# The Effect of One-Abutment at One-Time on Marginal Bone Loss Around Implants Placed in Healed Bone: A Systematic Review of Human Studies

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***Objectives:*** *The primary aim of the present article was to review the effect and the clinical significance of abutment dis- and reconnection on the peri-implant marginal bone levels.*

***Materials and methods:*** *English articles published from 2009 to April 2019 were identified on the MEDLINE, Cochrane Library, and PubMed databases, according to the PRISMA guidelines. Comparative in vivo studies on humans were included.*

***Results:*** *A total of 4 studies with different levels of bias were included in this review. A significant heterogeneity of the reported data was observed, which limited the comparison of the findings. The only parameter that was homogenous throughout all 4 studies was the marginal bone level measurement.*

***Conclusion:*** *Within the limitations of the present review, it can be suggested that minimizing the number of abutment dis- and reconnections would be beneficial to ensure minimal disruption to the peri-implant tissue and marginal bone level. However, the clinical significance of the marginal bone level changes is still inconclusive. (Implant Dent 2019;00:1–10)*

***Key Words: bone level, crestal bone resorption, implant–abutment connection, peri-implant tissue***

The clinical success of a dental implant is now one of the most commonly studied areas of modern dentistry. Survival rates have been shown to be very predictable with cumulative survival rates of up to 90% over 10 years.[1] Although such high success rates exist, the long-term success is dependent on the integrity of the peri-implant soft and hard tissues. Several implant modifications and protocols have been discussed throughout the literature in the attempts to preserve marginal bone and soft tissue levels and improve the osseointegration process. These include implant surface treatments such as sand blasting, grit blasting, acid etching, laser ablation,[2] platform-switching concepts,[3] and various surgical guidelines.[4] These advancements have improved biological processes at the time of implant placement. However, after achieving osseointegration, the standard prosthetic restorative procedure still involves numerous componentry that require dis- and reconnection to complete the final restoration.

The stability and function of a load-carrying implant is dependent on a well-functioning transmucosal barrier. This barrier comprises of a 2-mm long junctional epithelium and 1 mm of connective tissue, which serves to protect the zone of osseointegration from factors released by plaque and the oral cavity.[5] Abrahamsson et al[6] demonstrated that after 5 abutment dis- and reconnections, the mucosal barrier was compromised and resulted in its apical migration. This led to a re-establishment of the mucosal barrier with subsequent epithelial proliferation and bone resorption.

The "one abutment–one time"[7] protocol was introduced to eliminate the potential for disturbances to the peri-implant mucosal barrier. This protocol involves placement of the final or definitive abutment (DA) at the time of implant placement, as opposed to

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placing a cover screw or healing abutment, therefore overcoming the need to repeatedly change the prosthetic components after delivery of the final prosthesis.

Despite the one abutment–one time protocol, there is still limited evidence regarding the response of the peri-implant soft and hard tissue after repeated abutment changes. A subsequent animal study by Abrahamsson et al[8] showed that after 1 or 2 abutment dis/reconnections, no significant changes in the marginal bone level or other soft tissue parameters occurred. Another animal study by Becker et al[9] subjected platform-switched implant abutments to 2 repeated dis/reconnections at 4 and 6 weeks compared with no dis/reconnections and concluded that repeated abutment manipulation caused a disruption with the mucosal seal and may be associated with dimensional changes of the peri-implant soft and hard tissues formed around Ti and ZrO.

A prospective randomized clinical trial with up to 15 years of follow-up by Romanos et al[10] concluded that the factors affecting crestal bone maintenance might be associated with platform switching when the abutments are not removed and when the restorations are fabricated with abutment impression copings directly over the abutments.

These clinical studies all provide limited data, and although there are documented macro- and microscopic changes, the clinical relevance of the results provided by these studies require further analysis. Thus, the purpose of this article was to review the current literature and determine the effect and the clinical significance of abutment dis- and reconnection on the peri-implant marginal bone levels.

## MATERIALS AND METHODS

### Search Strategy

PRISMA guidelines for systematic review/meta-analyses have been adopted.[11] A preliminary electronic search for scientific articles was performed on multiple databases. MEDLINE, Cochrane Library, and PubMed databases were identified as source of scientific articles.

