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# Necessity of Keratinized Tissue Around Dental Implants to Maintain Peri-Implant Tissue Health: A Systematic Review

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## Abstract

Background: The need for certain amount of keratinized tissue around dental implants for maintaining optimal peri-implant tissue health has been discussed for many years. This systematic review aims to investigate the effect of keratinized tissue on various peri-implant health-related parameters.

Materials and methods: An electronic search of Pubmed, Scopus and Web of Science for relevant articles were performed. Human studies with data on the relationship between the amount of existing keratinized tissue around dental implants supporting fixed prosthesis and various peri-implant parameters, with a follow-up period of at least 6 months, were included.

Results: Nine studies, seven cross-sectional and two longitudinal, were included. Weighted mean difference (WMD) and confidence interval (CI) were calculated with meta-analyses for each clinical parameter. The results showed statistically significant differences in plaque index (PI) and modified plaque index (mPI), gingival index (GI), recession, and bone loss, all favoring implants with wide keratinized tissue. However, comparisons of other parameters (bleeding on probing, modified bleeding index (mBI), and probing depth, did not reach statistically significant differences. The result of heterogeneity test showed only probing depth had a low degree of heterogeneity among analyzed studies.

Limitations of the present review include limited number of selected studies (n = 9), existence of heterogeneity and publication bias, and only English-written articles searched.

Conclusion: Based on current available evidence, a lack of adequate keratinized tissue around dental implants is associated with more plaque accumulation, tissue inflammation, recession, and bone loss.



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# “Necessity of keratinized tissue around dental implants to maintain peri-implant tissue health: A systematic review”

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## ABSTRACT:

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## INTRODUCTION:

The gingiva, which is part of the oral epithelium, covers and protects the periodontal ligament and the bony apparatus surrounding the tooth, and are usually the only visible part of the periodontium. The gingiva fits tightly around the teeth like a collar. It is divided into free and attached gingiva. The free gingiva is the part that surrounds the tooth, but does not directly attach to its surface. The attached gingiva is the part that tightly binds to the underlying periodontium, tooth, and bone. Keratinized tissue extends from the gingival margin to the mucogingival junction. Both free and attached gingiva are keratinized.Background: The need for certain amount of keratinized tissue around dental implants for maintaining optimal peri-implant tissue health has been discussed for many years. This systematic review aims to investigate the effect of keratinized tissue on various peri-implant health-related parameters.
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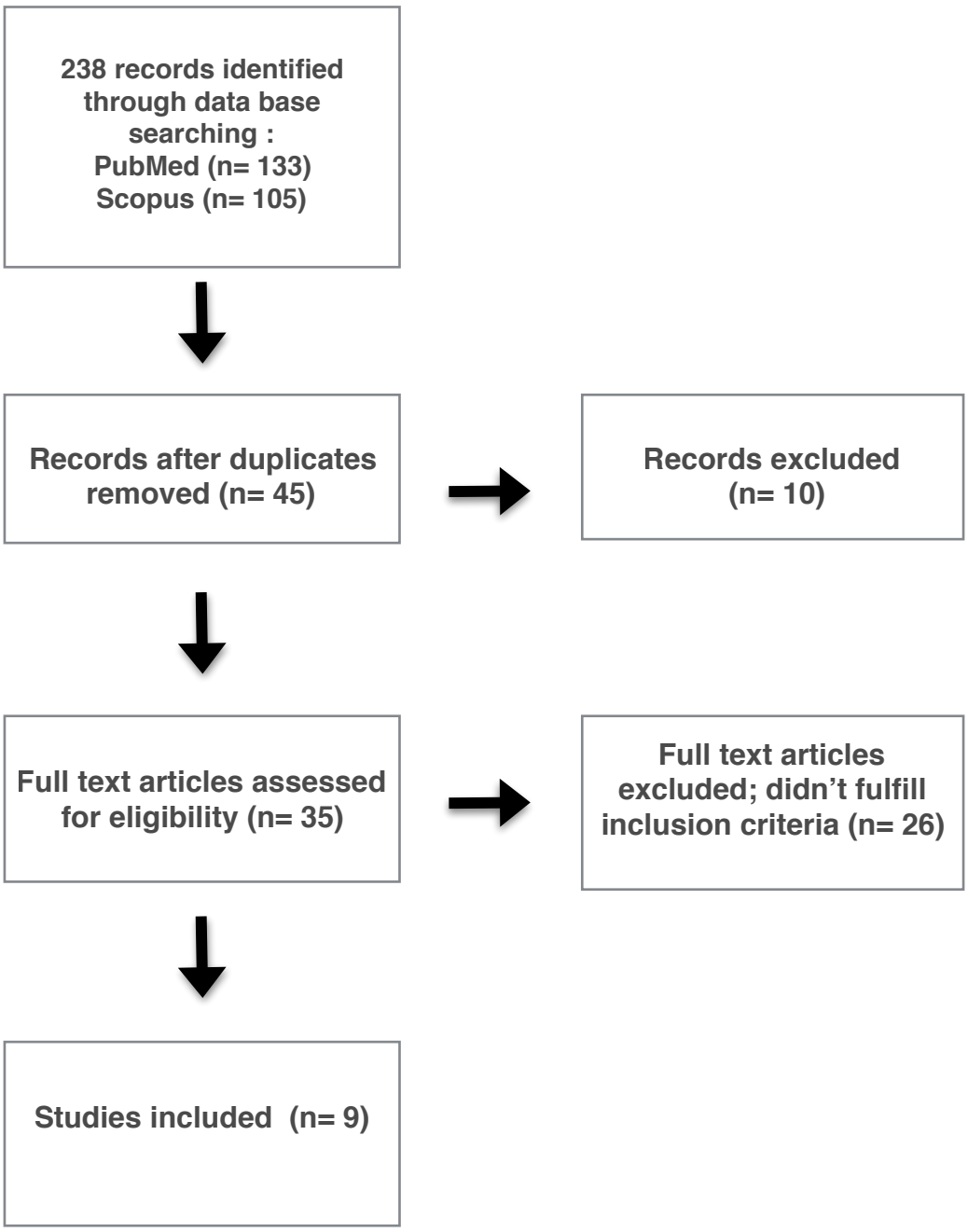
Limitations of the present review include limited number of selected studies (n = 9), existence of heterogeneity and publication bias, and only English-written articles searched.
Conclusion: Based on current available evidence, a lack of adequate keratinized tissue around dental implants is associated with more plaque accumulation, tissue inflammation, recession, and bone loss.
Keratinization is the process which keratinocytes undergo to reach the final layer constituting a structurally and functionally distinct keratin[1]. The most important function of keratinized tissue is thought to be protection as the oral mucosa forms a functional barrier from the oral environment. It is also important for sensation and patient comfort during tooth brushing.

