

## Systematic Review Dental Implants

# Evaluation of the papilla level adjacent to implants placed in fresh, healing or healed sites: A systematic review

M. C. Goiato<sup>1</sup>, R. A. de Medeiros<sup>2</sup>,  
E. V. F. da Silva<sup>2</sup>, D. M. dos Santos<sup>1</sup>

<sup>1</sup>Aracatuba Dental School, São Paulo State University (UNESP), Department of Dental Materials and Prosthodontics, Aracatuba, São Paulo, Brazil; <sup>2</sup>Aracatuba Dental School, São Paulo State University (UNESP), Department of Dental Materials and Prosthodontics, Aracatuba, São Paulo, Brazil

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**Abstract.** A better understanding of factors that can lead to papilla formation or recession, such as the type of site where the implant was placed, is of fundamental importance to the aesthetic success of the rehabilitation. The aim of this study was to perform a systematic review of the literature regarding the formation or recession of papilla adjacent to implants placed in fresh, healing or healed sites. The protocol for this study was registered in the PROSPERO database (registration number CRD 42016033784). An electronic search was performed by two independent reviewers who applied the inclusion and exclusion criteria on the PubMed/MEDLINE, Scopus, and Embase databases from January 2005 up to February 2016. The initial screening yielded 1,065 articles, from which 15 were selected for a systematic review after applying the inclusion and exclusion criteria. Nine studies compared fresh and healed sites, four studies compared healing and healed sites, one study compared fresh and healing sites, and one study analysed all three sites. The majority of studies identified by this systematic review showed no difference between groups after the longer follow-up period. The sites where the implants were placed did not have a long-term influence on papilla formation or recession.

Key words: dental implants; dental papillae; single-tooth implants.

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Dental implants for treatment of partially edentulous patients present high success rates and are well documented in scientific literature. Initially, the focus of studies was directed to important points, such as evaluation of osseointegration and marginal bone loss, which are essential to the clinical longevity of these implants<sup>1,2</sup>.

In addition, currently, aesthetic treatment through implant-supported restorations is also considered important for the clinical success of rehabilitation<sup>3</sup>, increasing patient satisfaction<sup>4</sup>. In partially edentulous patients, this factor is even more crucial, since the clinician should achieve harmonization between the prosthesis and

the adjacent teeth, especially when the region in question is the anterior maxilla<sup>3</sup>. Therefore, the prosthesis must be manufactured respecting colour, shape, and texture of the tooth to be restored<sup>3</sup>. Another very important factor for an aesthetic result is the architecture of peri-implant soft tissue<sup>5</sup>, which includes the preservation or

creation of gingival papilla, avoiding the formation of “black spaces”<sup>3,4,6</sup>. Disparities in papilla level and fill are considered a parameter for the aesthetic result of prosthetic rehabilitation<sup>2</sup>.

Changes in concepts of the osseointegration protocol implemented by Brånemark are performed to reduce the period between tooth extraction and dental implant placement<sup>4</sup>, which is an impact factor on the aesthetic result<sup>7</sup>. Different therapies are successfully used for rehabilitation<sup>1</sup>, these being the placement of implants in fresh, healing, or healed sites. This classification can also be made based on changes observed in soft and hard tissues, according to a consensus conference held in 2004<sup>8</sup>: type 1 – implant placement immediately following tooth extraction; type 2 – complete covering of the socket with soft tissue (4–8 weeks); type 3 – substantial clinical and/or radiographic bone tissue of the socket (12–16 weeks); type 4 – healed site (>16 weeks)<sup>8</sup>. Since these treatments are associated with bone remodelling, the interproximal papilla may suffer alterations<sup>6</sup>.

A better understanding of factors that can lead to papilla formation or recession, such as the type of site where the implant was placed, is of fundamental importance to the aesthetic success of the rehabilitation<sup>9</sup>. Therefore, this study aimed to perform a systematic review of literature regarding the papilla formation or recession adjacent to implants placed in fresh, healing, or healed sites. The null hypothesis is that there is no difference in the papilla level between the implant installation sites.

## Materials and methods

This systematic review was conducted following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement<sup>10</sup>. The protocol for this study was registered in the PROSPERO (International Prospective Register of Systematic Review) database (registration number CRD 42016033784). Initially, the PICO population (P), intervention (I), comparison (C), and outcome(s) (O) question was defined: “In partially edentulous patients, the installation of implants in fresh, healing or healed sites influences the papillary level?”

## Search strategy

The articles were searched for by two independent reviewers (R.A.M. and E.V.F.S.) on the PubMed/MEDLINE, Scopus, and Embase databases from January 2005 up

to February 2016. Disagreements between them were discussed and, when unresolved, a third reviewer was consulted (M.C.G.). Only studies published in English and related to the evaluation of the papilla level adjacent to dental implants placed in fresh (immediate), healing, or healed sites were selected by inserting the keywords: “dental papillae (Mesh term) AND dental implant (Mesh term)” and “dental implant (Mesh term) AND soft tissue height (non-Mesh term). Initially, the titles and abstracts were read; and after applying the inclusion and exclusion criteria; the studies were accessed for full text reading and final selection. The Cohen kappa method was used to assess the agreement between reviewers in each search step.