The search was conducted using the combination of the following keywords:

1. implant [All Fields] AND abutment [All Fields] AND reconnection [All Fields] AND disconnection [All Fields]
2. effect [All Fields] AND implant [All Fields] AND abutment [All Fields] AND disconnection [All Fields]
3. effect [All Fields] AND implant [All Fields] AND abutment [All Fields] AND reconnection [All Fields]
4. implant [All Fields] AND abutment [All Fields] AND disconnection [All Fields]
5. implant [All Fields] AND abutment [All Fields] AND reconnection [All Fields]

The search was restricted to the following inclusion criteria:

1. Studies with data on peri-implant marginal bone level changes after disconnection and reconnection of abutment;
2. Studies on humans;
3. Studies in English;
4. Comparative in vivo studies on humans;
5. No specification to implant type;
6. Implants placed with a delayed approach (in healed sites);
7. Studies published within the 10 years (2009–2019).

Exclusion criteria were the following:

1. Studies involving placement of post-extractive/immediate or immediate-delayed implants;
2. Studies involving laboratory simulation or nonhuman subjects;
3. Languages other than English;
4. Studies where bone augmentation was used at the time of implant placement;
5. Studies concerning treatment of patients with pathological conditions possibly affecting the success rate of implant placement;
6. Studies, which did not disclose all relevant data.

After an electronic search using specific search terms as mentioned previously, a further manual search was performed, limited to the main scientific journals on Prosthodontic and Implant Dentistry, (*Clinical Oral Implants Research, The International Journal of Oral & Maxillofacial Implants, The International Journal of Prosthodontics, Journal of Prosthetic Dentistry, Clinical Implant Dentistry and Related Research, International Journal of Periodontics and Restorative Dentistry, Journal of Periodontology, European Journal of Prosthodontics and Restorative Dentistry, Journal of Oral Maxillofacial Surgery, Journal of Oral Surgery, Journal of Clinical Periodontology, Clinical Oral Investigations, European Journal of Oral Implantology, and Implant Dentistry*) covering the period of 2009 to 2019. Reference lists of the identified studies were searched for further citations. The date of the last search was April 2019.

### PICO Focus Question

Does the disconnection and reconnection of implant abutments affect the peri-implant marginal bone levels around implants placed in healed sites (type IV)?

### PICO Criteria

*Participants.* Participants of any age receiving implants in healed sites.

*Intervention.* Placement of dental implants with or without abutment disconnection and reconnection.

*Comparison.* The comparison included the marginal bone levels of implants given a provisional abutment (PA) at the time of implant placement and restored successfully thereafter requiring abutment disconnection and reconnection versus implants restored with a DA (one-abutment) at the time of implant placement with no disconnection and reconnection.

*Outcome.* Marginal bone level changes (mm).

### Study Selection, Eligibility, and Data Collection Process

First, the inclusion selection process was performed by screening of the abstracts of the articles by 3 reviewers

(V.P., D.Z., and A.Q.). The full text of all relevant studies was obtained, and eligibility assessment and data extraction were independently performed in an unblinded and standardized manner by the 3 authors. Extracted data included eligibility criteria, baseline characteristics, interventions, outcomes, and methodological quality. All the included studies were then read in full text and carefully evaluated.

The following information and clinical outcomes were extracted from each randomized control trial: (1) type of study design, (2) location of the study, (3) number of patients and implants, (4) mean age, (5) methods of assessment, (6) implant placement protocol, (7) implant location, (8) implant diameter and length, (9) final prosthesis connection, (10) platform switching, (11) number of implant disconnections, (12) postoperative care protocol, and (13) marginal bone level changes.

### Quality Assessment

Assessment of methodological study quality was performed using the criteria proposed by The Cochrane Handbook for Systematic Reviews of Interventions.[12] The proposed domains for the assessment include (1) sequence generation, (2) allocation concealment, (3) blinding of participants, personnel, and outcome assessors, (4) incomplete outcome data, (5) selective outcome reporting, and (6) other sources of bias. In all domains, an answer of Yes (+), No (−) or Unclear (?) was determined through certain criteria outlined in the handbook. An answer of Yes indicates low risk of bias, and an answer of No indicates a high risk of bias.