The need for certain amount of keratinized tissue around teeth for maintaining optimal periodontal health has been discussed for many years. Some studies suggest that the presence of an adequate amount of keratinized tissue is necessary for maintaining periodontal health. It was believed that at least 2 mm of keratinized tissue with at least 1 mm attached tissue is required for the stability of the periodontium[2]. However, other studies disagreed with this concept and stated that periodontal health can be maintained even in the absence of keratinized tissue[3,4,5].
In the current time, dental implants have become a popular method of replacing missing teeth and the evaluation of the factors that affect their health and success have become equally important. In the last decade, there were some studies that reviewed the necessity of keratinized tissue to maintain the health of peri-implant tissue, but there is controversy throughout the literature. Some studies emphasize the importance of keratinized tissue around dental implants by reporting more dental plaque, recession, and attachment loss in implants without keratinized tissue than implants with keratinized tissue[6]. On the other hand, some studies found that keratinized tissue had no influence on the peri-implant tissue health[7]. Peri-implant health is defined according the American Academy of Periodontology 2017 world workshop by the absence of visible inflammation and bleeding on probing.

The aim of this systematic review is to assess the necessity of keratinized tissue around dental implants to maintain peri-implant tissue health.

## MATERIALS AND METHODS:

Main question:
Is the presence of sufficient amount of keratinized tissues around dental implants necessary to maintain peri-implant tissue health ?
Search strategy:
A search of the MEDLINE data base was carried out. PubMed and Scopus were utilized to search original articles. The search terms used on electronic databases were“dental implants” OR “implants” AND “keratinized tissues” OR “keratinized mucosa” OR “keratinized gingiva” AND “peri-implant tissue health”. The reference lists of the retrieved articles were hand searched for publications that were missed in the database searches.



Inclusion criteria:
Eligible studies were included if they met the following general inclusion criteria:
1. Human studies published in English language
2. Studies evaluated the association between existing keratinized tissues width and the peri-implant tissue health
3. Studies that evaluated implants restored with fixed prosthesis
4. Studies that have follow up of ≥ 6 months
Human cross-sectional, longitudinal (prospective or retrospective) studies that evaluated the association between the keratinized tissue width around dental implants and the outcomes of various peri-implant tissue health-related parameters, with a follow-up period of at least 6 months after implant placement, were considered for inclusion.
Animal studies were excluded or if the studies contained inadequate data or were irrelevant to the association between keratinized tissues width around dental implants and peri-implant tissues health. In addition, studies that evaluated tissues around implants that underwent mucogingival surgeries, or implants that support removable prosthesis.
The titles and abstracts of all potentially relevant studies were reviewed. Full text copies of all relevant and potentially relevant studies were obtained. For all studies appearing to meet the inclusion criteria, or if the title and abstract were unclear as to whether it met the inclusion criteria or not, a full text copy was reviewed. All eligible studies that were quoted in the studies reviewed, were searched manually and were added to the list of potential studies to be included in this review. After assessment, any duplicate publications or remaining studies that did not match the inclusion criteria were excluded from further review.
All the selected studies were reviewed by two independent readers. Screening and selection process is outlined in a PRISMA flow chart in Figure 1.

The following parameters were reported: 1) Plaque Index[8,9,10] (PI); 2) modified Plaque Index[11] (mPI) 3) Gingival Index[8,9,10] (GI); 4) modified Gingival Index[11] (mGI); 5) bleeding on probing (BOP); 6) modified Bleeding Index[9] 7) Probing depth (PD); 8) Recession; 9) Bone loss; 10) Clinical Attachment Level (CAL).