## Inclusion and exclusion criteria

Inclusion criteria for selecting articles were

- studies written in English;
- studies that compared interproximal papilla in dental implants placed in fresh, healing or healed sites;
- randomized, prospective and retrospective studies.

Exclusion criteria were

- studies not written in English;
- duplicated studies
- animal studies
- in vitro studies;
- cadaver studies;
- case reports;
- interviews, comments, and questionnaire studies;
- literature or systematic reviews;
- studies reporting or evaluating surgical techniques;
- studies evaluating only one site of implant placement;
- studies evaluating gingival grafts;
- studies that did not report the type of implant placement site;
- studies with insufficient data for collection of results;
- studies comparing the different gingival biotypes in the soft tissue stability;
- studies assessing non-oral implants.

## Quality of studies

The quality of the selected studies was evaluated according to the Jadad scale<sup>11</sup>. In this method, the studies are scored from 0 to 5, according to the randomization, double-blind method, and descriptions of withdrawals. Studies scoring less than 2

were considered “low quality”, and between 3 and 5 were categorized as “high-quality” studies.

## Meta-analysis

The mean difference of the papillary distance of the mesial and distal papilla (in millimetres), the papilla index (JEMT score), and the PES (Pink Esthetic Score) between studies (continuous outcome) were performed. The calculation was performed with a 95% confidence interval using a computer program (Review Manager 5.0, Cochrane Collaboration). The calculation of the heterogeneity among the studies was performed by the  $I^2$  statistic. Fixed effects were used for all calculations except for Papilla index (random effects). Forest plots were generated for data analysis with  $P < 0.05$ .

## Results

The initial screening yielded 487 articles on PubMed/MEDLINE, 495 on Scopus, and 83 on the Embase databases. After the removal of duplicated articles (564 studies), and after reading titles and abstracts and applying the inclusion and exclusion criteria, 18 articles were obtained for full text reading ( $\kappa = 0.99$ ) (Fig. 1). The reasons for the exclusion of articles after reading titles and abstracts are shown in Table 1. After reading the full text, three articles were excluded, resulting in 14 articles for the systematic review ( $\kappa = 1.00$ ) (Fig. 1). The reasons for the exclusion of these three articles are shown in Table 2.

The studies were classified according to the Jadad scale, and only four studies had a score higher than 3, being considered high-quality studies (Table 3). Within this classification, no study was considered double blind, since the patient will always know when the implant is placed in fresh, healing, or healed sites, resulting in lower scores on the Jadad scale.

A total of 797 implants were placed, with 291 in fresh, 144 in healing, and 362 in healed sites. After the longer follow-up period of the studies, 633 implants remained, with 247 placed in fresh, 103 in healing, and 283 in healed sites (Table 4). Studies from Somanathan et al.<sup>15</sup> and Schropp and Isidor<sup>16</sup> did not describe the number of losses of implants and/or patients according to the sites evaluated after the follow-up period. The characteristics and survival rate of implants placed are detailed in Table 5.

These implants were restored with 247 metal-ceramic and 237 all-ceramic prosthesis. These data pertain to studies that

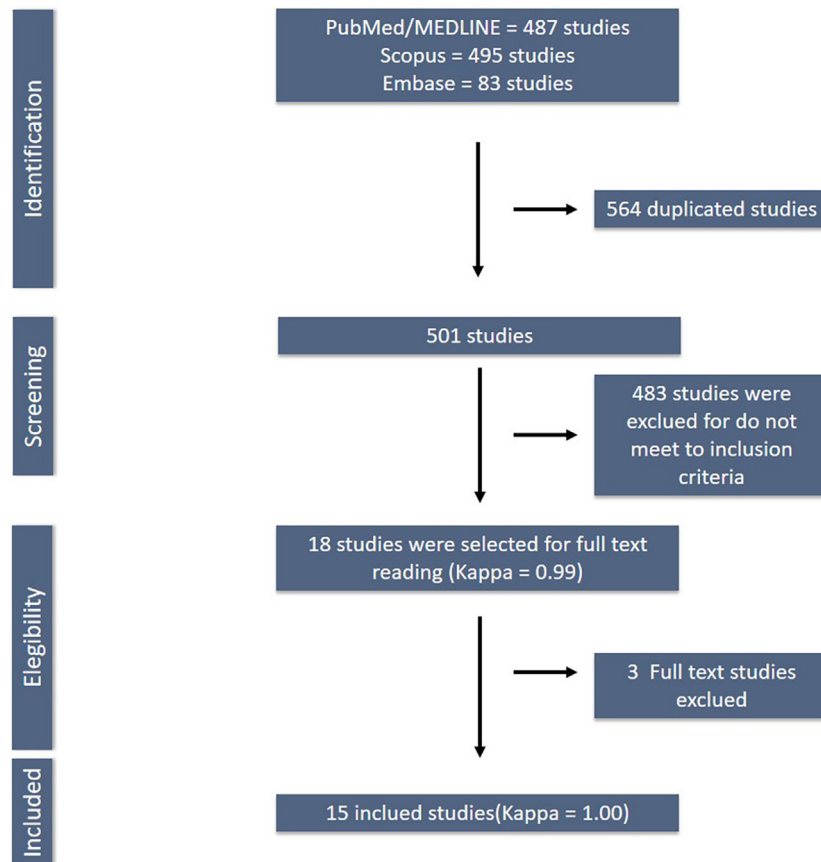


Fig. 1. Flow chart of the screening process.

