al. (2004). Thereupon, an implant impression was made for a screw-retained provisional crown with concave emergence profile as described by De Rouck et al. (2008a). Deproteinized bovine bone particles (Bio-Oss® 0.25–1 mm; Geistlich Pharma AG, Wolhusen, Switzerland) soaked in blood were inserted to fill the void between the implant and alveolar socket (Cornelini et al. 2004). An appropriate healing abutment was applied until the provisional restoration was installed approximately 3 h later. The latter was fabricated in the dental laboratory by means of an engaging titanium temporary abutment (Nobel Biocare, Göteborg, Sweden) serving

as a carrier for an appropriate hollowed denture tooth (De Rouck et al. 2008a). The provisional restoration was tightened at 15 Ncm torque and adjusted to clear centric and eccentric contacts to avoid full functional load.

Three months following implant surgery a connective tissue graft (CTG) was inserted into the buccal mucosa in case of advanced mid-facial recession (>1 mm) and/or major alveolar process re-modelling. The latter was clinically evaluated on the basis of occlusal inspection of the ridge as described by Fürhauser et al. (2005). Details on the augmentation of the buccal mucosa can be found in a recent study by De Bruyckere et al. (2015). In brief, an appropriate CTG was harvested from the palate through a single-incision approach and pulled into the buccal peri-implant mucosa following a pouch procedure. The transmucosal buccal aspect of the provisional restoration was made concave to avoid soft tissue pressure and to allow for in-/up-growth. All aforementioned procedures were performed by the same periodontist (J.C.).

Replication of emergence profile and permanent restoration

Between 3 and 6 months the emergence profile was slightly adjusted when deemed necessary. A concave profile was shaped in proximity of the bone, whereas a slightly convex profile was created in proximity of the mucosal margin. The latter was performed by adding flowable composite (Charisma® Flow; Heraeus Kulzer GmbH, Hanau, Germany).

Six months following implant surgery, clinical procedures were initiated for fabrication of the permanent restoration. Attention was paid to an accurate replication of the emergence profile that had been created by the provisional restoration. First, the provisional restoration was connected onto an implant replica and embedded in silicon paste (Optosil® Comfort Putty; Heraeus Kulzer GmbH). Then, the provisional restoration was replaced by an open tray impression coping (Nobel Biocare, Göteborg, Sweden). The void between the silicon and impression coping was filled with autopolymerizing acrylic resin (TAB

2000®; Kerr, Orange, CA, USA). This individualized impression coping was used to make the final implant impression. Permanent restorations were screw retained or cemented with temporary cement (Temp-Bond NE®; Kerr, Scafati, Italy). All restorative procedures were performed by the same prosthodontist (R.C.) and all permanent restorations were fabricated in the same dental laboratory.

Clinical outcome

- *Implant survival and complications* were evaluated over the 5-year follow-up period. The latter included biological (abscess, fistula, peri-implantitis), technical (loosening of the abutment screw, loss of retention of the crown and fracture of components) as well as aesthetic (major alveolar process re-modelling and advanced mid-facial recession [> 1 mm]) complications.
- *Marginal bone loss* was calculated as the change in bone level between the day of surgery and, respectively, 1 and 5 years on the basis of digital peri-apical radiographs taken with the long-cone paralleling technique. Bone level was defined as the distance from the implant–abutment interface to the first bone-to-implant contact and was calculated for each implant (mean of mesial and distal side) and for each time point (day of surgery, 1 year, 5 years) using designated software (DBSWIN; Dürr Dental AG, Bietigheim-Bissingen, Germany). To control for magnification errors, the implant length served as the reference distance.
- *Plaque score* was assessed at four sites (mesial, mid-facial, distal and palatal) around the implant restoration at 1 and 5 years. A dichotomous score was given (0 = no visible plaque at the soft tissue margin; 1 = visible plaque at the soft tissue margin).
- *Probing depth* was measured at four sites (mesial, mid-facial, distal and palatal) around the implant restoration at 1 and 5 years. Registrations were performed to the nearest 0.5 mm using a manual probe (CP 15 UNC, Hu-Friedy®, Chicago, IL, USA).

