

## Review

## Systematic Review of Soft Tissue Alterations and Esthetic Outcomes Following Immediate Implant Placement and Restoration of Single Implants in the Anterior Maxilla

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**Background:** The aim of this review is to assess the outcome of single-tooth immediate implant placement and restoration (IPR) in the maxillary anterior region, with a particular emphasis on soft tissue and esthetic outcomes.

**Methods:** An electronic search in Medline, EBSCOhost, and Ovid (PubMed) was performed to identify studies that reported on soft tissue outcomes following immediate placement and restoration of implants in the maxillary esthetic region with a mean follow-up of  $\geq 1$  year.

**Results:** Nineteen studies on single implants inserted immediately into fresh extraction sockets and provisionally restored in the maxillary esthetic region were included. Soft tissue changes were found to be acceptable, with most studies reporting mean gingival recession of  $0.27 \pm 0.38$  mm and mean papillary height loss of  $0.23 \pm 0.27$  mm after follow-up of  $\geq 1$  year. Advanced buccal recession ( $>1$  mm) occurred in 11% of cases. Long-term follow-up studies ( $>2$  years) reported that the interdental papillae, in particular, showed a tendency to rebound over time. The few studies that reported on patient-centered outcomes showed a high level of patient satisfaction with the outcomes of IPR treatment.

**Conclusions:** The IPR protocol resulted in generally acceptable soft tissue and esthetic outcomes, with suboptimal results reported in  $\approx 11\%$  of low-risk cases. Factors such as preoperative tissue biotype or use of a flap or connective tissue graft did not significantly influence soft tissue and esthetic outcomes. Long-term prospective controlled clinical trials are necessary to identify factors that may influence the esthetic outcomes associated with IPR. *J Periodontol* 2015;86:1321-1330.

### KEY WORDS

Dental implants, single-tooth; esthetics; maxilla; gingival recession; patient satisfaction; prospective studies.

Dental implant-supported restorations have become an acceptable, and often preferred, treatment option for tooth replacement in many clinical scenarios.<sup>1-3</sup> Original implant treatment guidelines advocated a 3-month waiting period after tooth extraction to allow for soft and hard tissue healing before placing an implant, which was followed by an additional 3- to 6-month load-free period after implant placement to achieve osseointegration.<sup>4,5</sup>

Immediate implant placement into a fresh extraction socket has been advocated as a protocol that can reduce treatment time, as socket healing and implant osseointegration occur concurrently.<sup>6,7</sup> Immediate placement can further be combined with immediate restoration (IPR protocol),<sup>8</sup> which provides the patient with a fixed restoration immediately after tooth extraction. Definitions of immediate placement and immediate restoration are based on widely accepted consensus reports.<sup>9,10</sup> Immediate implant placement, also known as Type I placement, is defined as the placement of an implant immediately after tooth extraction,<sup>9</sup> whereas immediate restoration has been defined as any restoration placed within 48 hours of implant insertion but with no contact with the opposite dentition in both centric and eccentric occlusion.<sup>10</sup>

IPR<sup>8,11</sup> has a number of proposed benefits, including reduced overall treatment

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duration, fewer surgical procedures for the patient, less traumatic surgery (as the implant may be placed without raising a flap), and patient satisfaction resulting from a fixed esthetic restoration being placed immediately after tooth extraction. The limitations of this treatment protocol include the possibility of unpredictable soft and hard tissue healing and subsequent unfavorable soft tissue and esthetic outcomes.

Several published systematic reviews have shown that IPR can achieve survival rates comparable to those achieved with traditional protocols.<sup>11-14</sup> In a recent systematic review on IPR in the esthetic zone,<sup>14</sup> all identified variables affecting the treatment outcome were reviewed. However, the evidence regarding soft tissue and esthetic outcomes in patients treated with IPR in the maxillary esthetic zone is still inconclusive. With the increasing emphasis on implant success rather than survival and the importance of patient-centered outcomes in what is a very esthetically sensitive region, it would be of significant clinical benefit to identify the effects of this treatment modality on the surrounding soft tissues and its overall effect on esthetic outcomes. Thus, the objective of this systematic review is to assess soft tissue dimensional changes and esthetic outcomes of the IPR protocol when replacing a single maxillary tooth in the esthetic region.