defined the types of prosthesis used in the studies<sup>1,3-5,14,16-19</sup>. Huynh-Ba et al.<sup>20</sup>, Hof et al.<sup>6</sup>, Somathan et al.<sup>15</sup>, and Van Kesteren et al.<sup>21</sup> did not report the types of

prosthesis used in their studies. Cosyn et al.<sup>2</sup> and Kan et al.<sup>22</sup> used metal-ceramic and all-ceramic prosthesis. However, they did not show the separation between them.

Table 1. Reasons for the exclusion of articles after reading titles and abstracts.

Reasons for exclusion	Number of articles
Not related to the topic studied	155
Systematic review	9
Literature review	14
Case report	39
A language other than English (Chinese, Dutch, Polish, and Portuguese)	18
Evaluation of only one site of implant placement	34
Flap technique description	17
Cadaver studies	1
<i>In vitro</i> studies	2
Animal studies	3
Did not provide abstract	3
Comments	6
Total	301

Table 2. Reasons for the exclusion after full text reading.

Study	Reasons for exclusion
Di Alberti et al. 2012 <sup>12</sup>	Did not report data regarding gingival papilla
De Kok et al. 2006 <sup>13</sup>	Did not report the papilla index score of tested groups
Raes et al. 2011 <sup>7</sup>	Same data and follow-up period presented by Raes et al. 2013 <sup>14</sup>

The characteristics of the prosthesis used in the studies are described in Table 6.

Most studies compared fresh and healed sites<sup>1,5,14,15,17-19,21,22</sup>, four studies compared healing and healed sites<sup>2-4,16</sup>, one study evaluated fresh and healing sites<sup>20</sup>, and one study analysed all three sites<sup>6</sup>. Table 7 describes the periods between tooth extraction and implant placement considered in the studies and the time according to the classification of the 2004 consensus conference<sup>8</sup>. We note the difference between the two classifications, which shows that, despite the conference, the authors of the articles relate the classification according to their concepts.

The evaluation of mesial and distal papilla filling of these studies was performed by measuring the papilla formation or recession in millimetres (Table 8) using the papilla index score developed by Jemt<sup>23</sup> (Tables 9 and 10), or by the pink aesthetic score (PES) described by Belser et al.<sup>24</sup> (Table 11).

Hof et al.<sup>6</sup> found better values of the papilla index score for implants placed in fresh and healed sites than those placed in healing sites (Table 9).

In the study from Raes et al.<sup>14</sup>, complete filling of the papilla was observed in 60% of cases. However, the distal papilla of implants placed in fresh sites exhibited a 0.38-mm recession after 1 year of function (Table 8).

Somanathan et al.<sup>15</sup> and Kant et al.<sup>22</sup> found higher values of the papilla index score for implants placed in fresh sites than those placed in healed sites. However, Somanathan et al.<sup>15</sup> did not report if this difference was statistically significant and Kan et al.<sup>22</sup> did not exhibit statistical analysis.

Eleven studies showed no statistically significant difference between the groups tested after a longer follow-up period<sup>1-5,16-21</sup>. De Bruyn et al.<sup>5</sup> found differences between the groups evaluated (fresh and healed sites) when compared with the prosthesis placement period and after the 1-year follow-up, with greater recession values for the group with healed sites. After this period, there was no difference between groups. Schropp et al.<sup>3</sup> observed differences between the 1.5 year follow-up and baseline assessment for implants placed in healed sites, with an improvement over time.

Through meta-analysis, the only evaluated criterion with a significant difference was the papilla distal distance ( $P = 0.02$ ) (mean difference,  $-0.53$ ; 95% CI  $-0.96$  to  $-0.09$ ;  $P = 0.02$ ) being that greater papillary recession was found in fresh socket

Table 3. Quality assessment of the selected studies according to the Jadad scale.

	Author, year														
	Schroopp et al. 2015	Huynh-Ba et al. 2015	Cooper et al. 2015	Hof et al. 2014	Raes et al. 2013	Grandi et al. 2013	Cosyn et al. 2013	Bruyn et al. 2013	Cosyn et al. 2012	Van Kesteren et al. 2010	Schroopp et al. 2008	Palattella et al. 2008	Somanathan et al. 2007	Kan et al. 2007	Schroopp et al. 2005
Was the study described as randomized? (+1: yes or 0: no)	1	1	0	0	0	0	0	0	0	1	1	1	0	0	1
Randomization appropriate? (+1: yes or -1: no)	1	1	NA	NA	NA	NA	NA	NA	NA	1	0	1	NA	NA	0
Double-blind study? (+1: yes or 0: no)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Double-blind method appropriate? (+1: yes or -1: no)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Descriptions of drop outs? (+1: yes or 0: no)	1	1	1	0	1	1	1	1	1	1	0	1	0	1	1
Total	3	3	1	0	1	1	1	1	1	3	1	3	0	1	2

NA, not applicable.