- *Bleeding on probing* was measured at four sites (mesial, mid-facial, distal and palatal) around the implant restoration at 1 and 5 years. A dichotomous score was given (0 = no bleeding; 1 = bleeding).

Aesthetic outcome

- *Mesial and distal papillary recession* was registered at 1 and 5 years using an acrylic stent provided with direction grooves as described by De Rouck et al. (2008a). Baseline registration was performed with the failing tooth still *in situ*. A positive value corresponded to papillary recession, a negative value to papillary gain.
- *Mid-facial recession* was recorded at 1 and 5 years in a similar way as papillary recession.
- *Pink Esthetic Score (PES)* (Fürhauser et al. 2005) was registered at 1 and 5 years.

Statistical analysis

Data analysis was performed using the patient as the experimental unit. Descriptive statistics on the outcome variables included central measures (mean, median) and measures of spread (standard deviation, interquartile range) where applicable and frequency distributions. Changes between 1 and 5 years were evaluated using the Wilcoxon signed ranks test. The level of significance was set at 0.05.

Results

Twenty-two patients (12 men, 10 women; mean age of 50 with a range from 27 to 74) were consecutively treated with a single immediate implant in the aesthetic zone. In seven patients aesthetic complications already occurred at 3 months (advanced mid-facial recession (>1 mm) in two patients; major alveolar process re-modelling in five patients). These patients were treated with a CTG.

Eleven teeth were removed because of root fracture, nine because of caries and sequels and two as a result of root resorption.

Eleven teeth were in a central incisor position, six in a lateral incisor position, four in a pre-molar position and one in a cuspid position.

From the 22 patients, four dropped out (1 at 6 months and 3 at 5 years) of whom 2 had been treated with a CTG. Reasons for drop-out included death ($n = 1$) and unwillingness to return ($n = 3$). However, the latter confirmed the presence of the implant at 5 years upon contact by phone.

One patient still had the provisional restoration at 1 year. Nine patients were treated with a full-ceramic crown and 12 with a metal-ceramic crown. Permanent crowns were screw retained in 11 patients and cemented in 10 patients.

Clinical outcome

Two weeks following surgery, one implant had to be removed because of pain and mobility (central incisor position; diameter 4.3 mm – length 15 mm). The remaining implants remained in function throughout the study period.

With respect to *complications*, one provisional crown lost retention after 1 month and another broke after 2 months. In another patient, the denture tooth was found detached from the temporary abutment. Porcelain chipping occurred in one permanent metal-ceramic crown after 4 years and this restoration was renewed. Besides these technical complications, seven patients demonstrated aesthetic complications after 3 months. Five related to major alveolar process re-modelling and two related to advanced mid-facial recession (>1 mm). A CTG was used at the buccal aspect of the peri-implant mucosa in all seven patients to optimize aesthetics.

Marginal bone loss amounted on average to 0.12 mm and 0.19 mm at 1 and 5 years, respectively ($p = 0.595$) (Table 1). At study termination, 7/17 of the implants demonstrated full bone preservation or even slight bone gain.

Plaque score was on average 12% and 15% at 1 and 5 years, respectively ($p = 0.739$).

Probing depth amounted on average to 3.1 mm at 1 and 5 years ($p = 0.064$).

Bleeding on probing was on average 24% and 32% at 1 and 5 years.

Table 1. Clinical outcome of single immediate implants

Parameter	1 year ($n = 20$)	5 years ($n = 17$)	p -value*
Marginal bone loss (mm) [†]	0.12 (0.51) <i>0.18 (0.00; 0.44)</i> [−1.31; 0.80]	0.19 (0.30) <i>0.09 (−0.03; 0.38)</i> [−0.10; 0.95]	0.595
Plaque score (%)	12 (17) <i>0 (0; 25)</i> [0; 50]	15 (15) <i>25 (0; 25)</i> [0; 50]	0.739
Probing depth (mm)	3.1 (0.4) <i>3.0 (2.8; 3.5)</i> [2.3; 3.8]	3.1 (0.4) <i>3.0 (2.8; 3.5)</i> [2.5; 3.8]	0.064
Bleeding on probing (%)	24 (20) <i>25 (0; 50)</i> [0; 50]	32 (19) <i>25 (25; 50)</i> [0; 50]	0.021

Values in bold: Mean (SD); italic: Median (IQ range); square bracket: [Minimum; maximum].