The weighted mean difference (WMD) and the 95% confidence interval (CI) were measured using a computer program. Random-effects meta-analyses of the included studies were applied. Forest plots for the different parameters were produced to graphically represent the difference between the group with sufficient amount of keratinized tissue around implants and the group with insufficient keratinized tissue. Heterogeneity was assessed with $I^2$ test.

## RESULTS:

A total of 238 articles and abstracts about the effect of the keratinized tissue around dental implants on peri-implant tissue health were found. The screening process was charted as a PRISMA diagram. The article selection process is summarized in the flow chart of literature search (Figure 1). After excluding duplicate articles, reviewers were left with 45 relevant studies, of which 10 were excluded as they were reviews and 35 were selected for more detailed evaluation. Twenty-six studies were excluded because they did not fill the inclusion criteria, as described previously.
Of these 9 included studies, 7 were cross-sectional and 3 were longitudinal. Only 2 of the studies measured the outcomes on both buccal and lingual aspects, while the others evaluated the outcomes only on the buccal aspect.

A total of 706 patients with 2684 implants were included in the studies.
Plaque index, modified gingival index, gingival index, gingival recession and bone loss showed significant differences between patients who had sufficient keratinized tissue and patients that do not (Table 1). However, most comparisons presented considerable heterogeneity between studies. Only probing depth showed low heterogeneity (Table 1). Heterogeneity of results refers to the wide range of outcomes within a particular study. During evaluation of PI/mPI, the WMD = - 0.31 mm, with a 95% CI = - 0.44 to - 0.17. For GI/mGI, the WMD = - 0.36, with a 95% CI = - 0.61 to - o.11. For BOP/mBI, the WMD = - 0.11, with a 95% CI = - 0.35 to - 0.12. In evaluation of PD, the WMD = - 0.06, with a 95% CI = - 0.12 to 0.00. For recession, the WMD = - 0.56, with a 95% CI = - 0.86 to - 0.25. For bone loss, the WMD = - 0.16, with a 95% CI = - 0.30 to - 0.02. Results of meta-analysis are shown in figures 2-7.

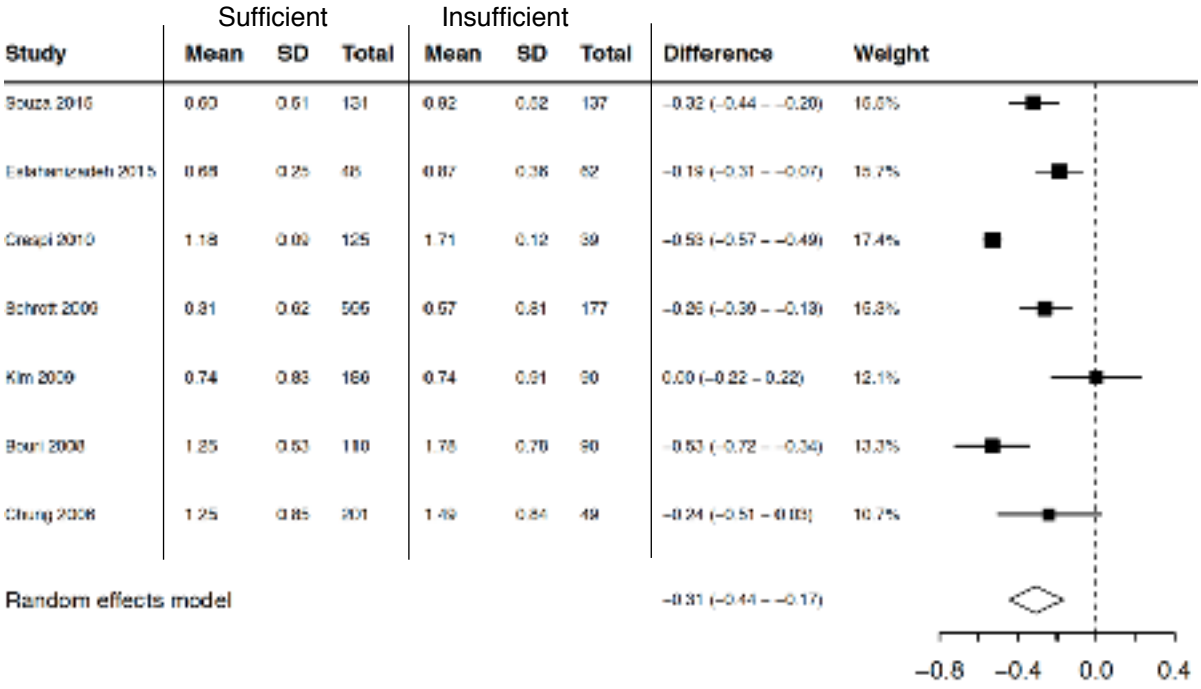



Figure 2. Meta-analysis for the comparison of PII/mPII between implants with sufficient and insufficient keratinized tissue