Table 4. Mean age, number of initial and final sites (longer follow-up period), arch and region evaluated in the selected studies.

Author, year	Type of site	Mean age (years)	Number of initial sites	Number of final sites	Region in arch	Arch
Huynh Ba et al. 2015	Fresh socket	52.5	17	17	Posterior and anterior	Mandible and maxilla
	Healing sites	50.9	15	15	Posterior and anterior	Mandible and maxilla
Schroopp et al. 2015	Healing sites	44	24	13	Posterior and anterior	Mandible and maxilla
	Healed Sites	46	24	15	Posterior and anterior	Mandible and maxilla
Cooper et al. 2015	Fresh socket	45 ± 14	55	45	Posterior and anterior	Maxilla
	Healed site	42 ± 14	58	49	Posterior and anterior	Maxilla
Hof et al. 2014	Fresh socket	37 ± 17	Retrospective study	26	Posterior and anterior	Maxilla
	Healing site		Retrospective study	35	Posterior and anterior	Maxilla
	Healed site		Retrospective study	13	Posterior and anterior	Maxilla
Raes et al. 2013	Fresh socket	45 ± 14	16	15	Posterior and anterior	Maxilla
	Healed site	40 ± 19	23	23	Posterior and anterior	Maxilla
Grandi et al. 2013	Fresh socket	54.72 ± 11.74	25	23	Posterior and anterior	Maxilla
	Healed site	59.04 ± 11.33	25	24	Posterior and anterior	Maxilla
Cosyn et al. 2013	Fresh socket	51 ± 15	Retrospective study	44	Anterior	Maxilla
	Healed site	52 ± 13	Retrospective study	28	Anterior	Maxilla
Bruyn et al. 2013	Fresh socket	45 ± 14	55	46	Posterior and anterior	Maxilla
	Healed site	42 ± 15	58	51	Posterior and anterior	Maxilla
Cosyn et al. 2012	Healing site	52	22	21	Posterior and anterior	Maxilla
	Healed site		27	25	Posterior and anterior	Maxilla
Van Kesteren et al. 2010	Fresh socket	NR	14	13	Posterior and anterior	Mandibular and maxillar
	Healed site		14	13	Posterior and anterior	Mandibular and maxillar
Schroopp et al. 2008	Healing site	48 ± 20	23	NR	Posterior and anterior	Mandible and maxilla
	Healed site		22	NR	Posterior and anterior	Mandible and maxilla
Palattella et al. 2008	Fresh socket	35	9	9	Posterior and anterior	Maxilla
	Healed site		9	9	Posterior and anterior	Maxilla
Somanathan et al. 2007	Fresh socket	29 ± 15.5	21	NR	Posterior and anterior	Maxilla
	Healed site		22	NR	Posterior and anterior	Maxilla
Kan et al. 2007	Fresh socket	45.1	23	22	Posterior and anterior	Maxilla
	Healed site		15	13	Posterior and anterior	Maxilla
Schroopp et al. 2005	Healing site	49	24	19	Posterior and anterior	Mandible and maxilla
	Healed site		24	20	Posterior and anterior	Mandible and maxilla

NR, not reported.

Table 5. Data of implants used in studies and success rate.