Negative value indicates bone gain.

*Comparison between 1- and 5-year data using Wilcoxon signed ranks test.

[†]Baseline: implant installation.

The increase in bleeding tendency was significant ($p = 0.021$).

Aesthetic outcome

Table 2 shows the results on vertical soft tissue changes at 1 and 5 years.

Mesial and distal papillary recession significantly reduced between 1 and 5 years ($p \leq 0.007$), indicative of embrasure fill after 1 year.

Mid-facial recession amounted on average to 0.28 and 0.53 mm at 1 and 5 years, respectively ($p = 0.072$). Table 3 shows the results on mid-facial recession at 1 and 5 years sorted per implant location. Interestingly, mean mid-facial recession for implants in a central incisor position was 0.28 mm at 1 year and 0.88 mm at 5 years. In contrast, mean mid-facial recession for implants in a lateral incisor position was 0.25 mm at

1 year and 0.30 mm at 5 years. Figures 1 and 2 illustrate these observations.

Mean mid-facial recession for cases treated without a CTG was 0.23 mm at 1 year ($n = 13$) and 0.63 mm ($n = 12$) at 5 years. The corresponding data for cases treated with a CTG were 0.21 mm ($n = 7$) and 0.50 mm ($n = 5$), respectively (Table 4).

At 5 years, three implants demonstrated advanced mid-facial recession (>1 mm). All were in a central incisor position, yet none of these had been treated with a CTG.

Table 5 shows the results on the *pink esthetic score* at 1 and 5 years. Mesial and distal papilla improved significantly ($p = 0.014$), whereas mid-facial contour and alveolar process deficiency deteriorated significantly between 1 and 5 years

Table 2. Vertical soft tissue changes around single immediate implants

Parameter	1 year ($n = 20$)	5 years ($n = 17$)	p -value*
Mesial papillary recession (mm)	0.22 (0.58) <i>0 (0; 5)</i> [−1; 1]	−0.09 (0.33) <i>0 (0; 0)</i> [−1; 0.5]	0.007
Distal papillary recession (mm)	0.50 (0.48) <i>0.5 (0; 0.5)</i> [0; 1.5]	0.25 (0.45) <i>0 (0; 0.5)</i> [0; 1.5]	0.006
Mid-facial recession (mm)	0.28 (0.48) <i>0.25 (0; 0.5)</i> [−0.5; 1]	0.53 (0.53) <i>0.5 (0.25; 1)</i> [−0.5; 1.5]	0.072

Values in bold: Mean (SD); italic: Median (IQ range); square bracket: [Minimum; maximum].

Baseline: pre-operative status.

Negative value indicates vertical growth.

*Comparison between 1- and 5-year data using Wilcoxon signed ranks test.

Table 3. Mid-facial recession at single immediate implants sorted per implant location

Implant location	1 year	5 years
Central incisor	0.28 (<i>n</i> = 9)	0.88 (<i>n</i> = 8)
Lateral incisor	0.25 (<i>n</i> = 6)	0.30 (<i>n</i> = 5)
Cuspid	0.50 (<i>n</i> = 1)	1.00 (<i>n</i> = 1)
Pre-molar	0.00 (<i>n</i> = 4)	0.17 (<i>n</i> = 3)

Baseline: pre-operative status.

Data represent mean mid-facial recession in mm.

($p \leq 0.008$). As a result, the total PES slightly deteriorated during follow-up from an average of 12.15–11.18 ($p = 0.030$).

Discussion

The objective of this prospective study was to evaluate the 5-year outcome of single immediate implants in the aesthetic zone. The results may add relevant information to the existing knowledge on type I placement as there are no long-term studies with details on soft tissue alterations and aesthetics. Given the concern for mid-facial recession following type I placement, only patients with a low risk for aesthetic complications were included and all procedures were performed by experienced clinicians.