## MATERIALS AND METHODS

### Search Strategy

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) guidelines.<sup>15</sup> A detailed electronic search strategy was used for each selected database to identify all of the articles published in relation to the stated aims of this review. In PubMed, EBSCOhost, and Ovid arms of Medline, articles were searched from 1980 to May 2015. The following search strategy was used: (“dental implants”[MeSH Terms] OR (“dental”[All Fields] AND “implants”[All Fields]) OR “dental implants”[All Fields]) OR (“dental implants, single-tooth”[MeSH Terms] OR (“dental”[All Fields] AND “implants”[All Fields] AND “single-tooth”[All Fields]) OR “single-tooth dental implants”[All Fields] OR (“dental”[All Fields] AND “implants”[All Fields] AND “single”[All Fields] AND “tooth”[All Fields]) OR “dental implants, single tooth”[All Fields])) AND (“maxilla”[MeSH Terms] OR “maxilla”[All Fields] AND (“tissues”[MeSH Terms] OR “tissues”[All Fields] OR “tissue”[All Fields]) OR (“esthetics”[MeSH Terms] OR “esthetics”[All Fields])). The search was complemented by checking the references of the selected articles for additional eligible publications. In addition, a manual search of the major journals related to dental implantology was carried out (see supplementary Appendix 1 in online *Journal of Periodontology*).

### Inclusion Criteria

Inclusion criteria were: 1) randomized controlled trials (RCTs), controlled clinical trials, prospective cohort studies, case control studies, and case series (only prospective studies were included in this review); 2) studies with a minimum of 10 human participants treated with IPR in the maxillary esthetic region (up to the second premolar); 3) minimum mean follow-up time of 1 year; and 4) English-language publications in the dental literature.

The following participants, intervention, comparison, outcomes (PICO) strategy was designed to select the studies to be included in this review:<sup>16</sup> P, patients requiring a single implant in the maxillary esthetic zone; I, implant placement using IPR; C, soft tissue dimensions and esthetic and patient-centered outcomes, before and after immediate placement and restoration in the maxillary esthetic zone; and O, soft tissue dimensional changes and esthetic outcomes.

### Selection of Studies

After the initial electronic search of titles by NK, titles and abstracts of all studies identified via electronic searches were scanned independently by two reviewers (NK and PK). The next step was to review all selected abstracts and apply the inclusion criteria to determine selection of full-text articles. The full texts of all studies of possible relevance were then obtained for independent review and assessment by the two reviewers. Disagreements between reviewers were resolved by discussion. κ agreement between the two reviewers was 0.91. All studies meeting the inclusion criteria then underwent data extraction. Studies rejected at this or subsequent stages were removed, and reasons for exclusion were recorded.

### Quality Assessment

Methodologic quality of the included studies was assessed by two reviewers (NK and HA) using specific study design-related forms designed by the Cochrane Collaboration. RCTs as well as prospective trials and case series were assessed, and the risk of bias was recorded for every study using a modified checklist as described in a previous review (Table 1).<sup>17,18</sup>

### Data Extraction

The data extracted are presented in supplementary Appendix 2 in online *Journal of Periodontology*.

### Statistical Analyses

κ statistics were used to evaluate interexaminer agreement on study eligibility and quality. Midfacial- and papillary soft tissue changes from the included studies were extracted, and pooled results are presented as mean ± SD. Individual study data were available to assess the effect of three variables, flap employment, tissue biotype, and use of connective tissue graft (CTG), on soft tissue changes after IPR. Results from the included studies pertaining to these variables were pooled