Author, year	Type of site	Implant (manufacturer)	Diameter/length (mm)	Success rate
Huynh Ba et al. 2015	Fresh socket	Bone level implants (Straumann)	3.3 or 4.4/10–14	100%
	Healing site	Bone level implants (Straumann)	3.3 or 4.4/10–14	100%
Schroop et al. 2015	Healing site	Osseotite Parallel Walled (Biomet/3i)	NR	91.60%
	Healed site	Osseotite Parallel Walled (Biomet/3i)		95.45%
Cooper et al. 2015	Fresh socket	OsseoSpeed (Dentsply)	3.5–5.0/11–17	95%
	Healed site	OsseoSpeed (Dentsply)	3.5–5.0/11–17	98%
Hof et al. 2014	Fresh socket	Branemark MK-III and Nobel Replace (Nobel Biocare)	3.3–5.0/10–18	NR
	Healing site	Branemark MK-III and Nobel Replace (Nobel Biocare)	3.3–5.0/10–18	
	Healed site	Branemark MK-III and Nobel Replace (Nobel Biocare)	3.3–5.0/10–18	
Raes et al. 2013	Fresh socket	Astra Tech Osseospeed (Astra Tech)	4.0–5.0/13–17	94%
	Healed site	Astra Tech Osseospeed (Astra Tech)	3.5–4.5/11–17	100%
Grandi et al. 2013	Fresh socket	JDEvolution (JDentalCare)	3.7–5.0/11.5–15	100%
	Healed site	JDEvolution (JDentalCare)	3.7 or 4.3/11.5–15	100%
Cosyn et al. 2013	Fresh socket	NobelReplace tapered TiUnite (Nobel Biocare)	3.5–5.0/10–16	93%
	Healed site	NobelReplace tapered TiUnite (Nobel Biocare)	3.5–5.0/10–16	
Bruyn et al. 2013	Fresh socket	Osseospeed (Astra Tech)	3.5–5.0/11–19	94.50%
	Healed site	Osseospeed (Astra Tech)	3.5–5.0/11–19	98.30%
Cosyn et al. 2012	Healing site	NobelReplace tapered TiUnite (Nobel Biocare)	NR	95.45%
	Healed site	NobelReplace tapered TiUnite (Nobel Biocare)		92.59%
Van Kesteren et al. 2010	Fresh socket	SLA (Straumann)	NR	96.42%
	Healed site	SLA (Straumann)		100%
Schroop et al. 2008	Healing site	Osseotite Parallel Walled (Biomet/3i)	NR	91.66%
	Healed site	Osseotite Parallel Walled (Biomet/3i)		95.45%
	Healed site	Osseotite Parallel Walled (Biomet/3i)		
Palattella et al. 2008	Fresh socket	Straumann Dental Implant System	4.8/10 or 12	100%
	Healed site	Straumann Dental Implant System	4.8/10 or 12	100%
Somanathan et al. 2007	Fresh socket	NR	3.7–5.0/12–16	100%
	Healed site		3.7–5.0/12–16	100%
Kan et al. 2007	Fresh socket	TiUnite (Nobel Biocare)	3.5–5.0/13–16	100%
	Healed site	TiUnite (Nobel Biocare)	3.5–5.0/13–16	100%
Schroop et al. 2005	Healing site	Osseotite Parallel Walled (Biomet/3i)	NR	NR
	Healed site	Osseotite Parallel Walled (Biomet/3i)		

NR, not reported.

Table 6. Data of unit prosthesis and types of loading used in selected studies.

Author, year	Type of site	Type of definitive prosthesis	Type of retention of definitive prosthesis	Implant loading
Huynh Ba et al. 2015	Fresh socket	NR	NR	≈4.5 months
	Healing site	NR	NR	≈4.5 months
Schroop et al. 2015	Healing site	Metal ceramic crowns	Cemented and screwed	≈4 months
	Healed site	Metal ceramic crowns	Cemented and screwed	≈4 months
Cooper et al. 2015	Fresh socket	All-ceramic crown	Cemented	IR/WF
	Healed site	All-ceramic crown	Cemented	IR/WF
Hof et al. 2014	Fresh socket	NR	Cemented and screwed	IR/WF and SHP
	Healing site	NR	Cemented and screwed	IR/WF and SHP
	Healed site	NR	Cemented and screwed	IR/WF and SHP
Raes et al. 2013	Fresh socket	All-ceramic crown	Cemented	IR/WF
	Healed site	All-ceramic crown	Cemented	IR/WF
Grandi et al. 2013	Fresh socket	Metal ceramic crowns	Screwed	IR/WF
	Healed site	Metal ceramic crowns	Screwed	IR/WF
Cosyn et al. 2013	Fresh socket	Metal- and all-ceramic crown	Cemented	IR/WF
	Healed site	Metal- and all-ceramic crown	Cemented	3 months after surgery
Bruyn et al. 2013	Fresh socket	All-ceramic crown	Cemented	IR/WF
	Healed site	All-ceramic crown	Cemented	IR/WF
Cosyn et al. 2012	Healing site	Metal- and all-ceramic crown	Cemented	3 months after surgery
	Healed site	Metal- and all-ceramic crown	Cemented	3 months after surgery
Van Kesteren et al. 2010	Fresh socket	NR	NR	NR
	Healed site			
Schroop et al. 2008	Healing site	Metal ceramic crowns	Cemented and screwed	≈4 months
	Healed site	Metal ceramic crowns	Cemented and screwed	≈4 months
Palattella et al. 2008	Fresh socket	Metal- and all-ceramic crown	Cemented and screwed	IR/WF
	Healed site	Metal- and all-ceramic crown	Cemented and screwed	IR/WF
Somanathan et al. 2007	Fresh socket	NR	NR	14 days after surgery
	Healed site	NR	NR	14 days after surgery
Kan et al. 2007	Fresh socket	Metal- and all-ceramic crown	Cemented and screwed	IR/WF
	Healed site	Metal- and all-ceramic crown	Cemented and screwed	IR/WF
Schroop et al. 2005	Healing site	Metal ceramic crowns	NR	≈4 months
	Healed site	Metal ceramic crowns	NR	≈4 months

NR, not reported; IR/WF, immediately restored/without function; SHP, submerged healing protocol.

Table 7. Description of installation time of implants after tooth extraction and classification according to the consensus conference<sup>8</sup>.

