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Original Article

# The assessment of periimplant soft tissue condition with morse taper abutment connection: a rapid review

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**Aim:** This study aims to evaluate the clinical assessment results of periimplant soft tissue with morse taper (internal abutment connection). **Methods:** The study was conducted using a rapid review by searching the articles from PubMed NCBI and Cochrane by using keywords. All articles were selected by the year, duplication, title, abstract, full-text, and finally, all selected articles were processed for final review. Following clinical parameters were included; Periimplant Probing Pocket Depth (PPD), Plaque Score (PS), modified Plaque Index (mPI), Mucosal Thickness (MTh), Gingival Height (GH), periimplant mucosal zenith, Pink Esthetic Score (PES), Bleeding On Probing (BOP), Sulcus Bleeding Index (SBI), and modified Gingival Index (mGI). **Results:** 9 selected articles were obtained from the initial literature searching count of 70 articles. The overall samples included 326 morse taper implants. Based on the evaluation, 3 out of 4 articles reported pocket depth < 4 mm, no bleeding was reported in 2 out of 4 articles. 4 out of 4 articles reported low plaque accumulation, low soft tissue recession was reported in 3 out of 3 articles, and 4 out of 4 articles reported acceptable PES values. **Conclusion:** The evaluations indicate that the morse taper (internal abutment connection) has favorable assessment results based on various clinical parameters.

**Keywords:** Dental implant-abutment design. Soft tissue injuries. Dental abutments. Dental implants. Gingiva. Mouth mucosa.

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## Introduction

Dental implants have been widely used for the replacement of missing teeth[1]. The survival rate of dental implant treatment for five years reached 96.3%[2]. However, this treatment still caused several complications such as; technical complications or screw loosening 8.8%; soft tissue complications 7.1%; marginal bone loss 5.2%; and aesthetic complications 7.1%[2].

The implant system can be differentiated based on the material used in dental implants, surface topography, morphology, and geometry of the abutment connection[3]. The geometry of the abutment connection influences the incidence of screw loosening and may play a crucial role of the bacterial composition in the neck area of the implant[4]. The formation of microgap due to bacterial leakage on the abutment connection causes microleakage to occur[5]. Microleakage allows penetration and accumulation of bacteria through the microgap which leads the periimplant soft tissue inflammation[5]. Therefore, this can affect the stability of marginal bone, periimplant soft tissue, and aesthetics condition[5].

Basically, the geometry of the abutment connection is divided into external connection and internal connection[1]. External connection was first implemented in the Branemark implant system and has a hexagonal structure[3,6]. Internal connection has several variants, including internal hexagon and morse taper[7]. Morse taper abutment connection that was placed in the anterior maxilla had the lowest global annual failure rate (0.2%)[8]. This design can reduce microgap and micromovement formation due to its ability to resist leakage[9]. Therefore, better load distribution on the abutment connection obtained and minimal marginal bone loss observed with morse taper[9].

The stability of periimplant soft tissue is one of the key aspects of successful dental implant treatment because it provides sealing ability and stability of the marginal bone, prevents penetration of oral microorganisms, and enables good aesthetic results[10]. A considerable amount of literature from NCBI PubMed and Cochrane databases regarding morse taper internal abutment connection have been published. However, no previous study has been conducted using a rapid review method for evaluating the periimplant soft tissue. Based on the explanation that has been presented, this paper aims to systematically evaluate the clinical assesment results of periimplant soft tissue using morse taper (internal abutment connection) with the rapid review method.

## Material and Methods

This rapid review was performed according to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) statement (Figure 1)[11,12]. Selected articles were English language articles between 2009-2019 that discussed morse taper and the clinical assesment result of periimplant soft tissue with a minimum follow-up period of 12 months. Non full-text article and narrative review were excluded.