**Table 1.**  
**Studies Using the IPR Protocol and Their Parameters**

| Reference                                 | Study Design (groups)                 | Risk of Bias | Follow-Up (months)         | Implants/Patients (n) | Implant Position (corono-apical)                        | Gingival Biotype    | Flap/Flapless         | Graft Used                                   | Measuring Technique                 | Midfacial Recession             | Interproximal Recession  | Papilla Index                    | PES/WES         | Patient Esthetic Evaluation |
|---|---------------------------------------|--------------|----------------------------|-----------------------|---|---------------------|-----------------------|--|-------------------------------------|---------------------------------|--------------------------|----------------------------------|-----------------|-----------------------------|
| Wöhle (1998) <sup>19</sup>                | Case study                            | High         | 9 to 36                    | 14§/14                | 3 mm apical to the labial gingival margin               | —                   | Flapless              | Autogenous (few cases)                       | Photographs                         | 14.3% showed >1 mm recession    | —                        | —                                | —               | —                           |
| Kan et al. (2007) <sup>20</sup>           | Case study                            | Medium       | 12                         | 23//23                | 3 mm from the predetermined gingival margin             | Thick: 10; thin: 13 | Flap: 15; flapless: 8 | Autogenous/Xenograft + Membrane (SCTG 11/23) | Digital photographs and study casts | >34.8% showed >1.5 mm recession | —                        | —                                | —               | —                           |
| Canullo and Raspigni (2007) <sup>21</sup> | Case study                            | Medium       | Mean: 22 (range: 18 to 36) | 10 <sup>§</sup> /9    | Level of bony wall                                      | Thick: 8; thin: 2   | Flapless              | Xenograft + blood                            | Digital photographs                 | -0.2 mm                         | M: -0.40 mm; D: -0.10 mm | —                                | —               | —                           |
| De Rouck et al. (2009) <sup>22</sup>      | RCT (IR versus DR)                    | Low          | 12                         | 24//24                | 1 mm subcrestally or 4 mm below the peri-implant mucosa | Normal/thick        | Flap                  | Xenograft                                    | Clinically                          | 0.41 mm                         | M: 0.44 mm; D: 0.31 mm   | —                                | —               | Mean 93/100                 |
| Kan et al. (2009) <sup>23</sup>           | Cohort study                          | Low          | 25.8                       | 20//20                | 3 mm from the predetermined gingival margin             | Thick/thin          | Flapless              | Xenograft + SCTG                             | Study casts                         | Overall: -0.13 mm               | —                        | NS                               | —               | —                           |
| Block et al. (2009) <sup>24</sup>         | RCT (IP versus DP)                    | High         | 18 to 24                   | 26 <sup>†</sup> //26  | 3 mm apical to the future gingival margin               | —                   | Flap/Flapless         | Human mineralized bone                       | Clinically                          | 0.41 mm                         | —                        | —                                | —               | —                           |
| Tortamano et al. (2010) <sup>25</sup>     | Case study                            | Medium       | 18                         | 12 <sup>**</sup> //12 | 2 mm apical to the future gingival margin               | —                   | Flapless              | None   | Study casts                         | -0.03 mm                        | M: -0.14 mm; D: -0.03 mm | —                                | —               | —                           |
| Pieri et al. (2011) <sup>26</sup>         | RCT (Morse taper versus conventional) | Low          | 12                         | 40 <sup>††</sup> //40 | 0.5 mm coronal to alveolar crest                        | —                   | Flapless              | Autogenous + Xenograft                       | Study cast photographed             | 0.61 mm                         | M: 0.24 mm; D: 0.28 mm   | —                                | —               | —                           |
| Kan et al. (2011) <sup>27</sup>           | PS                                    | Medium       | 24 to 96                   | 35//35                | —   | Thick/thin          | Flapless              | None   | Digital photographs                 | 1.13 mm                         | M: 0.22 mm; D: 0.21 mm   | —                                | —               | 11% unsatisfied             |
| Noellen et al. (2011) <sup>28</sup>       | PS                                    | High         | 13 to 36                   | 18//16                | 2 mm apical to soft tissue margin                       | —                   | Flapless              | Autogenous bone chips                        | Digital photographs                 | —                               | —                        | —                                | Mean 12.5/—     | —                           |
| Cosyn et al. (2011) <sup>29</sup>         | Case study                            | Low          | 36                         | 25//25                | 1 mm subcrestally or 4 mm below the peri-implant mucosa | Thick               | Flap                  | Xenograft + blood                            | Clinically                          | 0.34 mm                         | M: 0.05 mm; D: 0.08 mm   | —                                | Mean 10.48/8.17 | —                           |
| Tsuda et al. (2011) <sup>30</sup>         | Case study                            | High         | 12                         | 10 <sup>††</sup> //10 | 3 mm apical to the future gingival margin               | —                   | Flapless              | Xenograft + SCTG                             | Clinically                          | 0.05 mm                         | —                        | NS                               | —               | —                           |
| Brown and Payne (2011) <sup>31</sup>      | Case study                            | High         | 12                         | 28 <sup>§§</sup> //27 | 3 mm apical to mid-buccal mucosal level                 | —                   | Flapless              | —  | Digital photographs                 | -0.2 mm                         | —                        | Gradual increase in papilla fill | —               | —                           |

