

# Soft Tissue Response in Posterior Teeth Adjacent to Interdental Single Implants: A Controlled Randomized Clinical Trial Comparing Intrasulcular vs Trapezoidal Incision

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**Purpose:** To evaluate the soft tissue response in posterior teeth adjacent to interdental single implants comparing intrasulcular and trapezoidal incision, and to study their evolution over time.

**Materials and Methods:** A controlled randomized clinical trial was carried out in the Oral Surgery and Implantology Unit of a University Clinic. All the included patients received an interdental single implant (Frontier 2.45, Ilerimplant; Global Medical Implants). The incision type was randomized by sealed envelopes into two groups using the SPSS statistical package (SPSS): (1) intrasulcular or (2) trapezoidal incision. Probing depth and gingival recession at the mesial and distal teeth adjacent to the implant were measured before implant placement, 1 month after surgery, the day of the abutment connection, and at 6 months and 1 year postloading. Scar formation and papilla index were measured 1 month after surgery, and at 6 months and 1 year postloading. **Results:** Forty patients with one implant per patient were included: 20 in the intrasulcular and 20 in the trapezoidal group. No statistical differences were found between incision types in the measured parameters (probing depth, recession, and interproximal papilla). When analyzing periodontal changes of the total sample, significant differences were found between implant placement and the 1-year follow-up in recession, scar formation, and papilla index. **Conclusion:** The incision type used to place a single interdental implant did not significantly influence the periodontal parameters of the adjacent teeth. Considering the whole sample, the values between implant placement and 1 year postloading showed significant differences in recession, scar formation, and papilla index over time. INT J ORAL MAXILLOFAC IMPLANTS 2016;31:xxx-xxx. doi: 10.11607/jomi.4178

**Keywords:** dental papilla, gingival recession, incision, mucoperiosteal flap, scar, single-tooth implant

Mucoperiosteal flaps are used to obtain access to the bone and root surface in oral surgical procedures.<sup>1</sup> Different incisions can be performed to gain access to the bone. The intrasulcular incision presents good vascular supply of the mucoperiosteal flap and a lack of

scar formation,<sup>2</sup> but minor changes in the periodontal parameters of adjacent teeth can be expected.<sup>3</sup> The trapezoidal incision, which does not include the interproximal soft tissue of the adjacent teeth, can disturb the vascular supply of the gingival tissues, and scar formation is a possible complication.<sup>2,4</sup> The papilla base incision<sup>5</sup> preserves the interdental tissues and may be associated with faster recovery of the gingival blood flow postoperatively.<sup>6-8</sup> The flapless approach in implant surgery<sup>9</sup> is associated with better maintenance of the soft tissue profiles, including the gingival margins of adjacent teeth and the interdental papilla<sup>10-13</sup>; the major drawback is that it is a “blind” surgical technique.

Many publications have evaluated peri-implant hard and soft tissue changes around interdental implants.<sup>14-16</sup> Above all, studies have addressed the impact of immediate,<sup>14</sup> early,<sup>15</sup> or delayed implant placement<sup>16</sup> on the recession of the peri-implant facial mucosa. Changes in the soft tissues of teeth adjacent to interdental implants have been scarcely studied. Gomez-Roman<sup>17</sup> performed a prospective

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study to determine the influence of the surgical flap used during single implant placement on peri-implant interproximal crestal bone loss. The present author observed that the use of a trapezoidal flap (without reaching the interproximal soft tissue) yielded less interproximal bone loss and prevented the possible loss of papilla, in comparison with a flap including papillae. However, none of these studies were focused on the effect of implant surgeries on the soft tissues changes of adjacent teeth. Emecen-Huja et al<sup>18</sup> compared peri-implant soft tissue healing and periodontal healing in adjacent teeth, following single implant placement using intrasulcular incision. The observed differences suggest that peri-implant tissues, compared with periodontal tissues, represent a higher pro-inflammatory state, but no differences were found in clinical parameters. Moreover, clinical prospective controlled studies are recommended to compare soft tissue outcomes between different incision types.<sup>3</sup>

The aim of this randomized controlled clinical trial (RCT) was to evaluate the soft tissue response in posterior teeth adjacent to interdental single implants placed using intrasulcular or trapezoidal incision, and to analyze soft tissue changes over time.

The null hypothesis was that the incision type in implant surgery does not have any effect on soft tissue response.

The article was written following the CONSORT statement for improving the quality of RCTs.<sup>19</sup>

## MATERIALS AND METHODS

### Study Design and Patient Selection

A controlled randomized clinical trial was carried out in the Oral Surgery and Implantology Unit of a University Clinic. The study design was approved by the local ethics committee (Reference number: H1359714956078), and performed following the principles of the Declaration of Helsinki. All patients were required to sign an informed consent form to participate in the study.

The following inclusion criteria were used: (1) single posterior edentulous area with at least 8 mm of mesio-distal space; (2) healthy adjacent teeth (not supporting fixed prostheses and without periodontal alterations); (3) keratinized mucosa width of at least 3 mm; (4) indication of implant not requiring simultaneous bone regeneration techniques; (5) full-mouth plaque and full-mouth bleeding scores < 25%; (6) nonsmoking or smoking  $\leq$  10 cigarettes/day (all pipe or cigar smokers were excluded); and (7) follow-up of 1 year after implant loading. The exclusion criteria were: (1) implants placed closer than 2 mm to adjacent teeth; (2) systemic diseases contraindicating surgery; and (3) sites with acute infection.

### Randomization

Random assignment of the patients to the groups was performed according to computer-generated randomization tables. A permuted block randomization approach was used to prepare the randomization tables to avoid imbalance between the two incisions. Assignment was performed using sealed envelopes. Participants were informed about the different incisions, but blinded to the assignment.