Author, year	Type of site	Installation time of implants after tooth extraction		Classification according to the consensus conference
Schroop et al. 2015	Fresh socket	10 days		Type 2
	Healing site	3 months		Type 3
Huynh Ba et al. 2015	Healing site	Immediate		Type 1
	Healed site	4–8 weeks		Type 2
Cooper et al. 2014	Fresh socket	Immediate		Type 1
	Healed site	NR		NR
Hof et al. 2014	Fresh socket	Immediate		Type 1
	Healing site	6–8 weeks		Type 2
	Healed site	6 months		Type 4
Raes et al. 2013	Fresh socket	Immediate		Type 1
	Healed site	>3 months		Type 3 or 4
Grandi et al. 2013	Fresh socket	Immediate		Type 1
	Healed site	4 months		Type 3
Cosyn et al. 2013	Fresh socket	Immediate		Type 1
	Healed site	>6 weeks		Type 2, 3, or 4
Bruyn et al. 2013	Fresh socket	Immediate		Type 1
	Healed site	NR		NR
Cosyn et al. 2012	Healing site	6–8 weeks		Type 2
	Healed site	>6 months		Type 4
Van Kesteren et al. 2010	Fresh socket	Immediate		Type 1
	Healed site	3 months		Type 3
Raes et al. 2013	Healing site	Immediate		Type 1
	Healed site	>3 months		Type 3 or 4
Schroop et al. 2008	Fresh socket	10 days		Type 2
	Healed site	3 months		Type 3
Palattella et al. 2008	Fresh socket	Immediate		Type 1
	Healed site	8 weeks later		Type 2
Somanathan et al. 2007	Fresh socket	Immediate		Type 1
	Healed site	NR		NR
Kan et al. 2007	Healing site	Immediate		Type 1
	Healed site	NR		NR
Schroop et al. 2005	Healing site	10 days		Type 2
	Healed site	3 months		Type 3

Table 8. Studies that measure the papilla formation or recession in millimetres.

Author, year	Type of site	Measurement of the papilla distance (longer follow-up period) (in mm)		Longer follow-up period
		Mesial papilla	Distal papilla	
Huynh Ba et al. 2015	Fresh socket	1.03 ± 0.20	0.84 ± 0.23	3 months
	Healing site	0.47 ± 0.31	1.29 ± 0.30	3 months
Cooper et al. 2014	Fresh socket	-0.13 ± 1.61	-0.21 ± 1.61	60 months
	Healed site	0.39 ± 1.52	0.50 ± 1.35	60 months
Raes et al. 2013	Fresh socket	0.07 ± 0.99	0.38 ± 1.21	12 months
	Healed site	0.30 ± 1.38	0.60 ± 0.87	12 months
De Bruyn et al. 2013	Fresh socket	0.29 ± 1.08		36 months
	Healed site	0.53 ± 1.07		36 months
Van Kesteren et al. 2010*	Fresh socket	1.73 ± 0.71	1.48 ± 0.8	6 months
	Healed site			6 months

\*Van Kesteren et al. 2010 does not differentiate the values between the groups tested, showed only that there was no statistically significant difference between implants placed in fresh and healed sites.

when compared with the healed site (Fig. 2). The papilla mesial distance, papilla index, and PES did not demonstrate a significant difference (Figs. 3–5).

## Discussion

The null hypothesis of the study was accepted as most of the selected studies found no statistically significant differ-

ence between the evaluated sites; it is important to consider other factors that influence the papillary level.

Initially, it is important to point out the advantages and disadvantages of implant placement in each studied site. Immediate placements of implants decrease the number of surgical interventions and reduce the treatment duration<sup>20</sup>; however, the implant primary stability can be difficult<sup>8</sup>.

Healing sites usually already have the resolution of any possible infection or pathology, as well as an improvement in the soft tissue quality<sup>8</sup>. The disadvantages also include the difficulty to achieve primary stability and anchorage of the implant, and variations in the socket walls because of the bone resorption process<sup>8</sup>. Healed sites offer great conditions for hard and soft tissues. However, the resorption

Table 9. Mean values of longer follow-up periods of studies that evaluated the papilla through the Papilla Index score, described by Jemt<sup>21</sup>.

Author, year	Type of site	Mean values of papilla index (score JEMT)	Longer follow-up period
Schroop et al. 2015	Healing site	2	120 months
	Healed site	1	120 months
Hof et al. 2014	Fresh socket	2.0 ± 0.7	56 months
	Healing site	1.7 ± 0.8	54 months
Grandi et al. 2013	Healed site	2.5 ± 0.5	58 months
	Fresh socket	2.82	12 months
Schroop et al. 2008	Healed site	2.62	12 months
	Healing site	NR	60 months
Palattella et al. 2008	Healed site	NR	60 months
	Fresh socket	2.22	24 months
Somanathan et al. 2007	Healed site	2.38	24 months
	Fresh socket	2.6 (Mesial papilla) and 2.7 (distal papilla)	NR
Kan et al. 2007	Healed site	2.4 (Mesial papilla) and 2.3 (distal papilla)	NR
	Fresh socket	2.7 ± 0.5	12 months
Schroop et al. 2005	Healed site	2.4 ± 0.6	12 months
	Healing site	NR	18 months
	Healed site	NR	18 months

NR, not reported.