## RESULTS

### Study Selection and Eligibility

The search resulted in 75 scientific articles published in the MEDLINE and Cochrane Oral Health Group databases. Forty-four were excluded as duplicates;

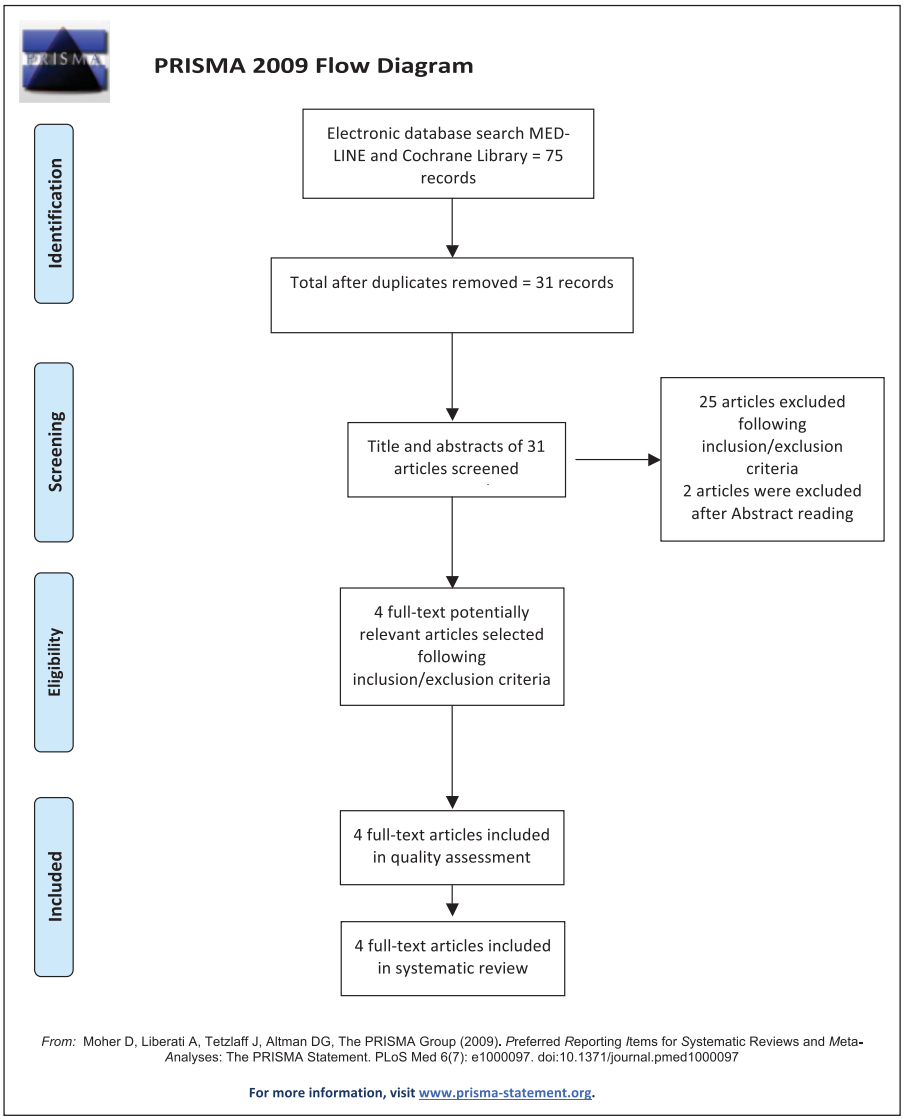


**Fig. 1.** Flow-chart of the review process and search strategy according to the PRISMA statement.[11] After removing duplicates, a total of 50 articles had been evaluated; 43 articles have been excluded after title and abstract reading and 4 additional studies after full-text examination. A total of 4 articles had been included in the present systematic review.

25 of the remaining 31[13–44] were excluded again because they did not respond to inclusion criteria (#4 on animals; #14 in vitro; #2 review, # 1 case report; #2 immediate implant, and #2 different topics) (Table 1). Upon evaluation of abstracts, 2 more articles were excluded; therefore, 4 articles potentially fulfilled the inclusion criteria and were considered eligible for full-text analysis (Fig. 1).[28,35,39,42] Additional manual searches of appropriate scientific databases yielded no extra scientific articles that met with the inclusion criteria of this article.

#### Characteristics of Included Studies

The publications meeting the inclusion criteria were 3 randomized controlled clinical trials and one case control study.