### Surgical and Restorative Treatment

All patients in the study underwent a tartrectomy 3 weeks before the implant surgery. Delayed implant placement was performed. All implants (Frontier 2.45, Ilerimplant; Global Medical Implants) were placed using the same surgical protocol under local anesthesia with 4% articaine with epinephrine 1:100,000.

At this point, an assistant was asked to open a randomization envelope, and the assigned incision technique was revealed and performed accordingly:

- Group A, intrasulcular incision: A crestal incision was performed in the attached mucosa of the edentulous area, including the sulcus of the adjacent teeth, without release incisions (Figs 1a and 1b).
- Group B, trapezoidal incision: A crestal incision was performed in the attached mucosa of the edentulous area without reaching the interproximal soft tissue surrounding adjacent teeth and making two release incisions. The distance from the midcrestal incision to the interproximal aspect of the adjacent teeth was approximately 1.5 to 2 mm (Figs 2a and 2b).

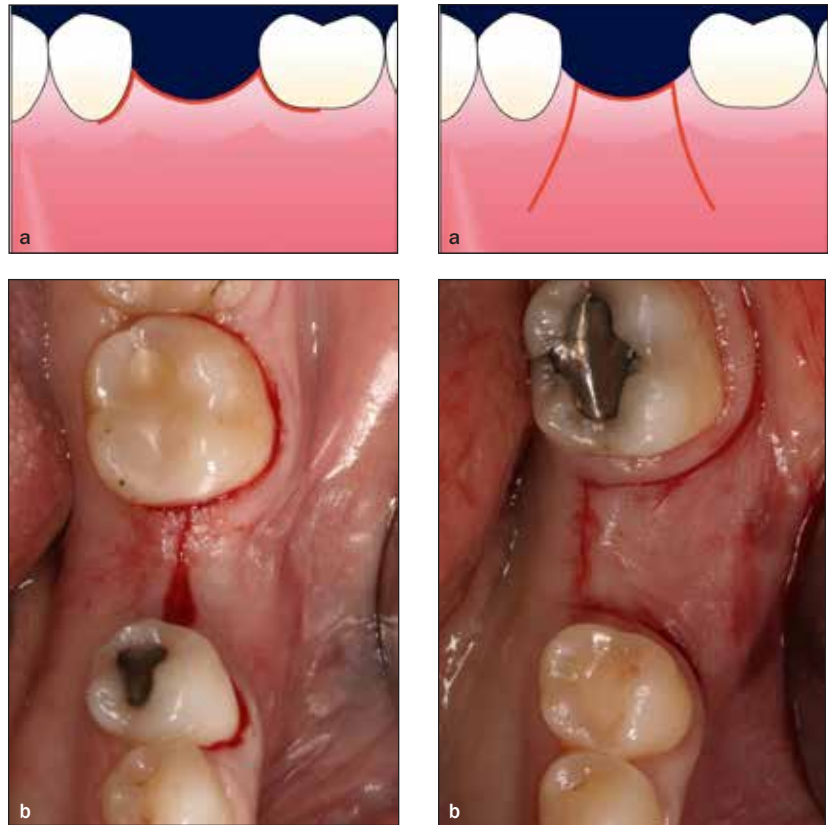
After the incision, a full-thickness mucoperiosteal flap was raised. Implants were placed according to a nonsubmerged approach, and then the flap was sutured with 4/0 silk sutures. Soft tissues were just replaced and sutured around the healing abutments. Only cases without a bone regeneration procedure were treated, so no advance flaps were needed. Perioperative antibiotic prophylaxis was initiated 2 hours prior to surgery and maintained for 3 days postsurgery (amoxicillin 1 g, twice a day, orally).<sup>15</sup> Patients were prescribed ibuprofen 600 mg tablets, when necessary, and were instructed to rinse with 0.12% chlorhexidine digluconate for 1 minute, twice a day for 2 weeks. No provisionalization was performed. It was considered that this may influence periodontal parameters and that it was not necessary since cases belonged to the posterior region. Sutures were removed 1 week after surgery. After a healing period of 12 weeks, single-tooth screw-retained porcelain restorations were loaded.

**Fig 1a** (top left) Picture representing the buccal view of the intrasulcular incision.

**Fig 1b** (bottom left) Occlusal view of the intrasulcular incision.

**Fig 2a** (top right) Picture representing the buccal view of the trapezoidal incision.

**Fig 2b** (bottom right) Occlusal view of the trapezoidal incision.



### Data Recording and Follow-up Examinations

Patients were followed for a period of 1 year after prosthetic rehabilitation. Because bacteria or their products may cause chronic inflammation, every patient received professional oral hygiene every 3 months to prevent eventual bias caused by differing hygiene levels.<sup>20</sup> All data collection was made by a blinded single trained clinician, different from the surgeon, following a preestablished protocol.

The following parameters were assessed before implant placement, 1 month after surgery, the day of the abutment connection, and at 6 months and 1 year after implant loading:

- Probing depth (PD): A periodontal probe (Colorvue Tip, Hu-Friedy) was used to measure the PD to the nearest 0.5 mm at the mesial, medial, and distal vestibular area.
- Recession: distance from the gingival margin to the cementoenamel junction was measured to the nearest 0.5 mm (negative values for sites with exposed root surface), at the vestibular area.

The following parameters were also measured at 1 month, 6 months, and 1 year after surgery:

- Scar formation: Digital clinical photographs were used to evaluate the scar formation at the release

incisions. The photographs were taken with 1:1 magnification, perpendicular to the buccal surface of the single-tooth implant crown and including at least one adjacent tooth on each side, using a Nikon D90 digital camera (Nikon) with macro lens and ring flash. Photographs were transferred to a computer, enlarged to 8 × 6 cm, and analyzed using software (Microsoft Office PowerPoint 2010, Microsoft). Scars were classified from more to less esthetic with the following grades: (0) no visible scar, (1) partially visible scar, and (2) clearly visible scar. This variable was only evaluated in the trapezoidal incision group. A photographic example of the different scores of this scar classification is shown in Figs 3a to 3c.