**Table 1. (continued)  
Studies Using the IPR Protocol and Their Parameters**

| Reference                               | Study Design (groups) | Risk of Bias | Follow-Up (months) | Implants/Patients (n) | Implant Position (corono-apical)             | Gingival Biotype | Flap/Flapless | Graft Used                        | Measuring Technique                       | Midfacial Recession | Interproximal Recession    | Papilla Index | PES/WES         | Patient Esthetic Evaluation               |
|---|-----------------------|--------------|--------------------|-----------------------|--|------------------|---------------|-----------------------------------|---|---------------------|----------------------------|---------------|-----------------|---|
| Raes et al. (2013) <sup>32</sup>        | PS (IP versus DP)     | Low          | 12                 | 16**/16               | At the crestal level of buccal bone          | Thick            | Flap/Flapless | None                              | Photographs, stand with bite fork and jig | 0.12 mm             | M: -0.07 mm; D: 0.38 mm    | —             | Mean 10.33/7.11 | Significant improvement in OHIP-14 scores |
| Cosyn et al. (2013) <sup>33</sup>       | Case study            | Low          | 12                 | 22/22                 | 2 mm apical to the midfacial gingival margin | Thick            | Flapless      | Xenograft + blood (7 cases SCTG)  | Clinically                                | 0.2 mm              | M: 0.20 mm; D: 0.50 mm     | —             | Mean 12.15/8.63 | —   |
| Malchiodi et al. (2013) <sup>34</sup>   | PS                    | Medium       | 36                 | 64/58                 | At the level of alveolar crest               | Thick/Normal     | Flapless      | Autogenous bone chips (if needed) | Digital photographs                       | 0.5 mm              | M: 0.6 mm; D: 0.8 mm       | —             | —               | —   |
| Cabello et al. (2013) <sup>35</sup>     | PS                    | High         | 12                 | 14**/14               | 2 mm or 3 mm apical to bone                  | —                | Flapless      | None                              | Clinically                                | 0.45 mm             | M: 0.38 mm; D: 0.80 mm     | —             | —               | —   |
| Cooper et al. (2014) <sup>36</sup>      | PS (IP versus DP)     | High         | 60                 | 58**/55               | At the level of facial osseous crest         | —                | Flapless      | —                                 | Clinically                                | -0.23 mm            | Mean papilla gain: 0.29 mm | —             | —               | —   |
| Cardaropoli et al. (2015) <sup>37</sup> | PS                    | High         | 12                 | 26*/26                | NR   | —                | Flapless      | Xenograft                         | Clinically                                | 0.21 mm             | 0.17 mm                    | 0.08 mm       | Mean 11.46/—    | —   |

PES = pink esthetic score; WES = white esthetic score; — = not reported; SCTG = subepithelial connective tissue graft; M = mesial; D = distal; IR = immediate restoration; DR = delayed restoration; NS = not significant; IP = immediate placement; DP = delayed placement; PS = prospective study; OHIP-14 = Oral Health Impact Profile 14.

and analyzed statistically with an unpaired *t* test using Welch correction. A *P* value <0.05 was considered to indicate statistical significance.

**RESULTS**

**Study Inclusion**

The initial search yielded 3,148 titles. After screening titles and abstracts, 70 studies were selected for full-text review. Further full-text reading and screening led to the exclusion of 49 studies (see details in supplementary Appendix 3 in online *Journal of Periodontology*). Two more studies were excluded because the same patient population was described, which resulted in the inclusion of 19 studies reporting on single implants inserted immediately into a fresh extraction socket and provisionally restored in the maxillary esthetic region (Table 1).<sup>19-37</sup> Figure 1 outlines the search process. One study was published in 1998,<sup>19</sup> and the other 18 studies were published during and after the year 2007. Most of the studies were prospective case series; the remainder were RCTs and prospective cohort studies (Table 1).