A bone condensing implant with variable-thread design, conical connection and platform switch was selected for this study. The macro-design was deemed advantageous to attain proper primary implant stability in an extraction socket. Apart from one early failure, all implants survived the 5-year re-assessment. Studies have shown comparable survival rates for this implant system under various conditions (Kielbassa et al. 2009, Babbush et al. 2011, 2013, Arnhart et al. 2012, Babbush & Brokloff 2012, Cosyn et al. 2013, 2015, Ho et al. 2013, Bell & Bell 2014, Pozzi et al. 2014, Cristalli et al. 2015). Also high survival rates have been described in a recent systematic review on single immediate implants (Slagter et al. 2014).

Especially in long-term studies it is important to evaluate complications. In the early healing phase aesthetic complications occurred in seven patients, all relating to



Fig. 1. Single immediate implant locus 11. One-year outcome (left), 5-year outcome (middle), 5-year digital peri-apical radiograph (right). Note mid-facial recession between 1 and 5 years, yet full bone preservation.



Fig. 2. Single immediate implant locus 12. One-year outcome (left), 5-year outcome (middle), 5-year digital peri-apical radiograph (right). Note stable soft tissues and full bone preservation.

horizontal or vertical soft tissue deficit at the buccal aspect. A CTG was used in these patients to eliminate the defect. Eghbali et al. (2016) and De Bruyckere et al. (2015) demonstrated limited shrinkage of soft tissue grafts at the buccal aspect of single implants after 1 year of function. Clearly, the limited sample size does not allow to draw meaningful conclusions on the stability of such grafts in this study. Apart from aesthetic complications, technical complications occurred in four patients mainly relating to the provisional restoration. According to a systematic review of Jung et al. (2012), single implant restorations frequently demonstrate aesthetic, technical and biological complications.

Marginal bone loss was low and remained stable between 1 and 5 years, pointing to a mean loss of 0.19 mm at study termination. This is within the range of what has been reported for the implant system (Kielbassa et al. 2009, Arnhart et al. 2012, Cosyn et al. 2013, Ho et al. 2013, Pozzi et al. 2014, Cristalli et al. 2015). The bone preservation observed in this study is remarkable when compared to the mean marginal bone loss of 0.81 mm as described by Slagter et al. (2014) in a systematic review on single immediate implants.

The soft tissue parameters were particularly interesting in this study given the lack of a steady state after 1 year of function. A positive finding

Table 4. Vertical soft tissue changes around single immediate implants treated without and with connective tissue graft

Parameter	Without CTG		With CTG	
	1 year (<i>n</i> = 13)	5 years (<i>n</i> = 12)	1 year (<i>n</i> = 7)	5 years (<i>n</i> = 5)
Mesial papillary recession (mm)	0.23	−0.13	0.21	0.00
Distal papillary recession (mm)	0.42	0.29	0.50	0.10
Mid-facial recession (mm)	0.23	0.63	0.21	0.50

Baseline: pre-operative status; CTG: connective tissue graft.

Data represent mean values; Negative value indicates vertical growth.

Table 5. Pink Esthetic Score of single immediate implants

Parameter	Score	1 year (<i>n</i> = 20)	5 years (<i>n</i> = 17)	<i>p</i> -value*
Mesial papilla	0	0	0	0.014
	1	10	1	
	2	10	16	
Distal papilla	0	1	0	0.014
	1	11	4	
	2	8	13	
Mid-facial level	0	0	3	0.059
	1	4	5	
	2	16	9	
Mid-facial contour	0	0	0	0.005
	1	0	9	
	2	20	8	
Alveolar process deficiency	0	0	0	0.008
	1	1	9	
	2	19	8	
Soft tissue colour	0	1	0	0.317
	1	8	12	
	2	11	5	
Soft tissue texture	0	0	0	0.083
	1	0	3	
	2	20	14	
Pink Esthetic Score (/14)		12.15 (0.99)	11.18 (1.38)	0.030
		<i>12 (12; 13)</i>	<i>11 (10.5; 12)</i>	
		[10; 13]	[8; 13]	

Values in bold: Mean (SD); italic: Median (IQ range); square bracket: [Minimum; maximum].