Table 10. Values of each score of longer follow-up periods of studies that evaluated the papilla through the Papilla Index, described by Jemt<sup>21</sup>.

Author, year	Type of site	Papilla index (score JEMT)				
		0	1	2	3	4
Schroop et al. 2015	Healing site	11.50%	11.50%	38.50%	38.50%	NA
	Healed site	13.30%	13.30%	46.70%	26.70%	NA
Hof et al. 2014	Fresh socket	23%		77%		NA
	Healing site	54%		46%		NA
Grandi et al. 2013	Healed site	8%		92%		NA
	Fresh socket	0%	0%	17.39%	37.50%	0%
Schroop et al. 2008	Healed site	0%	0%	82.61%	62.50%	0%
	Healing site	≈5%	≈12%	≈45%	≈38%	NA
Palattella et al. 2008	Healed site	≈9%	≈12%	≈33%	≈46%	NA
	Fresh socket	0%	16.66%	44.44%	38.89%	0%
Somanathan et al. 2007	Healed site	0%	11.11%	38.89%	50%	0%
	Fresh socket	NR	NR	NR	NR	N
Kan et al. 2007	Healed site	NR	NR	NR	NR	N
	Fresh socket	0%	2.27%	25%	72.73%	0%
Schroop et al. 2005	Healed site	0%	7.70%	46.15%	46.15%	0%
	Healing site	8%	NR	57%	NR	NR
	Healed site	3%	NR	63%	NR	NR

NR, not reported; NA, not assessed.

Table 11. Mean values of longer follow-up periods of studies that evaluated the papilla through the pink esthetic score (PES), described by Belser et al.<sup>22</sup>.

Author, year	Type of site	PES	Longer follow-up period
Huynh Ba et al. 2015	Fresh socket	6.96 ± 0.36	3 months
	Healing site	6.07 ± 0.38	3 months
Hof et al. 2014	Fresh socket	10.7 ± 2.4	56 months
	Healing site	10.4 ± 2.2	54 months
Raes et al. 2013	Healed site	11.2 ± 2.0	58 months
	Fresh socket	10.33 ± 2.29	12 months
Cosyn et al. 2013	Healed site	10.35 ± 1.58	12 months
	Fresh socket	10.88 ± 2.41	33 ± 8 months
Cosyn et al. 2012	Healed site	10.07 ± 1.96	30 ± 8 months
	Healing site	9.9 ± 1.92	30 ± 9 months
	Healed site	10.4 ± 2.16	31 ± 8 months

caused after tooth extraction can influence the results of this type of treatment<sup>6</sup>. Additionally, the larger number of procedures may increase the risk of incomplete formation of the papilla, resulting in grooves and depressions of the soft tissue<sup>25</sup>.

The majority of studies identified by this systematic review showed no difference between groups after the longer follow-up period. In addition, only one study evaluated the interproximal papilla comparing fresh, healing, and healed sites<sup>6</sup>. In this study, implants placed in healing sites exhibited the worst results and those placed in healed sites showed the best results. However, the authors did not discuss the results for healing sites, showing only that results for the healed sites should be viewed with caution due to the smaller number of implants placed in this condition.

After one year of follow-up, Raes et al.<sup>14</sup> found a higher value of distal papilla recession for implants placed in fresh sites. In the same period, De Bruyn et al.<sup>5</sup> also observed differences between the groups. However, after this follow-up period, the values of groups were similar. It is believed that this difference between the results may be due to many factors that influence the papilla formation or recession, such as gingival biotype, age of patients, depth and angulation of implants, initial condition of the gingival papilla, marginal bone loss, loss of contact area between the prosthesis and the adjacent tooth, and quality of oral hygiene.

Although the results of the meta-analysis showed higher values of recession in the distal papilla in implants installed in fresh socketed, we believe in the reading of all the articles and their results that after a longer period of follow-up there is no difference between the groups evaluated.

Thus, papilla loss is a multifactorial process<sup>2,18</sup>; according to the results after 1 year of implant placement found in the selected articles, there is no difference in the evaluation of interproximal papilla of implants placed in fresh, healing, or healed sites.

Therefore, other factors that influence papilla formation or recession must be considered. Among them, the initial condition of the patient has great influence on the course of treatment. In patients who had lost teeth due to periodontal disease, the bone crest was probably affected, making them a high-risk group for papilla loss<sup>2,18,26</sup>.

The peri-implant papilla volume is related to the level of marginal bone loss between the dental implant<sup>6</sup> and adjacent

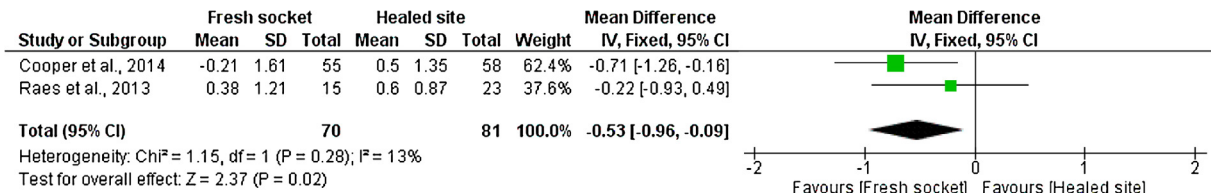


Fig. 2. Forest plot for the “fresh socket” in the comparison between “healed site” for distal papilla distance (in millimetres).