*Participants.* The included studies involved a total of 93 patients.

*Intervention.* A total of 157 implants were placed. Two studies[35,39] placed a total of 29 maxillary and 31 mandibular implants, whereas 2 other studies[28,42] provided no clear data about the number of implants placed in the maxilla or mandible. One study[35] placed implants only in the molar and premolar regions, and data for the number of implants placed in the anterior area or posterior area was not provided by the other 3 studies.[28,39,42]

Data from each article were analyzed, and information about the type of the study design, location, number of patients and implants, mean age, methods of assessment, implant placement protocol, implant location, diameter and length, final prosthesis connection, and platform switched was displayed in (Table 2).

*Outcomes.* In the present review, the changes in marginal bone level loss from baseline to 6 months were 0.0647[28], –0.605[39], 0.13[35] mm for the DA groups, and 0.357[28], –1.235[39], and –0.28[35] mm for the PA groups. Data extending up to 12 months provided by 2 of the studies[28,39] showed changes in marginal bone levels of 0.091[28] and –0.603[39] mm for the DA groups and 0.433[28] and –1.279[39] mm for the PA groups. In 1 study,[42] data were not clearly reported, although it was stated that no significant differences were found between the 2 groups (Table 3).

The length of the follow-up regarding the articles ranged from 2 weeks to 12 months with very highly variable mean values.

*Quality assessment.* With the exception of 1 aticle,[42] the risk of bias was considered low for all 3 studies[28,35,39] included in this review (Table 4).

#### Results of Individual Studies

The comparison of the findings of the selected studies is limited because of the heterogeneity of the data. Follow-up times were not equal in all the included studies, and lack of consistent methodology used for data collection and analysis was evident. The only parameter that was homogenous throughout all 4 studies was data reported on marginal bone levels. Therefore, it was decided to report the methodology of each study and the specific data collection technique used. The articles are reported in a chronological order.

**Table 1.** The Present Table Describes the Studies Excluded at the Abstract Evaluation; Specifically, the Type of Study and the Reason for the Exclusion Have Been Reported

| Reference | Type of Study | Reason for Exclusion |
|---|---|---|
| Esposito et al[36] | Randomized controlled clinical trial | Implant placement timing: Immediate implants were not included in the present review |
| Luongo et al[43] | Randomized controlled clinical trial | Implant placement timing: Immediate implants were not included in the present review |
| Bressan et al[22] | Randomized controlled clinical trial | Implant placement timing: Immediate implants were not included in the present review |
| Kuppusamy et al[42] | Randomized controlled clinical trial | Type of data: Unable to quantify the results described in this study. |

*Grandi et al, 2012.* This study consisted of a prospective multicenter randomized controlled trial conducted in Italy.[28] A total of 28 patients with partial edentulism were selected for a 2-implant–supported immediate restoration and randomized equally into PA and DA groups. The follow-up was performed at 6- and 12-month intervals. There were no implant failures at any point during the 12-month period. All 56 implants were inserted in healed sites by 3 experienced operators in 3 private dental offices.

Preoperative analysis of anatomical features was performed using CT scans.

Two tapered self-tapping implants were inserted in each patient at a crestal level in the healed edentulous ridge using a flapless technique, with an insertion torque of at least 45 Ncm.

In the DA group, platform-switched definitive titanium abutments were placed immediately after implant placement. In the PA group, implants were immediately restored using platform-switched provisional standard abutments. The definitive prosthesis was delivered 3 months after surgery.

For placement of the final prosthesis, the PA group underwent the standard prosthetic protocol. The PAs were removed, and the impressions were made with a customized tray using standard long-pin components directly on the implant platform. Abutments were also removed 3 more times at the metal framework, bisque try in and at the delivery of the final restoration. For the DA group, a conventional impression of the DA was made using a retraction cord, and the final restorations were seated avoiding abutment disconnection. For both groups, definitive restorations were cemented in full occlusal contact.

Patients were recalled at 6- and 12-month intervals after surgery to assess implant survival and bone level changes proximal to the implants measured on periapical radiographs. The prostheses were not removed at any recall interval.