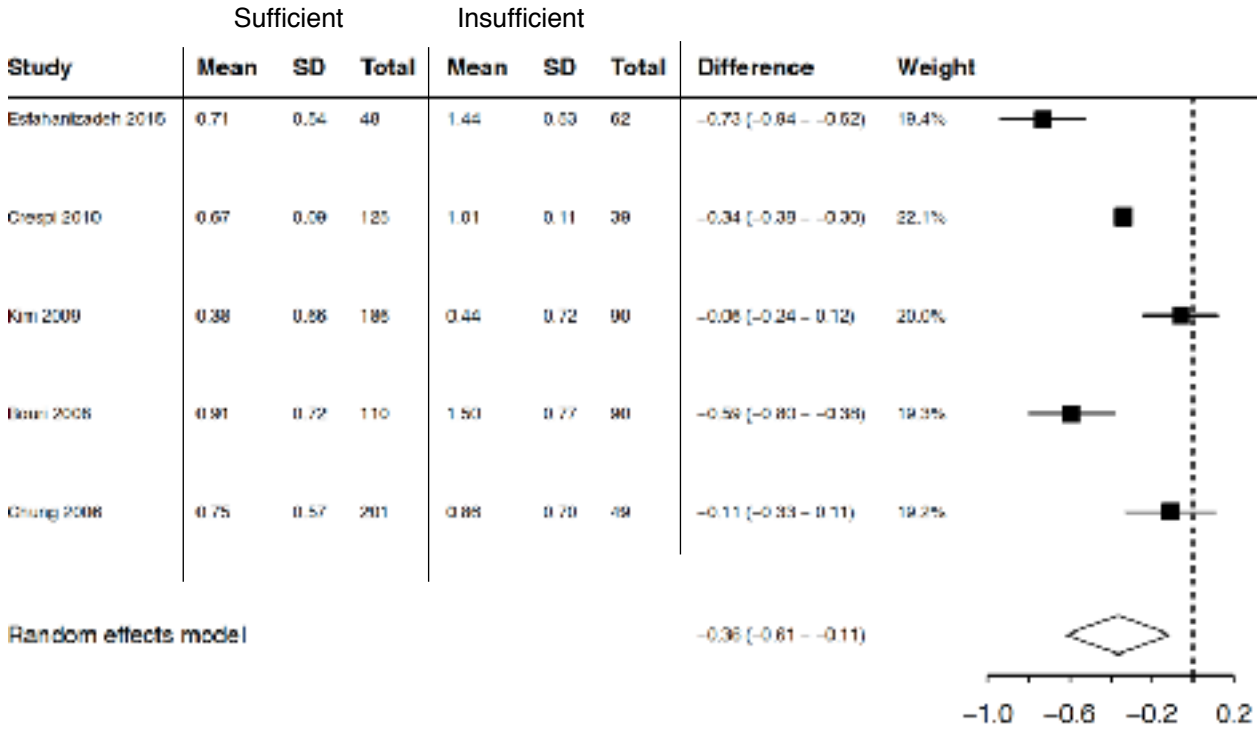



Figure 3. Meta-analysis for the comparison of GI/mGI between implants with sufficient and insufficient keratinized tissue

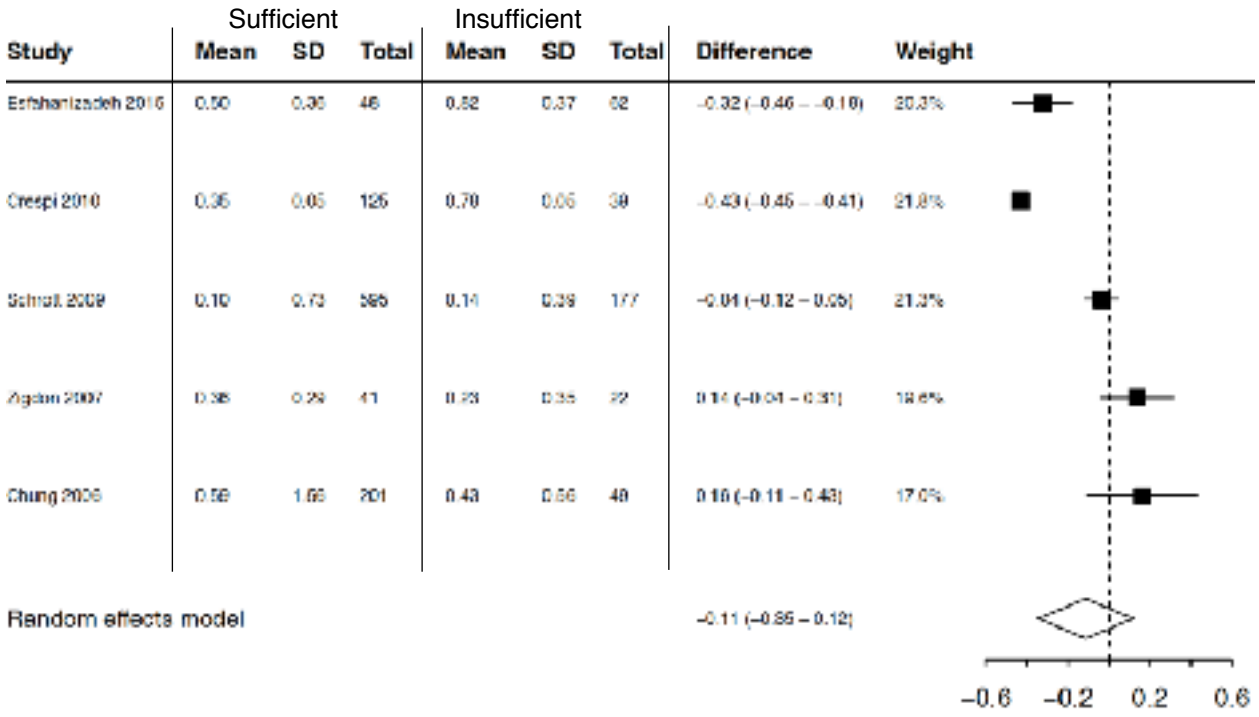



Figure 4. Meta-analysis for the comparison of BOP/mBI between implants with sufficient and insufficient keratinized tissue