*Comparison between 1- and 5-year data using Wilcoxon signed ranks test.

was a significant up-growth of papillae between 1 and 5 years, which is in agreement with an earlier study on single immediate implants (Cosyn et al. 2011). At 5 years mean mid-facial recession amounted to 0.53 mm. Although this outcome seems acceptable, mean mid-facial recession increased with borderline significance between 1 and 5 years ($p = 0.072$). Especially in such a scenario a type II error is conceivable and can be explained by a limited sample size. To explore the clinical significance of these findings, the data were sorted per implant location. Descriptive statistics suggest an increase in mid-facial recession especially for implants in a central incisor position. Interestingly, 3/17 implants demonstrated advanced mid-facial recession (>1 mm) at 5 years. All three were in a central incisor position and none had been treated with a CTG. Hitherto, only Cooper et al. (2014) have published soft tissue alterations around single immediate implants after 5 years of function. They reported advanced mid-facial recession (>1 mm) around 21% of the implants with no details on implant location. In contrast to the implants in a central incisor

position, implants in a lateral incisor position showed mid-facial stability in this study. The explanation for this may be twofold. First, the mesiodistal tooth gap is narrower in a lateral incisor position, hereby lowering the risk for advanced resorption of the buccal bone wall. Second, the buccal bone wall may also be slightly thicker in a lateral incisor position as described by Younes et al. (2016), again lowering the risk for advanced buccal bone resorption. The presence of buccal bone may be of key importance for stable mid-facial levels around an implant as shown by Benic et al. (2012). They reported that immediate implants without radiographically detectable buccal bone after 7 years presented with a 1 mm more apically located mucosal level in comparison to immediate implants with intact buccal bone. As 5/14 immediate implants demonstrated this lack of hard and soft tissues after 7 years, the general concern for possible aesthetic complications with type I placement may be justified. This can be confirmed by the results of this study pointing to aesthetic complications in 8/17 patients who could be followed for 5 years. Indeed, five

patients had early aesthetic complications and were treated with a CTG at 3 months, whereas three other patients demonstrated late aesthetic complications with 1.5 mm mid-facial recession at 5 years.

To the best of our knowledge, this is the first prospective study with 5-year aesthetic outcomes for single immediate implants based on a composite index. With a final PES of 11.18, the aesthetic outcome is acceptable. A small, yet significant decrease was seen between 1 and 5 years, mainly relating to a deterioration of mid-facial contour and alveolar process deficiency. This may be explained by the fact that mid-facial recession, mid-facial contour and alveolar process are all affected by ongoing resorption of the buccal bone wall, which seems common following type I placement as shown by Benic et al. (2012).

A number of limitations should be taken into account when interpreting the results of this study. First, this is not a randomized controlled study and therefore any comparison to an alternative method may be biased. Second, only 17 patients could be re-evaluated after 5 years of function. Such limited sample size greatly affects statistical power especially if small changes are to be detected. In that respect, the findings on mid-facial recession should be interpreted with caution. Prospective data preferably obtained from a larger cohort after an even longer observation period would be interesting to evaluate the external validity of the results of this study. Finally, patient-reported outcome measures were not registered. Hence, the judgement of the patient on the clinical and aesthetic outcome after 5 years is lacking. As suggested in a recent systematic review, future studies should also focus on these aspects of treatment outcome (De Bruyckere et al. 2015).

In conclusion, single immediate implants showed a favourable clinical outcome in the long term with high implant survival, only one complication after 1 year and limited marginal bone loss. However, mid-facial recession, mid-facial contour and alveolar process deficiency deteriorated after 1 year indicative of ongoing resorption of the buccal bone. Altogether, 8/17 patients who

could be followed for 5 years showed aesthetic complications. Knowing that all had a low aesthetic risk profile and taking into consideration that they had been treated by experienced clinicians, one could question whether type I placement can be recommended for daily practice.