- Papilla index (PI): Scores from 0 to 4 were assigned depending on the degree of papilla filling the embrasure (absent, < 50%, > 50%, complete and overgrowth, respectively) as described by Jemt.<sup>21</sup>

### Statistical Analysis

Continuous variables were described by the number of observations (n), minimum, median, maximum, mean, and standard deviation (SD) values and discrete variables by frequencies and percentages. Within-group and between-group comparisons were calculated using nonparametric statistics (Wilcoxon signed-rank and Mann-Whitney *U* test, respectively),



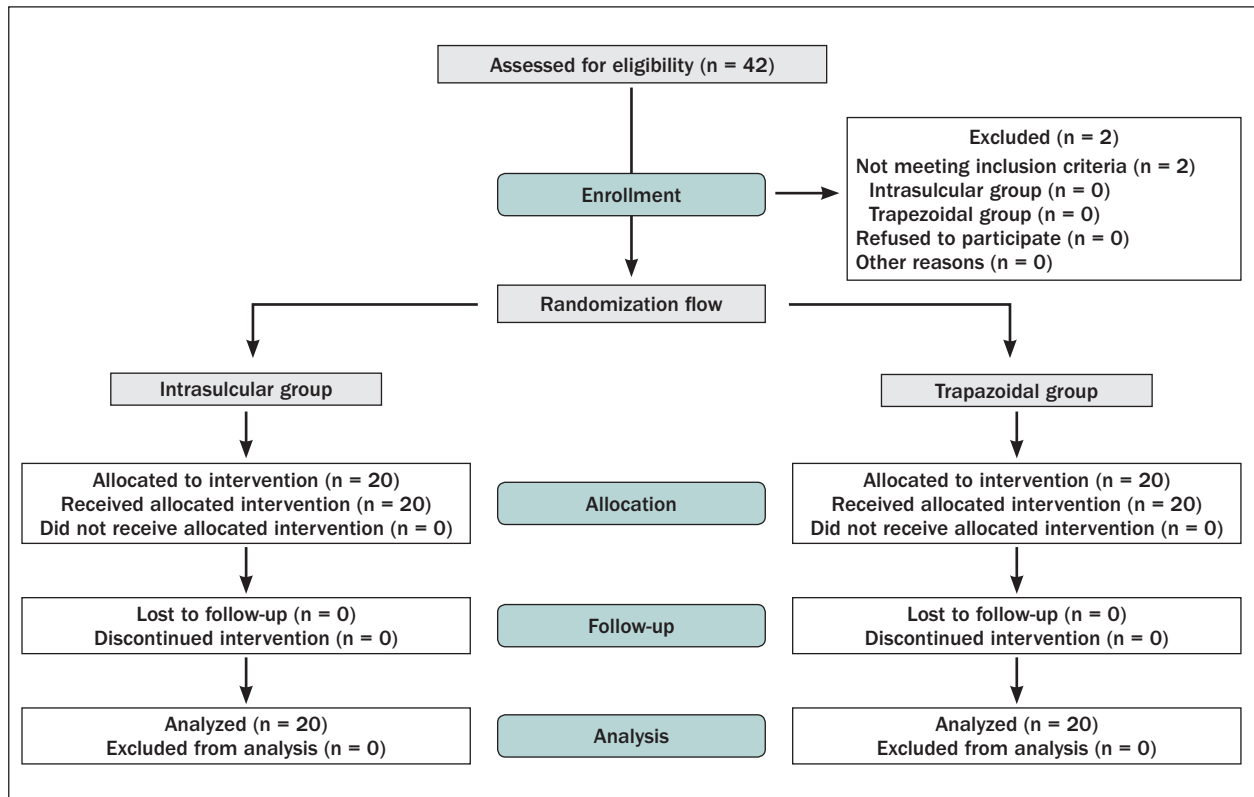
**Fig 3a** Patient example with no visible scar after 1 year postloading (Grade 0).



**Fig 3b** Patient example with partially visible scar after 1 year postloading (Grade 1).



**Fig 3c** Patient example with clearly visible scar after 1 year postloading (Grade 2).



using SPSS version 18.0.0 (IBM). A Fisher exact test was also used to check homogeneity between groups by sex and smoking. A two-sided *P* value of *P* < .05 was considered to be statistically significant.

The periodontal parameters analyzed were then evaluated after stratification, dental arch (maxilla or mandible), patient's smoking habit, and gingival bio-type (thin or thick tissue) measured with a periodontal probe.<sup>22</sup>

## RESULTS

During the study period, 42 patients were screened for inclusion, and 40 patients participated in the study. Two patients were excluded for not meeting the inclusion criteria: two patients smoked > 10 cigarettes/day.

No dropouts occurred during the observation period (Fig 4).

A total of 40 patients (18 men and 22 women, mean age of 47 years with a range of 19 to 80 years) were treated with 40 implants: 20 patients using the intrasulcular incision and 20 patients with the trapezoidal incision. 23 implants were placed in the mandible and 17 in the maxilla. Thirty-one patients were nonsmokers, and nine were smokers of ≤ 10 cigarettes per day. No statistically significant differences were found between the groups regarding sex, age, and smoking habit.

All surgical interventions and postoperative healing periods elapsed without any serious complications or side effects. In the first postoperative day, some patients reported moderate swelling without pain. After 1 week, no inflammation was detectable.