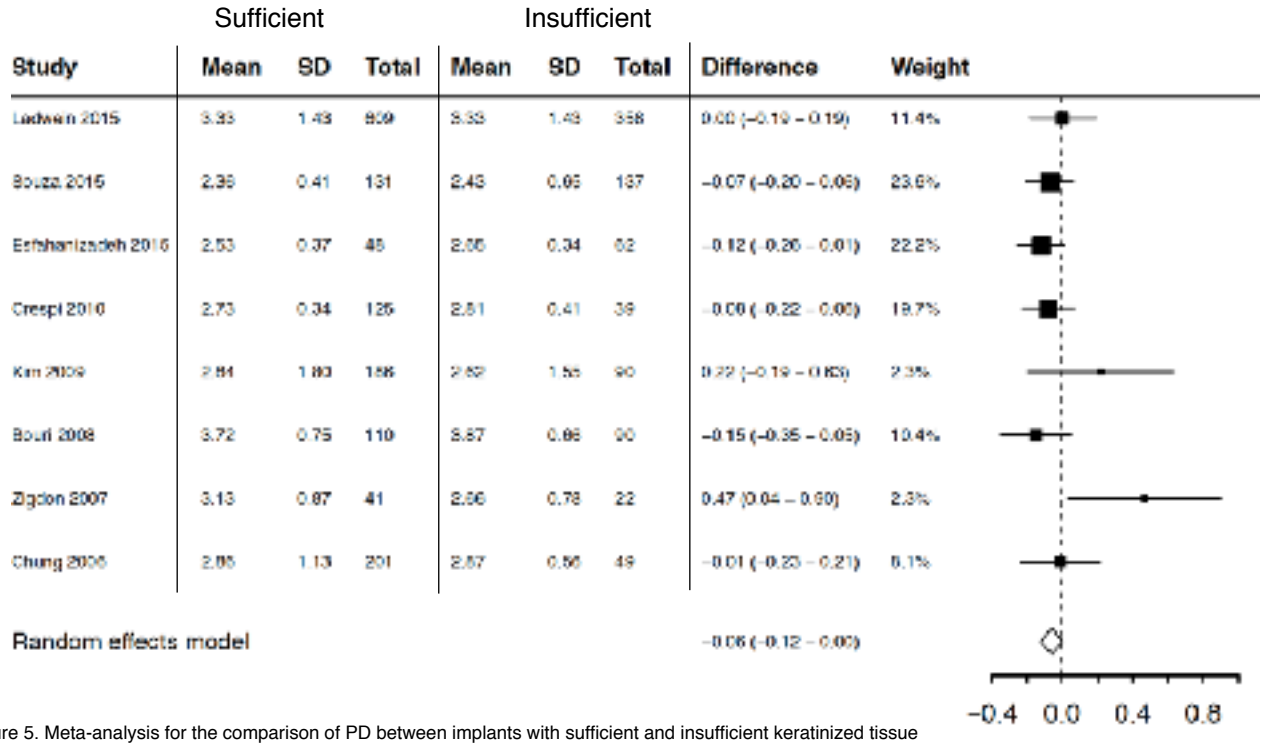



Figure 5. Meta-analysis for the comparison of PD between implants with sufficient and insufficient keratinized tissue