**Patient and Site Characteristics**

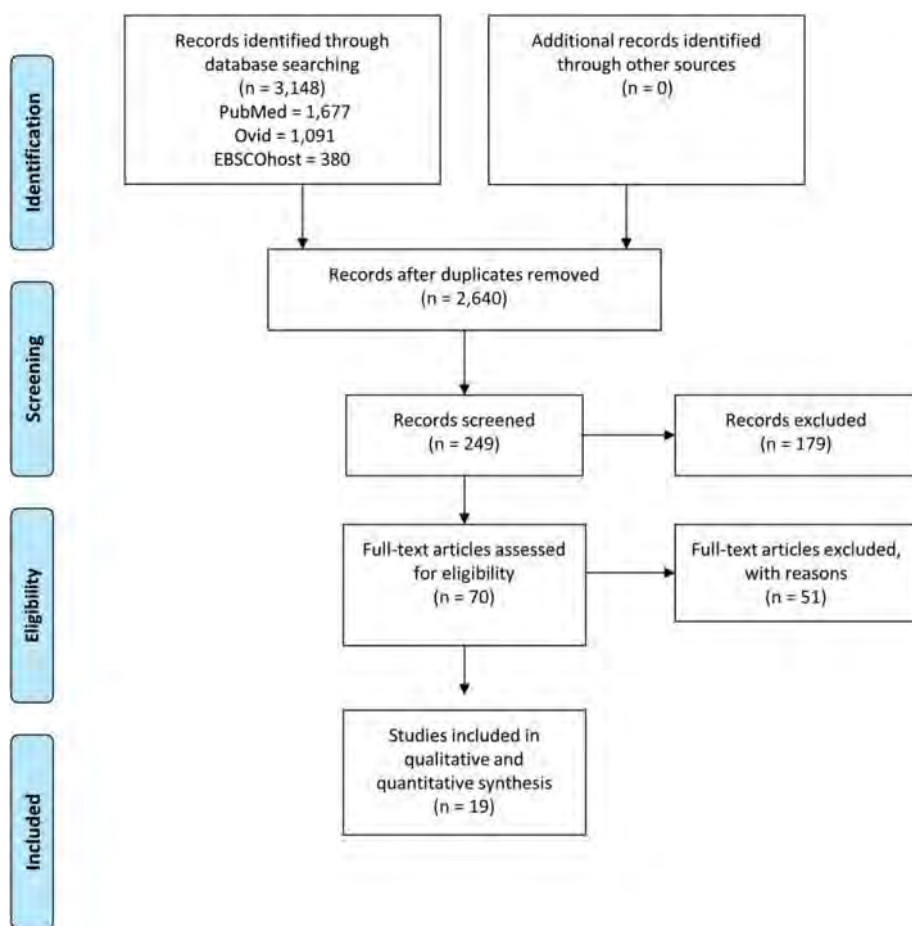
The 19 studies included data on 472 patients with 485 implants placed into fresh extraction sockets and immediately restored in the maxillary esthetic zone. Reasons for extraction included both periodontal and non-periodontal problems (caries, endodontic failure, root fracture, trauma, and root resorption). Details regarding site and implant characteristics and measuring techniques for the studies are outlined in Table 1.

**Soft Tissue Outcomes**

Most of the included studies quantified soft tissue alterations in terms of midfacial gingival height and/or mesial papilla and distal papilla (Table 1).<sup>21-23,25-27,29-36</sup> A variety of methods were used to measure this outcome, including standardized and non-standardized photographs, direct clinical measurements on the patient, and dental casts.

Midfacial mucosa showed a mean overall recession of 0.27 ± 0.38 mm after a follow-up period ranging from 1 to 5 years (Table 2). Most of these changes happened in the period between implant placement and definitive crown insertion. Within the first year of follow-up after

- ⊕ Steri-Oss, Nobel Biocare, Zurich, Switzerland.
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- ⊕ Defcon, Impladent, Barcelona, Spain.
- ⊕ Biomet 3i, Palm Beach Gardens, FL.
- ⊕ Institute Straumann, Basel, Switzerland.
- ⊕ BioSpark, Keystone Dental, Burlington, MA.
- ⊕ Astra Tech, DENTSPLY, York, PA.
- ⊕ Southern Implants, Irvine, CA.
- ⊕ FBR-coated implants, Pitt-Easy, Oraltronic, Bremen, Germany.



**Figure 1.**

Flowchart of study selection process according to the PRISMA statement.

the definitive crown, regrowth was seen, leading to gain in soft tissue levels ( $-0.04 \pm 0.19$  mm). A few studies with follow-ups  $>1$  year showed a very minimal loss of midfacial mucosa in the long term ( $0.01 \pm 0.46$  mm).<sup>24,25,27,29,36</sup>

In regard to papillary changes, a mean loss of  $0.23 \pm 0.27$  mm was seen (Table 2). Once again, most of these changes happened before definitive crown placement. Papillary rebound was seen after crown placement up to 1 year ( $-0.13 \pm 0.18$  mm) and then in some studies from 1 year to the final follow-up ( $-0.07 \pm 0.25$  mm).<sup>25,27,29,36</sup>

### Variables Influencing Soft Tissue Changes

The effect of various variables is presented in Table 3. The presence of a thin biotype did not show any significant negative effect on soft tissue changes after IPR. In addition, even though the use of CTG with bone grafting at the time of implant placement was seen to limit soft tissue recession, it failed to have any statistically significant advantage over using a bone graft without CTG. The limited number of studies that used a surgical flap<sup>22,29</sup> did not show any significant

difference in the amount of soft tissue changes compared with studies that did not use a flap.