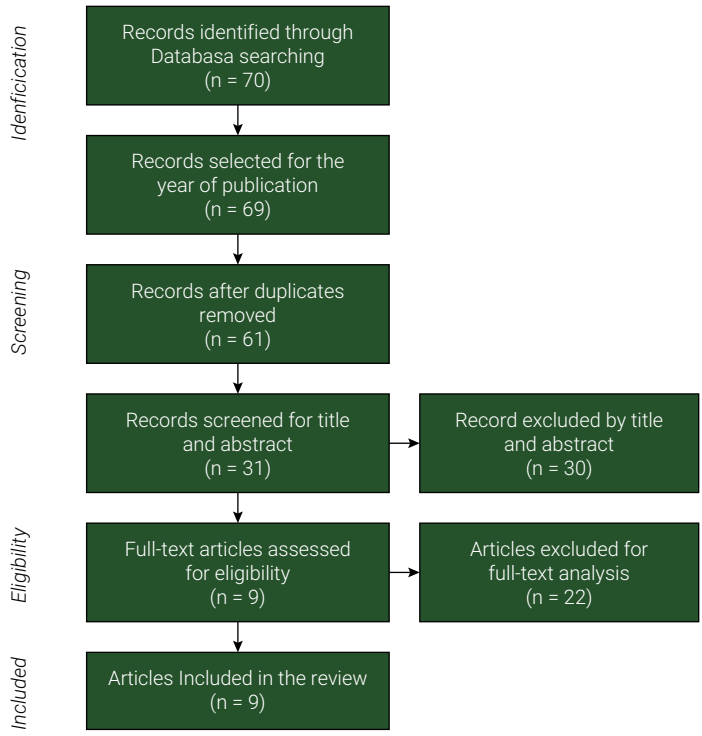


**Figure 1.** Flowchart of the study selection process

An electronic search through PubMed NCBI and Cochrane was conducted using the Boolean Operators method with keywords "(((((morse taper[Title/Abstract]) OR conical interface[Title/Abstract]) OR conical connection[Title/Abstract])) AND (((periimplant[Title/Abstract]) OR soft tissue[Title/Abstract])) AND clinical[Title/Abstract]". All articles were selected by the year, duplication, title, abstract, full-text, and finally, all articles were obtained and analyzed using the thematic analysis method.

Following data were assessed: Periimplant Probing Pocket Depth (PPD), Bleeding On Probing (BOP), Sulcus Bleeding Index (SBI), modified Gingival Index (mGI), modified Plaque Index (mPI), Plaque Score (PS), Mucosal Thickness (MTh), Gingival Height (GH), periimplant mucosal zenith, and Pink Esthetic Score (PES). Levels of evidence were identified using the Strength of Recommendation Taxonomy (SORT).

## Results

Through the literature searching, 70 articles were identified, selected by the year, duplication, title, and abstract. Finally, 9 full-text articles matched the inclusion criteria and were processed for the final review (Figure 1)[13-21]. Five articles were randomized controlled trials (SORT level of evidence-1)[13,15,16,19,20]. Three articles were prospective cohort studies (SORT level of evidence-2)[14,17,18]. One case series article (SORT level of evidence-3)[18]. The overall samples included 326 morse taper connection implants (MT); 151 non-morse taper internal connection implants (NMTI); and 69 non-morse taper external connection implants (NMTE)[13-21]. Table 2 presents the results of clinical periimplant soft tissue assessment parameters obtained from selected articles.