**Table 2.** The Present Table Summarizes the Type of Studies, Characteristics of Participants (Age, Number of Patients, and Number of Implants per Patients), Implant Features (Location, Diameter, Length, Implant System, and Protocol of Loading), and Methods of Assessment of the Studies Included in the Present Review

| | Grandi et al[28] | Molina et al[39] | Koutouzis et al[35] | Kuppusamay et al[42] |
|---|---|---|---|---|
| Study design | RCT parallel group | RCT parallel group | RCT parallel group | Case–control parallel group |
| Location | Multicenter, private practices, Italy | Post grad perio Clinic, University complutense of Madrid | University of Florida USA | Denatl implant clinic. University of Tokyo, Japan |
| Number (patients/ implants) | 28/56 | 39/60 | 16/21 | 10/20 |
| DA | 14/28 | 18/29 | 8/10 | 5/10 |
| PA | 14/28 | 21/31 | 8/11 | 5/10 |
| Number evaluated in study (patients/ implants) | 28/56 | 35/55 | 16/21 | 10/20 |
| DA | 14/28 | 16/26 | 8/10 | 5/10 |
| PA | 14/28 | 19/29 | 8/11 | 5/10 |
| Age (y) | | | | |
| DA | 53.2 ± 5.3 | 52.61 ± 10.93 | 59.1 ± 12.6 | 60 ± 12.0 |
| PA | 50.3 ± 5.3 | 51.62 ± 8.65 | 54.2 ± 13.6 | 60 ± 12.0 |
| Methods of assessment | PA Rx/perio probe | PA Rx/perio probe | PA Rx/perio probe | |
| Implant placement protocol | Delayed | Delayed | Delayed | Delayed |
| Implant location | Anterior and posterior max and mand | Posterior max and mand | Anterior max and mand | Anterior and posterior max and mand |
| Implant system | Tapered self-tapping implants (JDEvolution, Jdental care, Modena Italy) | Camlong conelog screwline implant | Bone level, straumann | Nobel Biocare Mark III, IV Nobel Biocare speedy |
| Implant diameter (mm) | 3.7, 4.3, 5 | 3.8, 4.3 | 4.1, 4.8 | NR |
| Implant length (mm) | 14, 17 | 9, 11, 13 | 8, 10 | NR |
| Type of restoration | Cemented-retained | Screw-retained | Cemented-retained | Screw-retained |
| Platform switched | Yes | Yes | Yes | No |
| Additional measurements and outcomes | Clinical parameters (PD, modified plaque score and bleeding index, and keratinized mucosa. | NIL | Clinical parameters (PD, height and width of peri-implant mucosa, bleeding on probing, and presence of visible plaque) and a series of soft tissue parameters. Patient-reported outcomes. | Clinical parameters (PD, plaque index, and bleeding on probing) and peri-implant crevicular fluid (IL1-ß and TNF-α) |

*(continued on next page)*

**Table 2.** (Continued)

| | Grandi et al[28] | Molina et al[39] | Koutouzis et al[35] | Kuppusamay et al[42] |
|---|---|---|---|---|
| Additional results and notes | Control group: Abutments removed 3 times | Control group: Abutments removed 1 time | Control group: Abutments removed 2 times | Control group: Abutments removed at least 3 times |
| | Flapless surgery | Light (10 cigarettes per d) smokers included | Mean probing depth values were statistically significantly lower in the control group. | Mean probing depth values were statistically significantly lower in the test group. |
| | Light (10 cigarettes per d) smokers included | | Light (10 cigarettes per d) smokers included | Statistically significant lower mean amounts of the IL-1b level in the test group. No difference in the TNF-a levels. All patient were nonsmokers |

NR, not reported.

Bone level assessments were performed using periapical radiographs by 2 blinded operators; the measurements were repeated 30 days after the first assessment. The radiographs were standardized using an individual rigid index made of polyether rubber placed between the film holder and the opposing occlusal contacts. Each image was calibrated twice; the first using the measurements of the film, and the second using the known diameter of the implant. Readings of the mesial and distal bone were made to the nearest 0.01 mm.

At the follow-up intervals, no dropouts occurred, and all treatments were accounted for. Healing was in general uneventful with little pain or swelling, and no prosthetic complications were observed in any of the patients.

The results of the study showed a statistically significant difference between the 2 groups for peri-implant bone level changes at the 6- and 12-month follow-up in favor of the DA group, suggesting that nonremoval of abutments placed at the time of surgery resulted in less reduction of crestal bone resorption around immediately restored implants in cases of partial edentulism.