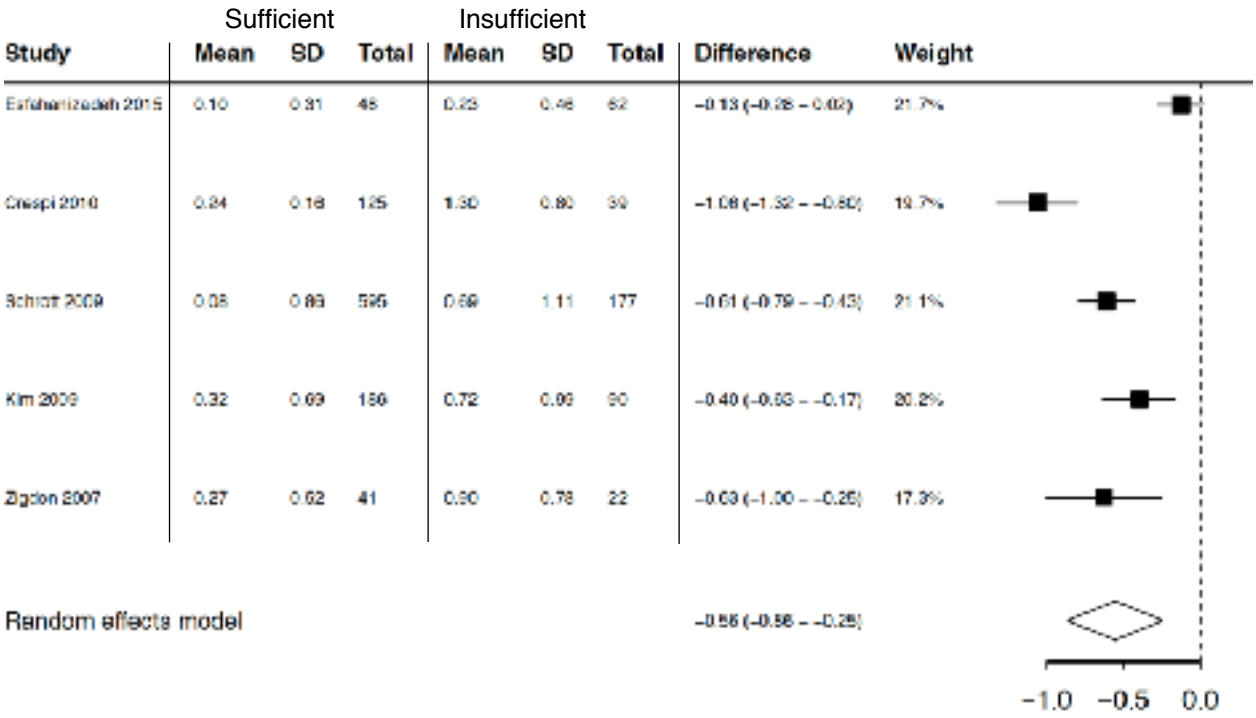



Figure 6. Meta-analysis for the comparison of recession between implants with sufficient and insufficient keratinized tissue

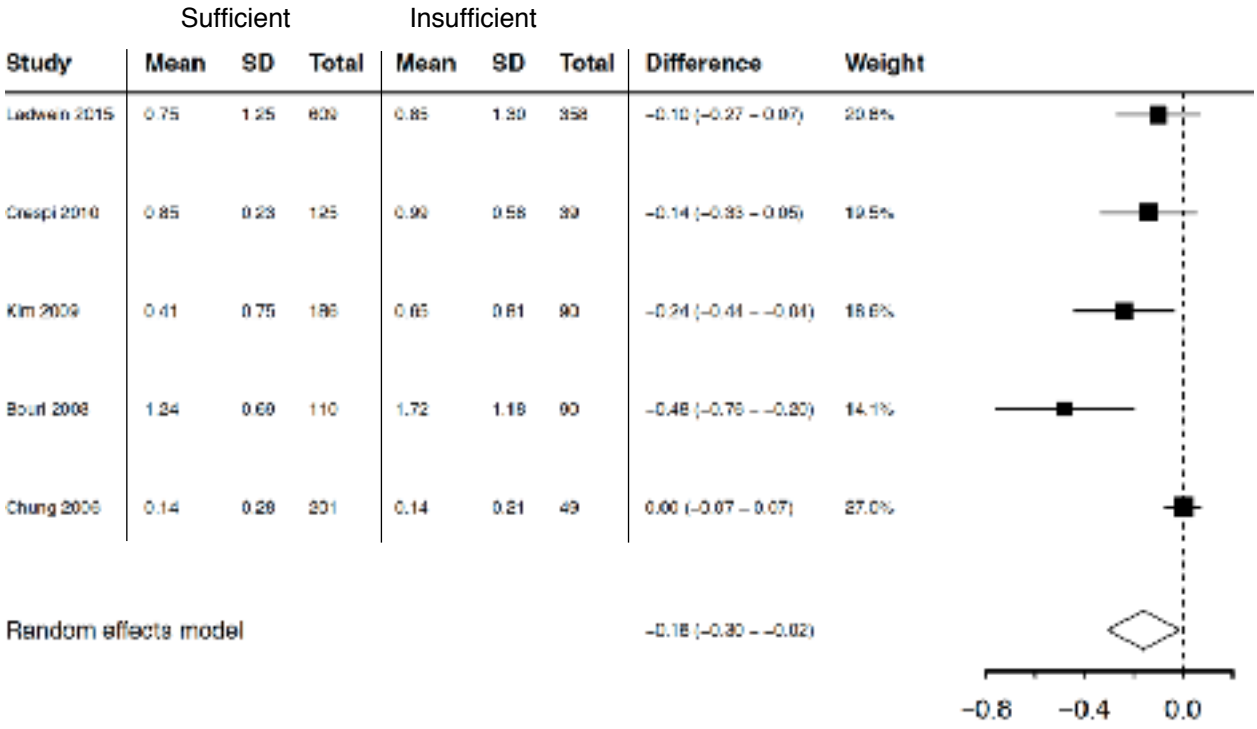



Figure 7. Meta-analysis for the comparison of bone loss between implants with sufficient and insufficient keratinized tissue

| Parameter | Number of studies | Mean difference | Heterogeneity | P-value |
|---|---|---|---|---|
| PII/mPII | 7 | -0.31 | 88.45% | < 0.0001 |
| GI/mGI | 5 | -0.36 | 92.96% | 0.0044 |
| BOP/mBI | 5 | -0.11 | 96.76% | 0.3465 |
| PD | 8 | -0.06 | 0.05% | 0.0614 |
| Recession | 5 | -0.56 | 90.33% | 0.0004 |
| Bone loss | 5 | -0.16 | 74.42% | 0.0295 |