### Advanced Soft Tissue Changes ( $>1$ mm Recession)

Seven studies provided data on advanced soft tissue recession of  $>1$  mm after IPR.<sup>19,20,29,30,32-34</sup> For the purpose of analysis, studies that included high-risk cases<sup>20</sup> or used a CTG during or after implant placement<sup>30,33</sup> were excluded from this analysis. Among the four analyzed studies,<sup>19,29,32,34</sup> midfacial advanced recession ( $>1$  mm) was reported as being  $<10\%$  by two studies,<sup>29,32</sup> with the other two studies<sup>19,34</sup> reporting an incidence from 10% to 20% (Table 4). Notwithstanding the different protocols used, as well as the variable sample sizes and follow-up durations of the studies, a weighted mean was calculated to determine the percentage of cases showing advanced recession. The results showed the frequency of advanced midfacial recession to be 11.02% across the four studies, including 119 implants (Table 4).

### Esthetic Outcomes

Five of the 19 included studies provided information about the esthetic outcomes of the treatment.<sup>28,29,32,33,37</sup> Esthetic evaluation was carried out using the pink esthetic score (PES)<sup>38</sup> or white esthetic score (WES).<sup>39</sup> A PES score of  $<7$  was used to define esthetic failure, as proposed by Cosyn et al.<sup>29</sup> All five studies quoted a mean PES score of  $>10$ , with no study reporting a mean WES score of  $<7$  (Table 1). Several studies were excluded for a variety of reasons including lack of details regarding esthetic failures,<sup>37</sup> inclusion of high-risk cases (fractured facial plate),<sup>28</sup> or use of CTG to manage recession.<sup>33</sup> The mean esthetic failure rate in the remaining two studies,<sup>29,32</sup> which included low-risk cases, was 11.2% (Table 4).

### Patient-Reported Outcome Measures

Only three of the included studies reported on patient satisfaction or patient-centered outcome measures (Table 1).<sup>22,27,32</sup> Kan et al.<sup>27</sup> found that after a mean follow-up period of 2 to 8 years, only 11% of patients were not satisfied with the esthetic outcome. Significant improvements in Oral Health Impact Profile 14 (OHIP-14)<sup>40</sup> scores were reported by Raes et al.<sup>32</sup> after a follow-up period of 1 year.

**Table 2.**  
**Soft Tissue Changes (in millimeters) at Various Time Points**

| Reference                                 | n  | Baseline to Final Follow-Up |         | Baseline to Definitive Crown |         | Definitive Crown to 1 Year |         | 1 Year to Final Follow-Up |         |
|---|----|-----------------------------|---------|------------------------------|---------|----------------------------|---------|---------------------------|---------|
|   |    | Midfacial Mucosa            | Papilla | Midfacial Mucosa             | Papilla | Midfacial Mucosa           | Papilla | Midfacial Mucosa          | Papilla |
| Canullo and Raspenni (2007) <sup>21</sup> | 10 | -0.2                        | -0.25   | NR                           | NR      | NR                         | NR      | NR                        | NR      |
| De Rouck et al. (2009) <sup>22</sup>      | 24 | 0.41                        | 0.38    | 0.47                         | 0.38    | -0.06                      | 0.0     | NR                        | NR      |
| Kan et al. (2009) <sup>23</sup>           | 20 | -0.13                       | NR      | NR                           | NR      | NR                         | NR      | NR                        | NR      |
| Block et al. (2009) <sup>24</sup>         | 26 | NR                          | NR      | NR                           | NR      | 0.24                       | NR      | -0.65                     | NR      |
| Tortamano et al. (2010) <sup>25</sup>     | 12 | NR                          | -0.09   | NR                           | 0.06    | -0.06                      | -0.15   | 0.03                      | -0.01   |
| Pieri et al. (2011) <sup>26</sup>         | 40 | 0.67                        | 0.3     | 0.58                         | 0.32    | 0.12                       | -0.02   | NR                        | NR      |
| Kan et al. (2011) <sup>27</sup>           | 35 | 1.13                        | 0.22    | 0.48                         | 0.44    | 0.07                       | 0.02    | 0.58                      | -0.26   |
| Cosyn et al. (2011) <sup>29</sup>         | 25 | 0.34                        | 0.07    | 0.54                         | 0.36    | -0.01                      | -0.1    | -0.19                     | -0.30   |
| Tsuda et al. (2011) <sup>30</sup>         | 10 | 0.05                        | NR      | 0.0                          | NR      | 0.05                       | NR      | NR                        | NR      |
| Brown and Payne (2011) <sup>31</sup>      | 28 | -0.2                        | NR      | -0.2                         | NR      | 0.0                        | NR      | NR                        | NR      |
| Raes et al. (2013) <sup>32</sup>          | 16 | 0.12                        | 0.16    | 0.35                         | 0.64    | -0.23                      | -0.48   | NR                        | NR      |
| Cosyn et al. (2013) <sup>33</sup>         | 22 | 0.2                         | 0.4     | 0.3                          | 0.4     | 0.1                        | 0.0     | NR                        | NR      |
| Malchiodi et al. (2013) <sup>34</sup>     | 64 | 0.5                         | 0.7     | NR                           | NR      | NR                         | NR      | NR                        | NR      |
| Cabello et al. (2013) <sup>35</sup>       | 14 | 0.45                        | 0.59    | NR                           | NR      | NR                         | NR      | NR                        | NR      |
| Cooper et al. (2014) <sup>36</sup>        | 58 | NR                          | 0.17    | NR                           | 0.26    | -0.35                      | -0.35   | 0.29                      | 0.26    |
| Cardaropoli et al. (2015) <sup>37</sup>   | 26 | 0.21                        | 0.13    | NR                           | NR      | NR                         | NR      | NR                        | NR      |
| Mean                                      |    | 0.27                        | 0.23    | 0.32                         | 0.36    | -0.04                      | -0.13   | 0.01                      | -0.07   |
| SD  |    | 0.38                        | 0.27    | 0.28                         | 0.16    | 0.19                       | 0.18    | 0.46                      | 0.25    |
| Weighted Mean                             |    | 0.37                        | 0.30    | 0.39                         | 0.34    | -0.06                      | -0.13   | 0.10                      | -0.01   |