**Table 1.** Clinical Periimplant Soft Tissue Assessment Parameters from Selected Articles

| Author (year) | Study design | Follow-up period | Number of Samples/ Connection type | Clinical Parameters | Results | Remarks |
|---|---|---|---|---|---|---|
| Cooper, et al.[13] (2019) | Randomized controlled trial | 3 years | 79 implants:<br>Experimental<br>• MT: 45 (Osseospeed)<br>Control<br>• NMTI: 34 (Nobel Speedy) | 1. PPD<br>2. Periimplant mucosal zenith recession | 1. PPD ≥ 4 mm buccal aspect:<br>• MT 7%<br>• NMTI 18%<br>PPD ≥ 4 mm lingual aspect:<br>• MT 2%<br>• NMTI 24%<br>2. Periimplant mucosal zenith recession ≤ 5 mm:<br>• MT 80%<br>• NMTI 61% | 1. PPD ≥ 4 mm buccal and lingual aspect the least occurred in MT<br>2. Periimplant mucosal zenith recession ≤ 5 mm mostly occurred in MT |
| Pessoa, et al.[15] (2017) | Randomized controlled trial | 1 year | 48 Implants:<br>Experimental<br>• MT: 24 (UNI-TITE)<br>Control<br>• NMTE: 24 (UNI-TITE) | 1. PPD<br>2. MTh<br>3. mGI | 1. Average PPD:<br>• MT 1.36 ± 0.7 mm<br>• MTE 1.57 ± 0.9 mm<br>2. Average MTh:<br>• MT 2.27 ± 0.85 mm<br>• NMTE 2.16 ± 0.94 mm<br>3. mGI<br>• Very low in both types | 1. Lower pocket depth and mucosal appearance were found with MT<br>2. No significant difference for pocket depth and mucosal thickness in both types<br>3. Very low bleeding index found in both types |
| Barwacz, et al.[36] (2016) | Randomized controlled trial | 3 years | 97 implants:<br>Experimental<br>• MT: 48 (Osseospeed)<br>Control<br>• NMTI: 49 (Nobelspeedy) | 1. PES | 1. Average PES:<br>• MT 10.4<br>• NMTI 10.0 | 1. Both types showed favorable PES values with no significant difference |
| McGuire, et al.[19] (2015) | Randomized controlled trial | 1 year | 8 implants:<br>Experimental<br>• MT: 4 (Osseospeed)<br>Control<br>• NMTI: 4 (Nobelspeedy) | 1. PES | 1. Average PES values:<br>• MT 11.35<br>• NMTI 11.55 | 1. Both types showed favorable PES values with no significant difference |

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|---|---|---|---|---|---|---|
| Pozzi et al.[20] (2014) | Randomized controlled trial | 3 years | 68 implants:<br>Experimental<br>• MT: 34 (Nobel active)<br>Control<br>• NMTE: 34 (Nobelspeedy) | 1. SBI<br>2. PS | 1. SBI found in 1 NMT<br>2. PS found in 1 MT and 1 NMTE (year 1) | 1. No significant difference in the assessment of SBI and PS<br>2. No bleeding in all soft tissue surfaces with MT<br>3. Plaque accumulation was found in 1 implants with MT and 1 implant with NMTE after 1 year in function |
| Heydecke, et al.[14] (2019) | Prospective Cohort | 3 years | MT: 99 (Nobel Replace Conical Connection) | 1. BOP<br>2. mPI<br>3. PES | 1. No BOP in 80.7% soft tissue surfaces<br>2. No plaque was observed on 65.9% implant sites from mPI assessment<br>3. Average PES: 9.87 ± 2.19 | 1. No bleeding was found in 80.7% periimplant soft tissue surfaces<br>2. No plaque accumulation was found in 65.9% implant sites<br>3. Acceptable PES result |
| Cosyn, et al.[18] (2016) | Prospective Case Series | 5 years | MT: 17 (Nobel Active) | 1. PPD<br>2. BOP<br>3. PS<br>4. PES | 1. Average PPD: 3.1 mm<br>2. Average PS: 15%,<br>3. Average BOP: 32%<br>4. Average PES:<br>• 12.15 (1 year)<br>• 11.18 (5 year) | 1. Favorable PPD and PS results<br>2. Bleeding was found in BOP assessment<br>3. Significant PES value reduction (-0.97) within 5 years follow-up |
| Gultekin, et al.[21] (2013) | Prospective Cohort | 15 months | 93 implants:<br>Experimental<br>• MT: 43 (Nobel Active)<br>Control<br>• NMTI: 53 (Nobel Replace Tapered Groovy) | 1. PPD<br>2. mPI | 1. Average PPD values:<br>• MT 2.6 ± 0.46 mm<br>• NMTI 3.33 ± 0.51 mm<br>2. Average mPI values:<br>• MT 0.64 ± 0.28<br>• NMTI 0.61 ± 0.36 | 1. Significant difference of the averages of pocket depth was found, the lowest pocket depth observed in MT<br>2. No significant plaque index values difference. Acceptable results were reported in both types |
| Kaminaka, et al.[17] (2015) | Prospective Cohort | 1 year | 22 implants:<br>Experimental<br>• MT: 12 (Nobel Active)<br>Control<br>• NMTE: 11 (Nobel Speedy Groovy)<br>• NMTI: 11 (Nobel Replace) | 1. GH reduction (the measurement from the implant platform to the marginal soft tissue level ) using CBCT | 1. ΔGH values:<br>• MT 0.06 ± 0.10 mm<br>• NMTE 0.39 ± 0.19 mm<br>• NMTI 0.28 ± 0.30 mm | 1. Significant differences of GH reduction values were observed, lowest reduction was found in MT |