*Koutouzis et al, 2013.* This study consisted of a university-based prospective, randomized controlled clinical trial in which partially edentulous patients (n = 16) were enrolled, needing at least 1 implant posterior to the mandibular or maxillary canines.[35]

The subjects were randomly assigned to test or control groups. In the test group, after placement of the dental implants, permanent abutments were placed and provisional composite crowns were fabricated chairside and cemented to the abutments. The permanent abutments were hand-tightened, and the provisional crowns were out of occlusion. Instead, in the control group, after positioning of implants, patients received titanium healing abutments. All the healing abutments extended transmucosally and remained completely out of occlusion. Definitive restorations were commenced 2 months after implant placement. For implants in the test group, the provisional crowns were removed, and the abutment screws were tightened to 35 Ncm. The definitive prosthesis was delivered 1 month later with polycarboxylate cement. For patients in the control group, the healing abutments were removed (first disconnection) and an implant level impression was taken subsequent to connection of an impression post. Healing abutments were reconnected after the impression was taken. The healing abutments were removed again before delivery of the definitive prosthesis (second disconnection). Custom abutments were fabricated and torqued to 35 Ncm, and the definitive prosthesis was cemented with polycarboxylate approximately 3 months after implant placement.

Radiographic examinations were performed immediately after the surgical procedure and at the 3- and 6-month follow-up. The periapical radiographs were taken using a paralleling device and digital imaging software; all measurements were made on ×7 magnified images on an image processing system. The known geometry of each implant was used to assess the distortion.

Both groups showed slight marginal bone loss from the time of implant placement to the 3- and 6-month examinations. However, there were no statistically significant differences between the 2 groups at any time interval. The results of the study failed to demonstrate that disconnection and reconnection for an abutment 2 times during the course of implant therapy significantly influences soft tissue and bone level changes during a 6-month period after implant placement. More specifically, there were no significant differences in 1-evel alterations between test and control groups at 3 (–0.07 vs –0.12 mm) and 6 months (0.13 vs –0.28 mm).

*Kuppusamy et al, 2015.* This study consisted of a comparative trial conducted in a university setting in Japan.[42] Ten patients were recruited and, at the second-stage surgery, were divided into 2 groups. The test group received the final abutment. The control group received healing abutments, which were removed at least 3 more times.

**Table 3.** Marginal Bone Level Changes Reported in the Included Studies

| Study | MBL | | MBLC | | Notes |
|---|---|---|---|---|---|
| | DA | PA | DA | PA | |
| Grandi et al[28] | | | | | |
| Baseline | 0.003 ± 0.03 | 0.002 ± 0.019 | N/A | N/A | |
| 6 mo | 0.065 ± 0.018 | 0.359 ± 0.028 | 0.0647* | 0.357* | |
| 12 mo | 0.094 ± 0.025 | 0.435 ± 0.025 | 0.091* | 0.433* | |
| Molina et al[39] | | | | | |
| Baseline | –0.013 ± 0.192 | –0.069 ± 0.264 | N/A | N/A | |
| 6 mo | 0.592 ± 0.303 | 1.167 ± 0.724 | –0.605 ± 0.396 | –1.235 ± 0.790 | |
| 12 mo | 0.590 ± 0.322 | 1.210 ± 0.816 | –0.603 ± 0.401 | –1.279 ± 0.865 | — |
| Koutouzis et al[35] | | | | | |
| 3 mo† | N/A | N/A | –0.07 ± 0.13 | –0.12 ± 0.17 | — |
| 6 mo‡ | N/A | N/A | 0.13 ± 0.2 | –0.28 ± 0.16 | |
| Kuppusamay et al[42] | | | | | |
| Baseline | 1.25 | 0.8 | N/A | N/A | |
| 5 mo | 1.5 | 1.0 | –0.25 | –0.2 | Values extrapolated from the author's published table |
| 12 mo | N/R | N/R | N/R | N/R | N/R |

*Arithmetic means calculated from the timepoint to baseline.
†No absolute bone levels given at 3 months; only mean bone level changes stated (in mm ± SD).
‡No absolute bone levels given at 6 months; only mean bone level changes stated (in mm ± SD).
MBL indicates the mean bone level (in mm ± SD); MBLC, changes in the mean bone level from the baseline to timepoint (in mm or mm ± SD); N/A, not applicable. N/R, not reported.