NR = not reported.  
 Negative values indicate gain in soft tissue.

**Table 3.**  
**Variables Influencing Soft Tissue Changes**

| Variable            | Midfacial Mucosa |                        |      | Papilla      |                        |      |
|---------------------|------------------|------------------------|------|--------------|------------------------|------|
|                     | Implants (n)     | Mean Change in mm (SD) | P    | Implants (n) | Mean Change in mm (SD) | P    |
| Flap                | 49               | 0.37 (0.04)            | 0.46 | 49           | 0.22 (0.21)            | 0.80 |
| Flapless            | 269              | 0.26 (0.42)            |      | 269          | 0.27 (0.29)            |      |
| Thin biotype        | 31               | 0.48 (0.88)            | 0.64 | 23           | 0.1 (0.14)             | 0.45 |
| Thick biotype       | 185              | 0.20 (0.31)            |      | 173          | 0.22 (0.31)            |      |
| Bone graft with CTG | 30               | -0.04 (0.12)           | 0.06 | NR           | NR                     |      |
| Bone graft only     | 189              | 0.32 (0.29)            |      | NR           | NR                     |      |

NR = not reported.

Negative values indicate gain in soft tissue.

**Table 4.**  
**Frequency of Advanced Soft Tissue Recession (>1 mm gingival recession) and Esthetic Failure (PES <7)**

| Authors                               | Implants (n) | Mean Follow-Up (months) | Midfacial Recession >1 mm (%) | Esthetic Failure (%) |
|---------------------------------------|--------------|-------------------------|-------------------------------|----------------------|
| Wöhrlé (1998) <sup>19</sup>           | 14           | 22                      | 14.3                          | NR                   |
| Cosyn et al. (2011) <sup>29</sup>     | 25           | 36                      | 8                             | 16                   |
| Raes et al. (2013) <sup>32</sup>      | 16           | 12                      | 7                             | 10                   |
| Malchiodi et al. (2013) <sup>34</sup> | 64           | 36                      | 12.5                          | NR                   |
| Weighted mean                         |              |                         | 11.02                         | 11.21                |

PES = pink esthetic score; NR = not reported.

## DISCUSSION

When assessing the adequacy of soft tissue outcomes in the context of esthetics, there is general consensus that the papillae adjacent to the single-unit crown should mimic those of a healthy tooth, in both height and embrasure fill, and the mid-buccal gingival margins should harmonize with those of the adjacent teeth.

It has been proposed that the patient's gingival biotype affects the likelihood of achieving a successful esthetic outcome. Indeed, a thick biotype was a prerequisite for patient inclusion in a few studies.<sup>22,32,33</sup> However, the results from this review failed to find any significant advantage of a thick tissue biotype. It should be noted that the number of cases compared was limited and included considerable inherent heterogeneity. In relation to the issue of surgical access, the choice of a flap or flapless approach did not appear to influence the final outcome. Therefore, it is still unclear whether the choice of using a surgical flap or a flapless approach influences the final outcome, although a practical consideration is that the flapless

approach is likely to make it easier to carry out the immediate restorative procedure.