**Table 1** Probing Depth Changes by Treatment Group (Intrasulcular vs Trapezoidal Incision) and PD Changes Over time in Adjacent Teeth

	Mesial teeth			Distal teeth		
	Presurgery	1 y postloading	Change from presurgery to 1 y	Presurgery	1 y postloading	Change from presurgery to 1 y
<b>Intrasulcular incision</b>						
No.	20	20	20	20	20	20
Mean $\pm$ SD (range)	1.80 $\pm$ 0.52 (1.00–3.00)	1.80 $\pm$ 0.70 (1.00–3.00)	0.00 $\pm$ 0.73 (–1.00–1.00)	2.25 $\pm$ 1.02 (1.00–4.00)	2.20 $\pm$ 0.89 (1.00–4.00)	0.05 $\pm$ 0.76 (–1.00–2.00)
Median	2.00	2.00	0.00	2.00	2.00	0.00
<b>Trapezoidal incision</b>						
No.	20	20	20	20	20	20
Mean $\pm$ SD (range)	1.60 $\pm$ 0.60 (1.00–3.00)	1.75 $\pm$ 0.55 (1.00–3.00)	–0.15 $\pm$ 0.67 (–2.00–1.00)	1.95 $\pm$ 0.69 (1.00–3.00)	2.10 $\pm$ 1.02 (1.00–5.00)	–0.15 $\pm$ 1.18 (–3.00–2.00)
Median	2.00	2.00	0.00	2.00	2.001	0.001
<b>Total</b>						
No.	40	40	40	40	40	40
Mean $\pm$ SD (range)	1.70 $\pm$ 0.56 (1.00–3.00)	1.78 $\pm$ 0.62 (1.00–3.00)	–0.08 $\pm$ 0.69 (–2.00–1.00)	2.10 $\pm$ 0.87 (1.00–4.00)	2.15 $\pm$ 0.95 (1.00–5.00)	–0.05 $\pm$ 0.99 (–3.00–2.00)
Median	2.00	2.00	0.00	2.00	2.00	0.00

### Probing Depth

A mean PD of 0 mm in mesial teeth and mean decrease of 0.05 mm in distal teeth in the intrasulcular group and a mean increase of 0.15 mm in mesial and distal teeth in the trapezoidal group were observed. No significant differences were found between incision type ( $P > .05$ , Mann-Whitney  $U$  test). Table 1 shows PD changes in adjacent teeth by treatment group.

Considering the whole sample, no significant differences were observed over time ( $P > .05$ , Wilcoxon signed-rank test). At the 1-year follow-up, a mean PD increase of 0.08 mm and 0.05 mm in both mesial and distal teeth were observed (Table 1).

No significant differences in PD changes over time were found between the mandible and the maxilla, and between smokers and nonsmokers. A mean increase in PD of 0.04 mm and 0.22 mm (in mesial and distal teeth) in thin biotypes, and a mean increase of 0.12 mm and a mean decrease of 0.18 mm (in mesial and distal teeth) in thick biotypes were observed. This difference was statistically significant ( $P < .05$ , Mann-Whitney  $U$  test). These results are reported in Table 2.

### Recession

A mean increase of 0.63 mm and 0.38 mm in mesial and distal teeth and a mean increase of 0.53 mm in mesial teeth and a mean decrease of 0.05 mm in distal teeth were observed in the intrasulcular and trapezoidal groups, respectively. At the 1-year follow-up, the differences were not statistically significant ( $P > .05$ , Mann-Whitney  $U$  test). These results are detailed in Table 3.

After 1 year of observation, the mean recession of the total sample was 0.58 mm in mesial teeth and 0.16

mm in distal teeth. This recession was statistically significant in mesial teeth ( $P < .05$ , Wilcoxon signed-rank test). These results are described in Table 3.

No significant differences in recession were found between the mandible and the maxilla in mesial and distal teeth, smokers and nonsmokers, and between thin and thick biotype ( $P > .05$ , Mann-Whitney  $U$  test). The statistical results for recession considering stratification are detailed in Table 4.

### Scar Formation

One month after implant surgery, none of the mesial and distal release incisions were classified as “no visible scar,” 10% of the mesial and 15% of the distal release incisions as “partially visible scar,” and 90% of the mesial and 85% of the distal release incisions as “clearly visible scar.” One year postloading, 50% of the mesial and 45% of the distal release incisions were classified as “no visible scar,” 45% of the mesial and 45% of the distal release incisions as “partially visible scar,” and 5% of the mesial and 10% of the distal release incisions as “clearly visible scar.” Of the 18 mesial release incisions categorized as “clearly visible scar” at 1 month after surgery, one remained within these categories at 1 year postloading. Of the 17 distal release incisions categorized as “clearly visible scar” at baseline, two remained in these categories at the 1-year follow-up visit. Significant reductions in scar formation were observed over time with the trapezoidal incision both in mesial and distal release incisions ( $P < .05$ , Wilcoxon signed-rank test; Table 5).

There were significant differences in scar formation between dental arches in mesial teeth ( $P < .05$ , Mann-Whitney  $U$  test). The proportions of “no visible scar” at