References

- Araújo, M. G., Sukekava, F., Wennström, J. L. & Lindhe, J. (2005) Ridge alterations following implant placement in fresh extraction sockets: an experimental study in the dog. *Journal of Clinical Periodontology* **32**, 645–652.
- Arnhart, C., Kielbassa, A. M., Martinez-de Fuentes, R., Goldstein, M., Jackowski, J., Lorenzoni, M., Maiorana, C., Mericske-Stern, R., Pozzi, A., Rompen, E., Sanz, M. & Strub, J. R. (2012) Comparison of variable-thread tapered implant designs to a standard tapered implant design after immediate loading. A 3-year multicentre randomised controlled trial. *European Journal of Oral Implantology* **5**, 123–136.
- Babbush, C. A. & Brokloff, J. (2012) A single-center retrospective analysis of 1001 consecutively placed NobelActive implants. *Implant Dentistry* **21**, 28–35.
- Babbush, C. A., Kanawati, A. & Brokloff, J. (2013) A new approach to the All-on-Four treatment concept using narrow platform NobelActive implants. *Journal of Oral Implantology* **39**, 314–325.
- Babbush, C. A., Kutsko, G. T. & Brokloff, J. (2011) The all-on-four immediate function treatment concept with NobelActive implants: a retrospective study. *Journal of Oral Implantology* **37**, 431–445.
- Bell, C. & Bell, R. E. (2014) Immediate restoration of NobelActive implants placed into fresh extraction sites in the anterior maxilla. *Journal of Oral Implantology* **40**, 455–458.
- Benic, G. I., Mokti, M., Chen, C. J., Weber, H. P., Hämmerle, C. H. & Gallucci, G. O. (2012) Dimensions of buccal bone and mucosa at immediately placed implants after 7 years: a clinical and cone beam computed tomography study. *Clinical Oral Implants Research* **23**, 560–566.
- Bianchi, A. E. & Sanfilippo, F. (2004) Single-tooth replacement by immediate implant and connective tissue graft: a 1-9-year clinical evaluation. *Clinical Oral Implants Research* **15**, 269–277.
- Botticelli, D., Berglundh, T. & Lindhe, J. (2004) Hard-tissue alterations following immediate implant placement in extraction sites. *Journal of Clinical Periodontology* **31**, 820–828.
- Buser, D., Martin, W. & Belser, U. C. (2004) Optimizing esthetics for implant restorations in the anterior maxilla: anatomic and surgical considerations. *International Journal of Oral and Maxillofacial Implants* **19**, 43–61.
- de Carvalho, B. C., de Carvalho, E. M. & Consani, R. L. (2013) Flapless single-tooth immediate implant placement. *International Journal of Oral and Maxillofacial Implants* **28**, 783–789.
- Chen, S. T. & Buser, D. (2014) Esthetic outcomes following immediate and early implant placement in the anterior maxilla – a systematic review. *International Journal of Oral and Maxillofacial Implants* **29**, 186–215.
- Chen, S. T., Darby, I. B., Reynolds, E. C. & Clement, J. G. (2009) Immediate implant placement postextraction without flap elevation. *Journal of Periodontology* **80**, 163–172.
- Cooper, L. F., Reside, G. J., Raes, F., Garriga, J. S., Tarrida, L. G., Wiltfang, J., Kern, M. & De Bruyn, H. (2014) Immediate provisionalization of dental implants placed in healed alveolar ridges and extraction sockets: a 5-year prospective evaluation. *International Journal of Oral and Maxillofacial Implants* **29**, 709–717.
- Cornelini, R., Cangini, F., Martuscelli, G. & Wennström, J. (2004) Deproteinized bovine bone and biodegradable barrier membranes to support healing following immediate placement of transmucosal implants: a short-term controlled clinical trial. *International Journal of Periodontics and Restorative Dentistry* **24**, 555–563.
- Cosyn, J., De Bruyn, H. & Cleymaet, R. (2013) Soft tissue preservation and pink aesthetics around single immediate implant restorations: a 1-year prospective study. *Clinical Implant Dentistry and Related Research* **15**, 847–857.
- Cosyn, J., Eghbali, A., De Bruyn, H., Collys, K., Cleymaet, R. & De Rouck, T. (2011) Immediate single-tooth implants in the anterior maxilla: 3-year results of a case series on hard and soft tissue response and aesthetics. *Journal of Clinical Periodontology* **38**, 746–753.
- Cosyn, J., Hooghe, N. & De Bruyn, H. (2012) A systematic review on the frequency of advanced recession following single immediate implant treatment. *Journal of Clinical Periodontology* **39**, 582–589.
- Cosyn, J., Pollaris, L., Van der Linden, F. & De Bruyn, H. (2015) Minimally Invasive Single Implant Treatment (M.I.S.I.T.) based on ridge preservation and contour augmentation in patients with a high aesthetic risk profile: one-year results. *Journal of Clinical Periodontology* **42**, 398–405.
- Cristalli, M. P., Marini, R., La Monaca, G., Sepe, C., Tonoli, F. & Annibali, S. (2015) Immediate loading of post-extractive single-tooth implants: a 1-year prospective study. *Clinical Oral Implants Research* **26**, 1070–1079.