In regard to bone augmentation procedures, four of the 19 studies did not use any material to graft the gap between the implant and socket.<sup>25,27,32,35</sup> From the limited data available, it was not possible to determine whether grafting between the implant and bone had any effect on soft tissue levels around implants placed using IPR. The use of CTG did not show any significant advantage in improving soft tissue outcomes. Although it has been used to manage advanced recession cases,<sup>33</sup> the CTG procedure has its own limitations, with necrosis of the graft potentially leading to inferior esthetic outcomes,<sup>30</sup> and hence CTG cannot be recommended as a routine procedure with the IPR technique.

The amount of midfacial gingival recession after IPR was  $0.27 \pm 0.38$  mm after  $\geq 1$  year of follow-up. These results are slightly better than the midfacial recession of 0.54 mm ( $\geq 12$  months of follow-up) reported by another review on immediate placement in the esthetic

zone,<sup>14</sup> with the slight difference in observed results due to the inclusion of both immediate and delayed restoration cases in the other review. It is noteworthy that various techniques, such as standardized and non-standardized photographs, direct clinical measurements on the patient, and dental casts, were used in different studies, which could have affected the results. It is difficult to standardize any specific method for a subjective measurement, but further research needs to be done to check the variability in results obtained with various techniques.

Weighted mean analysis of studies with low-risk cases showed an advanced (>1 mm) midfacial recession frequency of 11%. Cosyn et al.,<sup>18</sup> in their systematic review on single immediate implants, found advanced recession frequency to be an infrequent finding. Of four studies that provided data on advanced recession, Cosyn et al. found only one to have a frequency of >10%. In the current review, five studies provided data on advanced recession,<sup>19,29,32-34</sup> of which two<sup>19,34</sup> had a frequency of >10%. Therefore, if sensible patient selection criteria are followed, especially in relation to the integrity of the buccal socket wall, the incidence of advanced midfacial recession (>1 mm) is relatively low.

Mean papillary changes were limited to  $0.23 \pm 0.27$  mm recession after  $\geq 1$  year of follow-up. These findings are similar to changes observed in another review.<sup>14</sup> Interestingly, a gain in the level of interdental papillae was seen after definitive crown placement, suggesting a papillary rebound. Studies with follow-ups >1 year showed a tendency for the papillae to regrow, improving the overall esthetics. The finding of papillary rebound should be interpreted carefully, as it is based on a limited number of heterogeneous studies. Nonetheless, it is an interesting finding that needs further research in the form of long-term clinical trials.

Five studies used PES or WES to evaluate the esthetic outcome of immediately placed and restored implants.<sup>28,29,32,33,37</sup> When considering the esthetic outcomes according to the criteria described by Cosyn et al.,<sup>29</sup> the results from most of these studies suggest that an acceptable esthetic outcome can be achieved when using IPR in the maxillary anterior region. An estimate of the frequency of unfavorable results or esthetic failures (PES <7) showed 11% of cases falling below the threshold, but this finding was based on only two studies (Table 4).<sup>29,32</sup>

Patient assessment of the overall treatment procedure and results is a very important criterion, especially in relation to any restoration in the maxillary anterior region. However, patient-reported outcome measures were included in very few studies.<sup>22,27,32</sup> The studies included in this review used various measures, including a Visual Analog Scale<sup>41</sup> and the OHIP-14 index,<sup>40</sup> for patient assessment of treatment outcome. The results showed a significant improvement in patient

satisfaction after the replacement of an anterior tooth with the IPR technique. However, since only a very limited number of studies reported on patient-centered parameters, this as an outcome measure that requires further investigation.

## CONCLUSIONS

Considerable heterogeneity was evident when comparing the different studies included in this review. Despite the relatively short time span (2007 to 2015) in which most of these studies were performed, treatment procedures and materials changed considerably, leading to a large variance in the treatment protocols used.

Advanced mucosal recession was seen in 11% of low-risk cases. The use of a flap or flapless technique did not appear to significantly influence the amount of soft tissue changes when using IPR. Furthermore, although a thin gingival biotype has been considered a risk factor for this technique, definite evidence could not be found to substantiate this. Similarly, a beneficial effect of the use of CTG with bone graft could not be substantiated by the available evidence. More prospective, and ideally randomized, clinical trials are necessary to determine the effect of local and surgical factors on the soft tissue and esthetic outcomes following IPR.

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