Table 1. Summary of the meta analysis  for the included parameters

In regards to plaque accumulation, Chung, Bouri, Schrott, Crespi, Esfahanizadeh, Souza, and Ladwein found that sites with wider band of keratinized tissue around the implants had significantly less plaque accumulation. However, Kim found that there was no difference between the two groups (figure 2).
In addition, Chung, Bouri, Kim, Crespi, and Esfahanizadeh stated that the group of patients that had insufficient (< 2mm) amount of keratinized tissue had significantly more inflammation than the group that have enough keratinized tissue. However Kim mention that the difference was not statistically significant (figure 3). Similarly, Bouri, Schrott, Crespi, Esfahanizadeh, Souza, and Ladwein found that the group that had less keratinized tissue tend to bleed easier than the group with more keratinized tissue (figure 4).
It was also found by Chung, Bouri, Crespi, Esfahanizadeh, Souza, and Ladwein that probing depth is usually deeper in sites with narrower band of keratinized tissue. However, the difference was not statistically significant. Conversely, Zigdon and Kim found the opposite, and attributed this difference that the more recession in the narrower sites lead to less probing depths (figure 5).
Regarding recession, studies by Zigdon, Kim, Schrotti, Crespi, and Esfahanizadeh reported more recession around implants that have less amount of keratinized tissue (figure 6).
Additionally, Bouri and Kim found significantly more bone loss around implants with less keratinized tissue. However, Ladwein stated that the difference was not significant, and Chung found no difference between the two groups (figure 7).

## DISCUSSION:

This systematic review included a number of studies examining the clinical effect of keratinized tissues around dental implants in maintaining peri-implant tissue health. It was found that some studies concluded that having adequate amounts of keratinized tissues around dental implants could enhance the maintenance of peri-implant tissue health. However, others have concluded the opposite when good oral hygiene and maintenance therapy were obtained.
Chung concluded that the absence of adequate keratinized tissue or attached tissue in dental implants, especially in posterior implants, was associated with higher plaque accumulation and gingival inflammation but not with more bone loss, regardless of their surface configurations. Similarly, Ladwein et al showed that dental implants lacking keratinized tissues showed significantly more plaque accumulation and bleeding on probing than implants with a zone of keratinized tissues. However, the presence of keratinized tissues did not have a significant influence on the vertical peri implant bone level. Zigdon et al examined the clinical and immunological parameters around dental implants and found that the keratinized tissues around dental implants affects both the clinical and the immunological parameters. Additionally, Bouri et al concluded that increased width of keratinized mucosa around implants is associated with lower mean alveolar bone loss and improved indices of soft tissue health. However, Kim et al found that the insufficiency of keratinized tissues does not necessarily mediate adverse effects

on the hygiene management and soft tissue health condition. Nonetheless, the risk of the increase of gingival recession and the crestal bone loss is present. Another parameter, brushing discomfort, was evaluated by Souza et al. They found that implant sites with a band of <2 mm of keratinized tissues were shown to be more prone to brushing discomfort, plaque accumulation, and peri-implant soft tissue inflammation when compared to implant sites with ≥2 mm of keratinized tissues.

Clinicians should be aware of the limitations of this systematic review that focused on the necessity of keratinized tissue around dental implants to maintain peri-implant tissue health as most of the included studies are cross-sectional. It would be more useful to assess changes of peri-implant tissues over time to evaluate the necessity of keratinized tissue around dental implants. In addition, most comparisons presented considerable heterogeneity between studies. This could be attributed to the small number of included studies, or because of the differences in evaluating confounding factors such as implant position, implant location, implant surface, smoking status, medical conditions, and differences in follow-up periods. Furthermore, the fact that this systematic review only includes studies published in English, publication bias might exist.

On the basis of this systematic review, it might be suggested that although most of the included studies favored the presence of a wider band of keratinized tissue around dental implants, there is still controversy. There is still a need for well-designed prospective longitudinal clinical trials to assess the importance of keratinized tissue in maintaining peri-implant tissue health. This information might be of high importance to clinicians during treatment planning and periodic assessment of patients.

## CONCLUSION:

This systematic review included 9 studies investigating the effect of the presence or absence of sufficient amount of keratinized tissue around dental implants on peri-implant tissue health. The results of the meta-analysis concluded that the presence of sufficient amount of keratinized tissue is associated with less plaque accumulation, gingival inflammation, recession and less bone loss. However, no significant difference was found with regard to BOP, mBI, and PD. Further future standardized studies are needed to determine the clinical significance of keratinized tissue around dental implants, as there are still many disagreements in the literature.

## REFERENCES:


1. Shroeder HE. Differentiation of human oral stratified epithelia. J Anat. 1981 Oct; 133(Pt 3): 460.
2. Lang NP, Lo¨e H. The relationship between the width of keratinized gingiva and gingival health. J Periodontol 1972;43: 623-627.
3. Miyasato M, Crigger M, Egelberg J. Gingival condition in areas of minimal and appreciable width of keratinized gingiva. J Clin Periodontol 1977;4:200-209.
4. Kennedy JE, Bird WC, Palcanis KG, Dorfman HS. A longitudinal evaluation of varying widths of attached gingiva. J Clin Periodontol 1985;12:667-675.