- De Bruyckere, T., Eghbali, A., Younes, F., De Bruyn, H. & Cosyn, J. (2015) Horizontal stability of connective tissue grafts at the buccal aspect of single implants: a 1-year prospective case series. *Journal of Clinical Periodontology* **42**, 876–882.
- De Rouck, T., Collys, K. & Cosyn, J. (2008a) Immediate single-tooth implants in the anterior maxilla: a 1-year case cohort study on hard and soft tissue response. *Journal of Clinical Periodontology* **35**, 649–657.
- De Rouck, T., Collys, K. & Cosyn, J. (2008b) Single-tooth replacement in the anterior maxilla by means of immediate implantation and provisionalization: a review. *International Journal of Oral and Maxillofacial Implants* **23**, 897–904.
- De Rouck, T., Collys, K., Wyn, I. & Cosyn, J. (2009a) Instant provisionalization of immediate single-tooth implants is essential to optimize esthetic treatment outcome. *Clinical Oral Implants Research* **20**, 566–570.
- De Rouck, T., Eghbali, A., Collys, K., De Bruyn, H. & Cosyn, J. (2009b) The gingival biotype revisited: transparency of the periodontal probe through the gingival margin as a method to discriminate thin from thick gingiva. *Journal of Clinical Periodontology* **36**, 428–433.
- Eghbali, A., De Bruyn, H., Cosyn, J., Kerckaert, I. & Van Hoof, T. (2016) Ultrasonic assessment of mucosal thickness around implants: validity, reproducibility, and stability of connective tissue grafts at the buccal aspect. *Clinical Implant Dentistry and Related Research* **18**, 51–61.
- Evans, C. D. & Chen, S. T. (2008) Esthetic outcomes of immediate implant placements. *Clinical Oral Implants Research* **19**, 73–80.
- Fürhauser, R., Florescu, D., Benesch, T., Haas, R., Mailath, G. & Watzek, G. (2005) Evaluation of soft tissue around single-tooth implant crowns: the pink esthetic score. *Clinical Oral Implants Research* **16**, 639–644.
- Hämmerle, C. H., Chen, S. T. & Wilson, T. G. Jr (2004) Consensus statements and recommended clinical procedures regarding the placement of implants in extraction sockets. *International Journal of Oral and Maxillofacial Implants* **19**, 26–28.
- Ho, D. S., Yeung, S. C., Zee, K. Y., Curtis, B., Hell, P. & Tumuluri, V. (2013) Clinical and radiographic evaluation of NobelActive(TM) dental implants. *Clinical Oral Implants Research* **24**, 297–304.
- Jung, R. E., Zembic, A., Pjetursson, B. E., Zwahlen, M. & Thoma, D. S. (2012) Systematic review of the survival rate and the incidence of biological, technical, and aesthetic complications of single crowns on implants reported in longitudinal studies with a mean follow-up of 5 years. *Clinical Oral Implants Research* **23**, 2–21.
- Kan, J. Y., Rungcharassaeng, K., Lozada, J. L. & Zimmerman, G. (2011) Facial gingival tissue stability following immediate placement and provisionalization of maxillary anterior single implants: a 2- to 8-year follow-up. *International Journal of Oral and Maxillofacial Implants* **26**, 179–187.
- Kan, J. Y., Rungcharassaeng, K., Sclar, A. & Lozada, J. L. (2007) Effects of the facial osseous defect morphology on gingival dynamics after immediate tooth replacement and guided bone regeneration: 1-year results. *International Journal of Oral and Maxillofacial Surgery* **65**, 13–19.
- Khazam, N., Arora, H., Kim, P., Fisher, A., Mattheos, N. & Ivanovski, S. (2015) A systematic review of soft tissue alterations and aesthetic outcomes following immediate implant placement and restoration of single implants in the anterior maxilla. *Journal of Periodontology* **86**, 1321–1330.
- Kielbassa, A. M., Martinez-de Fuentes, R., Goldstein, M., Arnhart, C., Barlattani, A., Jackowski, J., Knauf, M., Lorenzoni, M., Maiorana, C., Mericske-Stern, R., Rompen, E. & Sanz, M. (2009) Randomized controlled trial comparing a variable-thread novel tapered and a standard tapered implant: interim one-year results. *Journal of Prosthetic Dentistry* **101**, 293–305.
- Lin, G. H., Chan, H. L. & Wang, H. L. (2014) Effects of currently available surgical and restorative interventions on reducing midfacial mucosal recession of immediately placed single-tooth implants: a systematic review. *Journal of Periodontology* **85**, 92–102.
- Mura, P. (2012) Immediate loading of tapered implants placed in postextraction sockets: retrospective analysis of the 5-year clinical outcome. *Clinical Implant Dentistry and Related Research* **14**, 565–574.
- O'Leary, T. J., Drake, R. B. & Naylor, J. E. (1972) The plaque control record. *Journal of Periodontology* **43**, 38.
- Pozzi, A., Tallarico, M. & Moy, P. K. (2014) Three-year post-loading results of a