Favorable PPD results with morse taper were reported in 3 out of 4 articles (75%). Cooper et al.[13] (2019) found PPD ≥ 4 mm the least occurred with morse taper. Three studies reported the PPD averages of 1.36 ± 0.7 mm, 2.6 ± 0.46 mm, and 3.1 mm[15,18,21].

No bleeding presence on most of the periimplant soft tissue surfaces was reported in 2 out of 4 articles (50%). Pessoa et al.[15] (2017) stated low mGI Score in the evaluated region with morse taper. Heydecke et al.[14] (2019) observed no bleeding occurred in 80.7% of surfaces and another study by Pozzi et al.[20] (2014) reported no bleeding found on all surfaces. On the contrary, as stated by Cosyn et al.[18] (2016) bleeding was found in 32% of periimplant soft tissue surfaces.

Low plaque accumulation was reported in 4 out of 4 articles (100%). Pozzi et al.[20] (2014) found a slight plaque accumulation in one morse taper implant after one year in function. Cosyn et al.[18] (2016) stated that the PS was on average of 15% after 5 years follow-up period. Heyecke et al.[14] (2015) found no plaque accumulation in 66.9% implants. A study by Gultekin et al.[21] (2013) stated the mean mPI value was 0.64 ± 0.28 after 12 months follow-up period.

Low soft tissue recession was reported in 3 out of 3 articles (100%). Kaminaka et al.[17] (2015) stated that among other designs, morse taper showed the lowest gingival height reduction, which was - 0.06 ± 0.10 mm. Cooper et al.[13] (2019) reported periimplant mucosal zenith reduction of less than 5 mm found in 80% of implants with morse taper. Pessoa et al.[15] (2017) reported the average MTh value of 2.27 ± 0.85 mm after implant placement.

Acceptable PES values were reported in 4 out of 4 articles (100%). Two studies that assessed PES in implants with morse taper internal connection and non-morse taper internal connection, stated that there was no significant difference and both types of abutment connection had equally good PES values[13,16]. Other authors reported PES value with the averages of 9.87 ± 2.19 and 11.18[14,18].

## Discussion

The examinations of PPD and BOP have been considered as the assessment to define a successful dental implant treatment[22-24]. Takei and Carranza[4] (2019) stated that pocket depth around 3 mm without any presence of bleeding on all surfaces could be identified as a healthy periimplant soft tissue condition. In this review, several studies showed the average of PPD ≤ 3.1 mm[15,18,21] Low percentages of BOP and SBI were also found[14,20].

This result might be explained by the concept of morse taper connection, which is a particular kind of internal abutment connection with a matching conical or taper shape and an equal angle (5-16° of conicity) between the wall of abutment and the implant[3]. This creates an intimate contact and a significant amount of mechanical friction locking. Hence, this design can stabilize under static load, eliminates microgap below dynamic load, and prevents micromovement[14]. Recent study reported that no type of abutment connection could 100% prevent microleakage[25]. However, the microgap formed in morse taper (2-3 μm) was smaller than in external connection (10 μm), which pointed out that morse taper had a better bacterial seal compared to the external connection[6,26-30]. Bacterial contamination through microgap causes an inflamma-

tory reaction in the periimplant soft tissue and triggers an osteoclastic process that may precipitate on marginal bone resorption around the implant[5,15,31]. Gingival recession due to bone resorption caused by the absence of supracrestal connective tissue as established in periodontal tissue leads the periimplant soft tissue to thoroughly rely on the supporting marginal bone[4]. This view is supported by the recent systematic review by Caricasulo et al.[9] (2018) who stated that the least marginal bone loss was found in the internal connection, especially in the morse taper.