Probing depth measurements were recorded, and the plaque index (mPI) was assessed at 6 sites; bleeding on probing (BOP) and gingival biotype by a probe transparency method were also recorded at every visit. An experienced independent radiologist performed the hard tissue measurements at the baseline and maintenance (up to 20 weeks). Peri-implant crevicular fluid was also collected and analyzed by ELISA for IL-1beta and TNF-alpha.

A 100% implant and prosthetic success was achieved in both groups. The total amount of IL-1beta in test groups was significantly lower than in controls, whereas there was no statistical difference in TNF-alpha levels between groups. mPI was excellent, and no BOP was registered throughout the study. Thin gingival biotype was shown by all the patients recruited. PD was significantly lower at all timepoints in the test group, although the crestal bone level measured on radiographs did not show significant differences.

The findings of this study demonstrated that the increased level of IL-1 beta and PD in control groups could lead to a greater bone loss and inflammation of peri-implant tissues in repeated disconnected and reconnected abutment implants over the long term.

*Molina et al, 2017.* This study consisted of a prospective randomized controlled clinical trial with a parallel design conducted in a university setting.[39] Thirty-nine patients were randomized using a computer-generated list and divided into control and test groups. Implants randomized to the test group (31 implants in 21 patients) received the final abutments, which were fitted with 20-Ncm torque. Titanium protection caps were placed to protect the abutment during the healing period. Implants in the control group (28 implants in 18 patients) received conventional healing caps, either cylindrical or wide body according to the surgeons' criteria. Implant sites were sutured according to the standard procedure for nonsubmerged healing with nonresorbable sutures. Standardized periapical radiographs were taken using a paralleling system with individual silicon bite blocks.

**Table 4.** The Present Table Describes the Risk of Bias of the Studies Included in the Present Systematic Review

| | Adequate Sequence Generation | Allocation Concealment | Blinding (Subjective Outcomes) | Incomplete Outcome Data Addressed | Free of Selective Reporting | Other Sources of Biases |
|---|---|---|---|---|---|---|
| Grandi et al[28] | + | + | ? | + | + | + |
| Koutouzis et al[35] | + | ? | + | + | + | + |
| Molina et al[39] | + | + | + | + | + | + |
| Kuppusamay et al[42] | – | – | ? | – | ? | + |

According to the Cochrane Handbook for Systematic Reviews of Interventions,[12] an answer of (+) indicates low risk of bias, and an answer of (–) indicates a high risk of bias and an answer of (?) indicates unclear risk.

Impressions were taken after a healing period of 6 weeks when implants were inserted in bone quality I to III and 12 weeks in bone quality of IV. For those implants randomized to the control group, healing caps were unscrewed and impressions were taken at an implant level for single implant restorations or at an implant or final abutment level for multiple implant restorations. For implants randomized to the test group, impressions were taken directly at an abutment level. As an exception, in the cases of single-tooth replacement, impressions were taken at an implant level during surgery. Impressions at an abutment level for single-tooth restorations were avoided because of the lack of an antirotation system in the final abutment, which would provoke prosthesis rotation at loading. Within 2 to 4 weeks after impressions, the final screw-retained prosthetic restorations were delivered with functional occlusion.

Clinical and radiographic parameters were recorded the day of prosthesis delivering and at 6 and 12 months after loading. Standardized radiographs and clinical photographs were taken at each follow-up visit.

Soft tissue changes were assessed with a periodontal probe, whereas changes to interproximal bone were measured through the standardized digital periapical radiographs. The changes at the mesial and distal crestal bone levels were calculated by measuring the distance from the implant shoulder to the first visible bone contact (DIB).

The healing was uneventful in all cases; there were no significant differences between the groups regarding the distribution of bone quality.

At follow-up, 3 patients did not show up for the 6-month visit; thus, the study sample at 6 months consisted of 36 patients and 56 implants. One further subject did not show up for the 12-month visit; thus, the sample at 12 months consisted of 35 patients and 55 implants.

After 6 months, there was a statistically significant difference between the control (–1.24 mm) and test (–0.61 mm) groups in DIB changes. At the 12-month visit, a total of 0.59-mm interproximal bone resorption compared with 1.21 mm in the control group was recorded.