- randomised, controlled, split-mouth trial comparing implants with different prosthetic interfaces and design in partially posterior edentulous mandibles. *European Journal of Oral Implantology* 7, 47–61.
- Raes, F., Cosyn, J., Crommelinck, E., Coessens, P. & De Bruyn, H. (2011) Immediate and conventional single implant treatment in the anterior maxilla: one-year results of a case series on hard and soft tissue response and aesthetics. *Journal of Clinical Periodontology* 38, 385–394.
- Ross, S. B., Pette, G. A., Parker, W. B. & Hardigan, P. (2014) Gingival margin changes in maxillary anterior sites after single immediate implant placement and provisionalization: a 5-year retrospective study of 47 patients. *International Journal of Oral and Maxillofacial Implants* 29, 127–134.
- Rungcharassaeng, K., Kan, J. Y., Yoshino, S., Morimoto, T. & Zimmerman, G. (2012) Immediate implant placement and provisionalization with and without a connective tissue graft: an analysis of facial gingival tissue thickness. *International Journal of Periodontics and Restorative Dentistry* 32, 657–663.
- Slagter, K. W., den Hartog, L., Bakker, N. A., Vis-sink, A., Meijer, H. J. & Raghoobar, G. M. (2014) Immediate placement of dental implants in the esthetic zone: a systematic review and pooled analysis. *Journal of Periodontology* 85, 241–250.
- Yoshino, S., Kan, J. Y., Rungcharassaeng, K., Roe, P. & Lozada, J. L. (2014) Effects of connective tissue grafting on the facial gingival level following single immediate implant placement and provisionalization in the esthetic zone: a 1-year randomized controlled prospective study. *International Journal of Oral and Maxillofacial Implants* 29, 432–440.
- Younes, F., Eghbali, A., Raes, M., De Bruyckere, T., Cosyn, J. & De Bruyn, H. (2016) Relationship between buccal bone and gingival thickness revisited using non-invasive registration methods. *Clinical Oral Implants Research* 27, 523–528.

Address:

Jan Cosyn

Department of Periodontology and Oral
Implantology
Faculty of Medicine and Health Sciences
Dental School

Ghent University

De Pintelaan 185, B-9000 Ghent
Belgium

E-mail: jan.cosyn@ugent.be

Clinical Relevance*Scientific rationale for the study:*

There is a paucity of long-term data on soft tissue aesthetics of single immediate implants. The objective of this study was to evaluate

the 5-year clinical and aesthetic outcome of this treatment concept.

Principal findings: Single immediate implants showed high implant survival and limited marginal bone loss in the long term. However, mid-facial recession, mid-facial contour

and alveolar process deficiency deteriorated after 1 year. Altogether, 8/17 patients showed aesthetic complications.

Practical implications: Type I placement may not be recommended for daily practice.