Favourable periimplant soft tissue assessment results in this review are likely to be related to the optimal support from the marginal bone due to low bone resorption[13,15,17,20]. Consequently, a healthy periimplant soft tissue condition and a satisfactory aesthetic result will be obtained[15]. This is consistent with that of Kaminaka et al.[17] (2015) who concluded that morse taper was more effective in preserving the stability of the periimplant hard and soft tissue. Another factor that might influence this condition is the presence of platform switch, which is a concept of the placement of narrower diameter abutment. Therefore, if the bacterial contamination on the microgap persists; a certain distance between the microgap and the neck of the implant that attached to the marginal bone will be maintained[15]. Hence, minimal marginal bone resorption obtained and adequate biological width will be established[15]. This accords with another study by Macedo et al.[26] (2016), that reported low marginal bone resorption and wide biological width observed in apical and lateral directions with morse taper and platform switch abutment.

In this article, all types of abutment connections reported acceptable PES results[13,14,16,18]. However, only some appeared to be in healthy periimplant soft tissue conditions and some of the results showed the presence of bleeding on probing and pocket depth ≥ 4 mm which may lead to periimplant mucositis and periimplantitis[20,21]. According to some studies, there were several factors other than the variation of the implant abutment connection that may influence the PES results such as, the presence of implant thread, the surface roughness of the implant neck, tissue biotype, and the experience of the clinicians[15,16]. Dani et al.[32] (2018) found that higher soft tissue recession was observed with inexperienced clinicians after 3 years following implant placement. Time may also play as a contributing factor to this outcome. Cosyn et al.[18] (2016) stated that recession more than 1 mm was found in 3 out of 17 implants after 5 years following implant placement, which caused a significant change in PES results. This finding seems to be consistent with a study by Pozzi et al.[20] (2014) which stated that statistically significant results may be obtained by the longer research period.

High plaque accumulation within the study period may increase the risk of periimplant disease[33]. likewise, Dhir[34] (2013) and Prado et al.[25] (2016) stated that bacterial contamination might exist in the implant abutment connection causing fluid leakage into the microgap and reduce the mechanical friction between surfaces. Therefore, this could affect the periimplant soft and hard tissue condition[25,34]. Better sealing capability from morse taper can reduce microgap and prevent any leakage[6]. This view is supported by low plaque accumulation results around the periimplant soft tissue surfaces with morse taper in this review[14,18,35]. In contrast to earlier findings, recent study have failed to demonstrate significant changes of plaque index results between morse taper (0.64 ± 0.28) and internal connection (0.61 ± 0.36)[21]. Mishra et al.[6] (2017) stated that

implant abutment connection plays an important role in preventing bacterial leakage. However, infiltration of inflammatory substances may occur regardless of the amount of plaque accumulation[6]. A possible factor that may increase the formation of biofilms other than the type of connection is the implant surface roughness ≥ 0.2 μm[34].

A limitation of this study is that only a few articles have assessed the role of implant abutment connection towards periimplant soft tissue condition in 5 years follow-up period with comprehensive assessment and randomized control trial method. Another source of uncertainty is the varied specifications of morse taper that came from several implant systems. Therefore, it is difficult to determine which factors have a significant impact on the assessment results. Future researches on the current topic are therefore suggested.

In conclusion, the results of this evaluation indicate that the morse taper (internal abutment connection) has favorable assessment results based on various clinical parameters such as; PPD; PS; mPI; MTh; GH; periimplant mucosal zenith; and PES. The low percentage of bleeding around periimplant soft tissue surfaces were reported from the assessment of BOP, SBI, and mGI examinations.

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