The findings of this clinical trial demonstrated that the disconnection and reconnection of healing abutments were associated with statistically significant increased bone loss when compared with the placement of the final abutment immediately after the surgical phase during healing periods between implant placement and 6 months.

## DISCUSSION

Abutment disconnections are a normal part of the implant restorative procedure, and often, a number of abutment removals are required to complete the final prosthesis. Numerous trials have been performed studying the influence of abutment disconnection and reconnection on peri-implant soft and hard tissue.[15,22,36,43] The difficulty, however, is that many of these studies are conducted with a number of confounding factors that may alter the remodeling process of the marginal bone and soft tissue surrounding the implant at the time of its placement. This may skew the results in a way that makes the true influence of the abutment change hard to quantify or study accurately. With this in mind, the aim of this review focused on possible confounding factors that could influence the marginal bone level during the initial period of implant placement.

Particular focus was given to exclude immediate/postextraction implants because it has been suggested that the immediate protocol may not be a good model to test the one-time abutment hypothesis due to the significant crestal resorptive changes both vertically and horizontally during the socket healing, which are not altered by the immediate placement of the implant.[41]

At the time of writing this article, only 4 journal articles[28,35,39,42] fulfilled these requirements. Owing to the methodological heterogeneity of the included studies, meta-analysis was unable to be performed. However, some very important conclusions can be drawn from this review.

Three of 4 studies[28,39,42] showed small but statistically significant changes in marginal bone levels. Two studies[35,42] suggested no significant difference during the study.

It seems that the one time–one abutment protocol provides minimal disruption to the peri-implant marginal bone and results in lower marginal bone resorption compared with the use of conventional healing abutments,[28,39] and lower inflammation and PD.[42] Moreover, avoidance of unnecessary disturbances to the transmucosal attachment by multiple abutment disconnections and reconnections is recommended.[35] Molina et al[39] reported that disconnection and reconnection of the healing abutment was associated with statistically

significant increased bone loss, even in the abutments that were only removed once before the final abutment connection. This could explain the lower amounts of bone remodeling reported by this investigation in comparison with other clinical studies whereby the abutments were removed up to 4 or 5 times.[22,35,36,43] The cumulative effect of repeated abutment disconnection and reconnections might be more pronounced the more times the mucosal barrier is disrupted and has to be reestablished. In the study by Kuppusamy et al,[42] the nonremoval of abutments significantly reduced IL-1beta levels and PD, although no significant differences in the radiographic measurements of bone loss were found probably because of the short follow-up period.

Owing to the lack of homogeneity among the procedures and parameters provided by the included studies, it would be beneficial if future studies regarding implant marginal bone loss and soft tissue parameters become more standardized. This is inclusive of the parameters assessed, review times, follow-up times, and techniques used to assess these parameters. We do acknowledge the limitations associated with maintaining standardized protocols due to the variety of implant systems and restorative techniques and equipment available to measure the parameters assessed. The included studies[28,35,39,42] have successfully implemented a strict inclusion and exclusion criteria that have allowed us to make some comparisons while removing probable confounding factors. More randomized controlled clinical trials with consistent data collection techniques and standardized review times are recommended so that data can be meta-analyzed appropriately for future reviews.

## Conclusion

In the present review, despite the limited number of clinical trials included, it was possible to conclude that there is a tendency for a reduced marginal bone loss in one-abutment at one-time implants. Therefore, it can be suggested that minimizing the number of abutment dis- and reconnections or, where it is possible, opting for a one-abutment at one-time restorative procedure, would be beneficial to ensure minimal disruption to the peri-implant tissue and marginal bone level. The clinical significance of the marginal bone level changes, however, is still inconclusive.

## Disclosure

The authors claim to have no financial interest, either directly or indirectly, in the products or information listed in this article.

## Roles/Contributions by Authors

V. Perrotti: Literature search, analysis, screening of the abstracts, and preparation of manuscript submission. D. Zhang: Literature search, analysis, screening of the abstracts, and preparation of the manuscript draft. A. Liang: Screening of the abstracts and preparation of the manuscript draft. J. Wang: Literature analysis, screening of the abstracts, and preparation of the manuscript draft. A. Quaranta: Original idea of the review, coordinator of the study, and contribution in the manuscript preparation and submission.

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