**Table 2 Probing Depth Changes by Dental Arch, Patient's Smoking Habit, and Gingival Biotype**

	Mesial teeth			Distal teeth		
	Presurgery	1 y postloading	Change from presurgery to 1 y	Presurgery	1 y postloading	Change from presurgery to 1 y
<b>Mandible</b>						
No.	23	23	23	23	23	23
Mean ± SD (range)	1.57 ± 0.66 (1.00–3.00)	1.65 ± 0.65 (1.00–3.00)	−0.09 ± 0.73 (−2.00–1.00)	2.17 ± 0.89 (1.00–4.00)	2.00 ± 0.85 (1.00–4.00)	0.17 ± 0.89 (−2.00–2.00)
Median	1.00	2.00	0.00	2.00	2.00	0.00
<b>Maxilla</b>						
No.	17	17	17	17	17	17
Mean ± SD (range)	1.88 ± 0.33 (1.00–2.00)	1.94 ± 0.56 (1.00–3.00)	−0.06 ± 0.66 (−1.00–1.00)	2.00 ± 0.87 (1.00–4.00)	2.35 ± 1.06 (1.00–5.00)	−0.35 ± 1.06 (−3.00–2.00)
Standard deviation	–	–	–	–	–	–
Minimum	–	–	–	–	–	–
Maximum	–	–	–	–	–	–
Median	2.00	2.00	0.00	2.00	2.00	0.00
<b>Nonsmoker</b>						
No.	31	31	31	31	31	31
Mean ± SD (range)	1.74 ± 0.58 (1.00–3.00)	1.90 ± 0.60 (1.00–3.00)	−0.16 ± 0.69 (−2.00–1.00)	2.06 ± 0.85 (1.00–4.00)	2.10 ± 0.98 (1.00–5.00)	−0.03 ± 1.11 (−3.00–2.00)
Median	2.00	2.00	0.00	2.00	2.00	0.00
<b>Smoker</b>						
No.	9	9	9	9	9	9
Mean ± SD (range)	1.56 ± 0.53 (1.00–2.00)	1.33 ± 0.50 (1.00–2.00)	0.22 ± 0.67 (−1.00–1.00)	2.22 ± 0.97 (1.00–4.00)	2.33 ± 0.87 (1.00–4.00)	−0.11 ± 0.33 (−1.00–0.00)
Median	2.00	1.00	0.00	2.00	2.00	0.00
<b>Thin biotype</b>						
No.	23	23	23	23	23	23
Mean ± SD (range)	1.70 ± 0.47 (1.00–2.00)	1.74 ± 0.69 (1.00–3.00)	−0.04* ± 0.64 (−1.00–1.00)	2.22 ± 0.90 (1.00–4.00)	2.43 ± 1.04 (1.00–5.00)	−.22* ± 1.09 (−3.00–2.00)
Median	2.00	2.00	.00	2.00	2.00	.00
<b>Thick biotype</b>						
No.	17	17	17	17	17	17
Mean ± SD (range)	1.71 ± 0.69 (1.00–3.00)	1.82 ± 0.53 (1.00–3.00)	−.12* ± 0.78 (−2.00–1.00)	1.94 ± 0.83 (1.00–3.00)	1.76 ± 0.66 (1.00–3.00)	.18* ± 0.81 (−1.00–2.00)
Median	2.00	2.00	0.00	2.00	2.00	0.00

\*Significant difference between variables ( $P < .05$ , Mann-Whitney  $U$  test).

1 year postloading were 27.3% for mesial and 45.5% for distal release incisions in the mandible, and 77.8% for mesial and 44.4% distal release incisions in the maxilla. In the trapezoidal incision group, there was only one smoker, which was insufficient to apply comparative statistics. When comparing biotypes, no significant differences were found. These results are shown in Table 6.

### Papilla Index

The proportion of “> 50%” or “complete” papilla improved from abutment connection to 1 year postloading. PI changed over time in mesial and distal papillae in both groups, but there were no statistically significant differences ( $P > .05$ , Mann-Whitney  $U$  test; Table 7).

Considering the whole sample, at abutment connection, 47.5% and 40% of the mesial and distal papillae were classified as “>50%” or “complete,” and at 1 year postloading, these proportions changed to 92.5% and 75%, respectively. Of the 21 mesial papillae categorized as “No papilla” or “< 50%” at abutment connection, three remained within these categories at 1 year postloading. From the 24 distal papillae categorized as “No papilla” or “< 50%” at abutment connection, 10 remained at the 1-year follow-up visit. Significant changes were observed in the total sample in both mesial and distal papillae ( $P < .05$ , Wilcoxon signed-rank test; Table 7).

There were no statistically significant differences in PI between dental arch, smokers and nonsmokers, and biotype (Table 8).

**Table 3** Recession Changes by Treatment Group (Intrasulcular vs Trapezoidal Incision) and Level of Recession Changes Over Time in Adjacent Teeth

	Mesial teeth			Distal teeth		
	Presurgery	1 y postloading	Change from presurgery to 1 y	Presurgery	1 y postloading	Change from presurgery to 1 y
<b>Intrasulcular incision</b>						
No.	20	20	20	20	20	20
Mean $\pm$ SD (range)	-0.58 $\pm$ 1.39 (-4.00-1.00)	-1.20 $\pm$ 1.09 (-3.00-1.00)	0.63 $\pm$ 1.02 (-1.00-2.50)	-0.58 $\pm$ 1.09 (-2.50-1.00)	-0.95 $\pm$ 1.10 (-3.00-0.00)	0.38 $\pm$ 0.93 (-1.00-3.00)
Median	.00	-1.00	1.00	.00	-1.00	.00
<b>Trapezoidal incision</b>						
No.	20	20	20	20	20	20
Mean $\pm$ SD (range)	-1.28 $\pm$ 1.52 (-4.00-1.00)	-1.80 $\pm$ 1.47 (-5.00-1.00)	0.53 $\pm$ 1.04 (-1.00-2.00)	-1.30 $\pm$ 1.58 (-3.50-1.00)	-1.25 $\pm$ 1.25 (-3.00-1.00)	-0.05 $\pm$ 1.01 (-2.00-2.00)
Median	-1.50	-2.00	.00	-1.00	-1.00	.00
<b>Total</b>						
No.	40	40	40	40	40	40
Mean $\pm$ SD (range)	-0.93 $\pm$ 1.48 (-4.00-1.00)	-1.50 $\pm$ 1.32 (-5.00-1.00)	0.58* $\pm$ 1.02 (-1.00-2.50)	-0.94 $\pm$ 1.39 (-3.50-1.00)	-1.10 $\pm$ 1.17 (-3.00-1.00)	0.16 $\pm$ 0.98 (-2.00-3.00)
Median	-1.00	-1.00	.25	-1.00	-1.00	.00

Significant difference between groups ( $P < .05$ , Mann-Whitney  $U$  test).