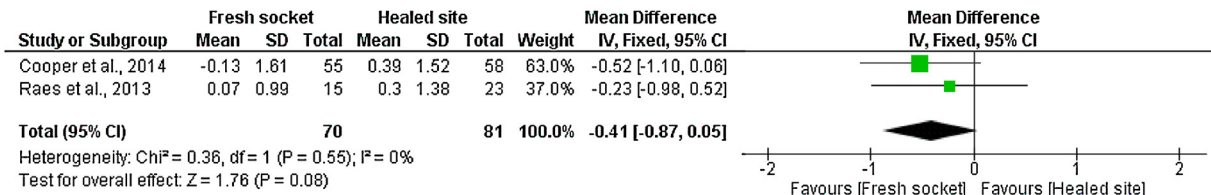


Fig. 3. Forest plot for the “fresh socket” in the comparison between “healed site” for mesial papilla distance (in millimetres).

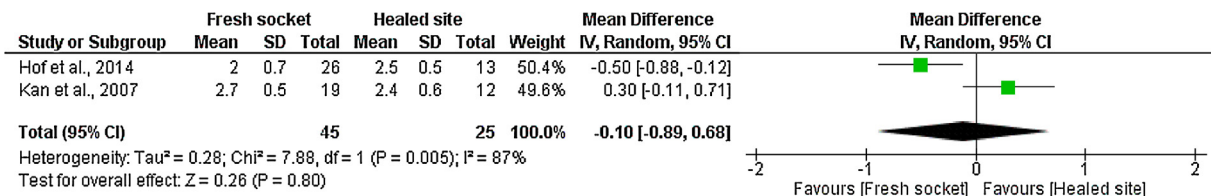


Fig. 4. Forest plot for the “fresh socket” in the comparison between “healed site” for papilla index.

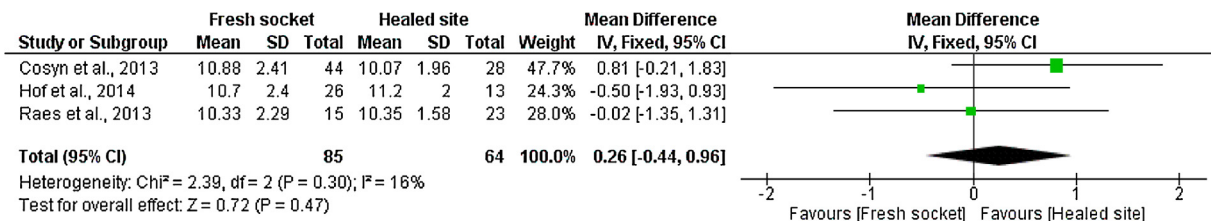


Fig. 5. Forest plot for the “fresh socket” in the comparison between “healed site” for PES.

tooth<sup>4</sup>. When the distance between the bone level and the cemento-enamel junction of the adjacent tooth to the implant is lower than 1.5 mm, there are more chances of complete formation of interproximal papilla<sup>25</sup>. Furthermore, the presence of peri-implant buccal bone defects at second surgical stage in healing and healed sites has a negative impact on soft tissue levels<sup>4</sup>.

Additionally, it is important to consider the age of patients<sup>3</sup>. Papilla formation in patients younger than 50 years showed better values after 1.5 years of follow-up than patients older than 50 years<sup>3,4</sup>.

Another relevant factor is the prosthesis fabrication retaining the contact area with the adjacent tooth, and with an adequate emergency profile<sup>27</sup>. The ideal distance between this contact area and the bone crest is 3 mm, with a fill of 80%<sup>28</sup> to 100%<sup>29</sup> of the interproximal papilla levels.

Regarding the gingival biotype, patients with thick gingiva tend to have better results concerning papilla formation or recession than thin gingiva<sup>6,18,30</sup>. However, some authors found no association between papilla loss and gingival biotype<sup>14,31</sup>.

All implants installed in the selected articles were single units. However, the formation of papilla between adjacent implants is also a factor that must be considered. The factors that determine the absence or presence of interproximal papilla between implants are not well understood. Some studies indicate that when the distance between implants is lower than 3 mm, there is an increase in crestal bone resorption, which can favour papilla loss<sup>27-29</sup>.

In conclusion, the sites where the implants were placed did not have a long-term influence on papilla formation

or recession. It is more important to consider other factors, such as age, initial condition of the patient, distance between the implant and the adjacent tooth, among others.

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## Address:

Marcelo Coelho Goiato  
 Aracatuba Dental School (UNESP)  
 Department of Dental Materials and Prosthodontics  
 José Bonifácio  
 1193  
 Vila Mendonça – CEP 16015-050 Aracatuba  
 Sao Paulo  
 Brazil  
 E-mail: goiato@foa.unesp.br