5. Wennstro¨m JL. Lack of association between width of attached gingiva and development of soft tissue recession. A 5-year longitudinal study. J Clin Periodontol 1987;14:181-184.
6. Warrer K, Buser D, Lang NP, Karring T. Plaque-induced peri-implantitis in the presence or absence of keratinized mucosa. An experimental study in monkeys. Clin Oral Implants Res 1995;6:131-138.
7. Adibrad M, Shahabuei M, Sahabi M. Significance of the width of keratinized mucosa on the health status of the supporting tissue around implants supporting overdentures. J Oral Implantol 2009; 35:232–237.
8. Albrektsson T, Zarb G, Worthington P, Eriksson AR. The longterm efficacy of currently used dental implants: A review and proposed criteria of success. Int J Oral Maxillofac Implants 1986;1: 11–25.
9. Block, M.S. & Kent, J.N. (1990) Factors associated with soft and hard tissue compromise of endosseous implants. Journal of Oral and Maxillofacial Surgery 48: 1153–1160.
10. Strub JR, Gaberthu¨el TW, Grunder U. The role of attached gingiva in the health of peri-implant tissue in dogs. 1. Clinical findings. Int J Periodontics Restorative Dent 1991;11:317-333.
11. Adell R, Lekholm U, Rockler B, Bra°nemark PI. A 15- year study of osseointegrated implants in the treatment of the edentulous jaw. Int J Oral Surg 1981;10: 387-416.
12. Becker W, Becker BE, Newman MG, Nyman S. Clinical and microbiologic findings that may contribute to dental implant failure. Int J Oral Maxillofac Implants 1990;5:31-38.
13. Wennstro¨m J, Lindhe J. Plaque-induced gingival inflammation in the absence of attached gingiva in dogs. J Clin Periodontol 1983;10:266-276.
14. Wennstro¨m JL, Bengazi F, Lekholm U. The influence of the masticatory mucosa on the peri-implant soft tissue condition. Clin Oral Implants Res 1994;5:1-8.
15. https://www.perio.org/node/876AMERICAN ACADEMY OF PERIODONTOLOGY RELEASES PROCEEDINGS FROM THE 2017 WORLD WORKSHOP ON THE CLASSIFICATION OF PERIODONTAL AND PERI-IMPLANT DISEASES AND CONDITIONS
16. Loe H, Silness J. Periodontal disease in pregnancy. I. Prevalence and severity. Acta Odont Scand 1963;21:533-51.
17. . Silness J, Loe H. Periodontal disease in pregnancy. II. Correlation between oral hygiene and periodontal condition. Acta Odont Scand 1964;22:121-35.
18. Lo¨e H. The gingival index, the plaque index and the retention index systems. J Periodontol 1967;38(Suppl.6) 610-616.
19. Mombelli A, van Oosten MA, Schurch E Jr., Land NP. The microbiota associated with successful or failing osseointegrated titanium implants. Oral Microbiol Immunol 1987;2:145-151.
20. Mombelli A, Lang NP. Clinical parameters for the evaluation of dental implants. Periodontol 2000 1994; 4:81-86.
21. Chung DM, Oh TJ, Shotwell JL, Misch CE, Wang HL. Significance of keratinized mucosa in maintenance of dental implants with different surfaces. J Periodontol. 2006;77(8):1410–20.
22. Zigdon H, Machtei EE. The dimensions of keratinized mucosa around implants affect clinical and immunological parameters. Clin Oral Implants Res 2008;19: 387-392.
23. Bouri A Jr., Bissada N, Al-Zahrani MS, Faddoul F, Nouneh I. Width of keratinized gingiva and the health status of the supporting tissues around dental implants. Int J Oral Maxillofac Implants 2008;23: 323-326.
24. Kim BS, Kim YK, Yun PY, et al. Evaluation of periimplant tissue response according to the presence of keratinized mucosa. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2009;107:e24-e28.
25. Schrott AR, Jimenez M, Hwang JW, Fiorellini J, Weber HP. Five-year evaluation of the influence of keratinized mucosa on peri implant soft-tissue health and stability around implants supporting full-arch mandibular fixed prostheses. Clin Oral Implants Res 2009;20: 1170-1177.
26. Crespi R, Cappare` P, Gherlone E. A 4-year evaluation of the peri-implant parameters of immediately loaded implants placed in fresh extraction sockets. J Periodontol 2010;81:1629-1634.
27. Esfahanizadeh N, Daneshparvar N, Motallebi S, Akhondi N, Askarpour F, Davaie S. Do we need keratinized mucosa for a healthy peri-implant soft tissue? Gen Dent 2016 Jul-Aug;64(4):51-55.

28. Ladwein C, Schmelzeisen R, Nelson K, Fluegge TV, Fretwurst T. Is the presence of keratinized mucosa associated with periimplant tissue health? A clinical cross-sectional analysis. Int J Implant Dent 2015 Dec;1(1): 11-015-0009-z. Epub 2015 Apr 29
29. Souza AB, Tormena M, Matarazzo F, Araujo MG. The influence of peri-implant keratinized mucosa on brushing discomfort and peri-implant tissue health. Clin Oral Implants Res 2016 Jun;27(6):650-655.