**Table 4** Recession Changes (mm) by Dental Arch, Patient's Smoking Habit, and Gingival Biotype

	Mesial teeth			Distal teeth		
	Presurgery	1 y postloading	Change from presurgery to 1 y	Presurgery	1 y postloading	Change from presurgery to 1 y
<b>Mandible</b>						
No.	23	23	23	23	23	23
Mean $\pm$ SD (range)	-0.74 $\pm$ 1.46 (-4.00-1.00)	-1.33 $\pm$ 1.33 (-4.00-1.00)	0.59 $\pm$ 1.08 (-1.00-2.50)	-0.67 $\pm$ 1.38 (-3.50-1.00)	-0.91 $\pm$ 1.16 (-3.00-1.00)	0.24 $\pm$ 1.06 (-2.00-3.00)
Median	.00	-1.00	.00	.00	-1.00	.00
<b>Maxilla</b>						
No.	17	17	17	17	17	17
Mean $\pm$ SD (range)	-1.18 $\pm$ 1.51 (-4.00-1.00)	-1.74 $\pm$ 1.30 (-5.00-0.00)	0.56 $\pm$ 0.97 (-1.00-2.00)	-1.29 $\pm$ 1.37 (-3.50-1.00)	-1.35 $\pm$ 1.17 (-3.00-0.00)	0.06 $\pm$ 0.88 (-1.50-1.00)
Median	-1.00	-2.00	1.00	-2.00	-1.00	.00
<b>Nonsmoker</b>						
No.	31	31	31	31	31	31
Mean $\pm$ SD (range)	-1.10 $\pm$ 1.54 (-4.00-1.00)	-1.65 $\pm$ 1.37 (-5.00-1.00)	0.55 $\pm$ 1.04 (-1.00-2.50)	-1.08 $\pm$ 1.49 (-3.50-1.00)	-1.19 $\pm$ 1.19 (-3.00-1.00)	0.11 $\pm$ 1.05 (-2.00-3.00)
Median	-1.00	-1.50	0.00	-1.00	-1.00	0.00
<b>Smoker</b>						
No.	9	9	9	9	9	9
Mean $\pm$ SD (range)	-0.33 $\pm$ 1.12 (-2.00-1.00)	-1.00 $\pm$ 1.00 (-3.00-0.00)	0.67 $\pm$ 1.00 (-1.00-2.00)	-0.44 $\pm$ 0.88 (-2.00-1.00)	-0.78 $\pm$ 1.09 (-3.00-0.00)	0.33 $\pm$ 0.71 (-1.00-1.00)
Median	0.00	-1.00	1.00	0.00	0.00	0.00
<b>Thin</b>						
No.	23	23	23	23	23	23
Mean $\pm$ SD (range)	-1.37 $\pm$ 1.21 (-4.00-1.00)	-1.65 $\pm$ 1.26 (-5.00-0.00)	0.28 $\pm$ 0.95 (-1.00-2.50)	-1.35 $\pm$ 1.12 (-3.50-1.00)	-1.30 $\pm$ 1.06 (-3.00-0.00)	-0.04 $\pm$ 0.81 (-1.50-1.00)
Median	-2.00	-2.00	0.00	-1.00	-1.00	0.00
<b>Thick</b>						
No.	17	17	17	17	17	17
Mean $\pm$ SD (range)	-0.32 $\pm$ 1.63 (-4.00-1.00)	-1.29 $\pm$ 1.40 (-4.00-1.00)	0.97 $\pm$ 1.01 (-1.00-2.00)	-0.38 $\pm$ 1.56 (-3.50-1.00)	-0.82 $\pm$ 1.29 (-3.00-1.00)	0.44 $\pm$ 1.14 (-2.00-3.00)
Median	0.00	-1.00	1.00	0.00	-1.00	0.00

No significant difference between variables ( $P < .05$ , Mann-Whitney  $U$  test).

**Table 5 Scar Formation and Scar Formation Changes Over Time in Patients Treated with Trapezoidal Incision**

	Mesial scar						Distal scar					
	1 mo after surgery		6 mo postloading		1 y postloading		1 mo after surgery		6 mo postloading		1 y postloading	
	n	%	n	%	n	%	n	%	n	%	n	%
<b>Trapezoidal</b>												
Total	20	100	20	100	20	100	20	100	20	100	20	100
No visible scar	0	0	2	10	10	50*	0	0	4	20	9	45*
Partially visible scar	2	10	16	80	9	45	3	15	13	65	9	45
Clearly visible scar	18	90	2	10	1	5	17	85	3	15	2	10

\*Indicates how the scar formation decreased significantly ( $P < .05$ , Mann-Whitney  $U$  test).

**Table 6 Scar Formation Changes by Dental Arch and Gingival Biotype**

	Mesial scar						Distal scar					
	1 mo after surgery		6 mo postloading		1 y postloading		1 mo after surgery		6 mo postloading		1 y postloading	
	n	%	n	%	n	%	n	%	n	%	n	%
<b>Mandible</b>												
Total	11	100	11	100	11	100	11	100	11	100	11	100
No visible scar	0	0	1	9.1	3	27.3*	0	0	3	27.3	5	45.5*
Partially visible scar	1	9.1	8	72.7	7	63.6	2	18.2	6	54.5	4	36.4
Clearly visible scar	10	90.9	2	18.2	1	9.1	9	81.8	2	18.2	2	18.2
<b>Maxilla</b>												
Total	9	100	9	100	9	100	9	100	9	100	9	100
No visible scar	0	0	1	11.1	7	77.8*	0	0	1	11.1	4	44.4*
Partially visible scar	1	11.1	8	88.9	2	22.2	1	11.1	7	77.8	5	55.6
Clearly visible scar	8	88.9	0	0	0	0	8	88.9	1	11.1	0	0
<b>Thin biotype</b>												
Total	11	100	11	100	11	100	11	100	11	100	11	100
No visible scar	0	0	1	9.1	5	45.5*	0	0	1	9.1	4	36.4*
Partially visible scar	1	9.1	8	81.8	5	45.5	1	9.1	9	81.8	6	54.5
Clearly visible scar	10	90.9	1	9.1	1	9.1	10	90.9	1	9.1	1	9.1
<b>Thick biotype</b>												
Total	9	100	9	100	9	100	9	100	9	100	9	100
No visible scar	0	0	1	11.1	5	55.6*	0	0	3	33.3	5	55.6*
Partially visible scar	1	11.1	7	77.8	4	44.4	2	22.2	4	44.4	3	33.3
Clearly visible scar	8	88.9	1	11.1	0	0	7	77.8	2	22.2	1	11.1

\*Indicates how the scar formation decreased significantly ( $P < .05$ , Mann-Whitney  $U$  test).

## DISCUSSION

The purpose of this prospective study was to compare changes in periodontal clinical parameters of teeth adjacent to interdental single implants, placed using two incision types: intrasulcular and trapezoidal. The results of the present investigation demonstrated that major soft tissue changes around teeth adjacent to single implants

take place between abutment connection and 1 year postloading. In a study about dimensional alterations of peri-implant tissues at single implants, Cardaropoli et al<sup>16</sup> observed most peri-implant soft tissue changes during the first 6 months after implant placement.

One of the parameters evaluated in this study was the papilla index. Better papilla scores were obtained with trapezoidal than with intrasulcular incision. Gomez-Roman<sup>17</sup>



**Table 7 Papilla Index by Treatment Group (Intrasulcular vs Trapezoidal Incision) and Changes Over Time**

	Mesial teeth						Distal teeth					
	Abutment connection		6 mo postloading		1 y postloading		Abutment connection		6 mo postloading		1 y postloading	
	N	%	N	%	N	%	N	%	N	%	N	%
<b>Intrasulcular</b>												
Total	20	100	20	100	20	100	20	100	20	100	20	100
Complete	0	0	4	20	6	30*	2	10	4	20	5	25*
> 50%	9	45	13	65	12	60	10	50	10	50	11	55
< 50%	10	50	2	10	1	5	6	30	3	15	2	10
No papilla	1	5	1	5	1	5	2	10	3	15	2	10
<b>Trapezoidal</b>												
Total	20	100	20	100	20	100	20	100	20	100	20	100
Complete	0	0	2	10	7	35*	0	0	1	5	4	20*
> 50%	10	50	13	65	12	60	4	20	12	60	10	50
< 50%	7	35	5	25	1	5	15	75	7	35	6	30
No papilla	3	15	0	0	0	0	1	5	0	0	0	0
<b>Total</b>												
Total	40	100	40	100	40	100	40	100	40	100	40	100
Complete	0	0	6	15	13	32.5*	2	5	5	12.5	9	22.5*
> 50%	19	47.5	26	65	24	60	14	35	22	55	21	52.5
< 50%	17	42.5	7	17.5	2	5	21	52.5	10	25	8	20
No papilla	4	10	1	2.5	1	2.5	3	7.5	3	7.5	2	5

\*Indicates how the papilla increased significantly ( $P < .05$ , Mann-Whitney  $U$  test).

pointed out that the intrasulcular incision denudes the interproximal bone adjacent to the teeth, which can affect the nutrition of the bone and produce a superficial resorption. This may be related to the possibility of obtaining better papilla filling in interdental single implants using the trapezoidal incision. Gastaldo et al<sup>23</sup> evaluated the interproximal area in two dimensions: mesiodistal (interimplant/tooth distance) and apicocoronal (base of the contact point to the bone crest) between tooth and implant. They concluded that a mesiodistal interproximal distance  $< 3$  mm determines the absence of an interproximal papilla. When the mesiodistal distance is 3 to 4 mm and the apicocoronal distance is 3 to 5 mm, the papilla is more frequently present. One of the inclusion criteria in the present study was implant placement without simultaneous bone regeneration. The diameter of the implant was chosen in the function of the mesiodistal and buccolingual/palatal distance. Implants of 3.75 or 4.25 mm were used.

Other authors<sup>14</sup> studied the influence of implant macrodesigns in the peri-implant soft tissue response, showing similar papilla filling with both implant designs. They did not obtain differences between anterior or posterior teeth and smoking habit. In the present study, neither smoking habit nor dental arch affected the periodontal parameters.

A higher mean recession value was observed with the trapezoidal than with the intrasulcular incision, not reaching statistical significance. The trapezoidal incision can severely impair the vascular supply, and scar formation

and gingiva shrinkage are possible complications.<sup>24</sup> In fact, Kleinheinz et al<sup>24</sup> performed a cadaveric study recommending intrasulcular incisions because they better respect the vascular supply than trapezoidal incisions. In this sense, Burkhardt et al<sup>25</sup> in a recent review recommended to avoid release incisions during periodontal surgery. In the present study, when the trapezoidal incision was made, the distance from the midcrestal incision to the adjacent tooth was approximately 1.5 to 2 mm. Fickl et al<sup>1</sup> compared tissue reduction following papilla-sparing and sulcular incisions in beagle dogs. They found soft tissue reduction with both incision techniques, but papilla-sparing induced less gingival reduction. These authors left a distance of 3 mm to the interproximal aspect of the tooth, but this is not clinically applicable in an interdental single implant, especially when the tooth to be replaced is a premolar.

There are not studies that assess the changes of the gingival margin at teeth adjacent to single implants. However, studies evaluating changes of periodontal parameters of teeth where a flap has been raised to perform periapical surgery can be used as a reference. Von Arx et al<sup>5</sup> found, after 1 year, a recession of 0.42 mm using intrasulcular incision and no recession (0.05-mm gain) with submarginal incision. These differences were statistically significant.

Regarding PD, the results of the present study were very similar comparing both incision types, and few changes over time were recorded. There are no studies evaluating modifications in PD in adjacent teeth after interdental

**Table 8 Papilla Index Changes by Dental Arch, Smoking Habits, and Gingival Biotype**

	Mesial teeth						Distal teeth					
	Abutment connection		6 mo postloading		1 y postloading		Abutment connection		6 mo postloading		1 y postloading	
	n	%	n	%	n	%	n	%	n	%	n	%
<b>Mandible</b>												
Total	23	100	23	100	23	100	23	100	23	100	23	100
Complete	0	0	5	21.7	6	26.1	2	8.7	3	13.0	5	21.7
> 50%	12	52.2	13	56.5	17	73.9	9	39.1	14	60.9	14	60.9
< 50%	10	43.5	5	21.7	0	0	11	47.8	5	21.7	3	13
No papilla	1	4.3	0	0	0	0*	1	4.3	1	4.3	1	4.3*
<b>Maxilla</b>												
Total	17	100	17	100	17	100	17	100	17	100	17	100
Complete	0	0	1	5.9	7	41.2	0	0	2	11.8	4	23.5
> 50%	7	41.2	13	76.5	7	41.2	5	29.4	8	47.1	7	41.2
< 50%	7	41.2	2	11.8	2	11.8	10	58.8	5	29.4	5	29.4
No papilla	3	17.6	1	5.9	1	5.9*	2	11.8	2	11.8	1	5.9*
<b>Nonsmoker</b>												
Total	31	100	31	100	31	100	31	100.0	31	100	31	100
Complete	0	0	2	6.5	11	35.5	0	0	2	6.5	11	35.5
> 50%	17	54.8	24	77.4	18	58.1	17	54.8	24	77.4	18	58.1
< 50%	11	35.5	5	16.1	2	6.5	11	35.5	5	16.1	2	6.5
No papilla	3	9.7	0	0	0	0*	3	9.7	0	0	0	0*
<b>Smoker</b>												
Total	9	100	9	100	9	100	9	100	9	100	9	100
Complete	0	0	4	44.4	2	22.2	0	0	4	44.4	2	22.2
> 50%	2	22.2	2	22.2	6	66.7	2	22.2	2	22.2	6	66.7
< 50%	6	66.7	2	22.2	0	0	6	66.7	2	22.2	0	0
No papilla	1	11.1	1	11.1	1	11.1*	1	11.1	1	11.1	1	11.1*
<b>Thin biotype</b>												
Total	23	100	23	100	23	100	23	100	23	100	23	100
Complete	0	0	4	17.4	8	34.8	0	0	4	17.4	8	34.8
> 50%	9	39.1	12	52.2	12	52.2	9	39.1	12	52.2	12	52.2
< 50%	11	47.8	6	26.1	2	8.7	11	47.8	6	26.1	2	8.7
No papilla	3	13.0	1	4.3	1	4.3*	3	13.0	1	4.3	1	4.3*
<b>Thick biotype</b>												
Total	17	100	17	100	17	100	17	100	17	100	17	100
Complete	0	0	2	11.8	5	29.4	0	0	2	11.8	5	29.4
> 50%	10	58.8	14	82.4	12	70.6	10	58.8	14	82.4	12	70.6
< 50%	6	35.3	1	5.9	0	0	6	35.3	1	5.9	0	0
No papilla	1	5.9	0	0	0	0*	1	5.9	0	0	0	0*

\*Indicates how the papilla increased significantly between variables ( $P < .05$ , Mann-Whitney  $U$  test).

implant placement. An increase from a mean of 2.4 to 3 mm between 1 and 3 years in nonsubmerged implants has been shown.<sup>26</sup> After implant placement with simultaneous guided bone regeneration, an increase in PD from 3.69 to 4.43 mm from 3 to 12 months postloading occurred.<sup>15</sup> In apical surgery, von Arx et al<sup>5</sup> assessed soft tissue changes after treatment. They compared three incision types, observing differences regarding the gingival margin position. One year after surgery, no significant differences in PD were found.

Kerner et al<sup>27</sup> pointed out that objective measurements in mucogingival surgery, such as the percentage

of root coverage, offer the advantage of reliability; however, esthetic evaluation (ie, scarring) is more difficult to assess. More explicit criteria are required to improve the reliability of scales for esthetic assessment. To the authors' knowledge, only Cairo et al<sup>28</sup> proposed a classification on scar formation in mucogingival surgery. They classified soft tissue texture as scar formation and/or keloid-like appearance (zero points) and absence of scar or keloid formation (one point). To the authors' knowledge, there is not peri-implant mucosa scar classification described in the literature, so they proposed a classification from more to less esthetic as: (0) no visible scar, (1) partially visible scar,

and (2) clearly visible scar. Significant reductions in scar formation were observed over time with the trapezoidal incision both in mesial and distal release incisions ( $P < .05$ , Wilcoxon signed-rank test). At the end of the follow-up, one of the mesial release incisions and two of the distal release incisions remained as “clearly visible scars.”

The findings of this study must be evaluated with caution because of some limitations. Variables such as the limited sample size, or the influence of suture-type material and the 4/0 to 5/0 suture, must be taken into account when generalizing these results. Another important factor is the different mesiodistal space in premolars and molars. At premolar implant sites, it is not possible to leave the recommended distance of 3 mm between the release incision and the interproximal soft tissue from the adjacent teeth.<sup>1</sup> Also, at this location, it is not possible to leave the recommended 3-mm implant-tooth distance.<sup>23</sup> The implant abutments used were platform-switching abutments, which allow shortened distances between the implant and tooth.<sup>29</sup> In the present study, a distance of at least 2 mm between the implant and tooth was always respected. However, the outcomes encourage further research to clarify the influence of the incision type in implant surgery on periodontal changes in adjacent teeth.

Within the limits of this study, data suggested that the incision type used to place a single interdental implant did not significantly influence the periodontal parameters of adjacent teeth. Both intrasulcular and trapezoidal incisions may be considered predictable options. Considering the whole sample, the values between implant placement and 1 year postloading showed significant differences in recession, scar formation, and papilla index over time.

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