The Significance of Keratinized Mucosa on Implant Health: An Umbrella Review

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Peri-implantitis is one of the challenges during implant treatments. This study helps improve implant treatments and reduce the risk of peri-implantitis. This study aims to provide the most recent insights into the therapeutic effectiveness of keratinized mucosa for dental implants that support prostheses. An electronic search was conducted across various databases, adhering to language restrictions and following PRISMA guidelines until August 2024. The PICO study question was: "For functioning dental implants, how effective is keratinized mucosa in enhancing peri-implant soft tissue conditions?" The eligibility requirements included all systematic reviews and meta-analyses that examined the impact of keratinized mucosa on the health of implants. Two qualified researchers evaluated the criteria independently while assessing the risk of bias associated with the selected articles. A third investigator is available to resolve any ambiguities that may arise during this process. A total of 10 research studies were found that investigated the impacts of keratinized mucosa on implant health. Involving 7139 participants, the findings indicated that a reduced width of keratinized tissue (KT) was linked to a higher incidence of increased plaque accumulation, soft tissue inflammation, and mucosal recession. The width of KT was notably linked to a reduction in inflammation around the implant. The presence of keratinized mucosa around dental implants correlates with improved peri-implant tissue health and a reduced risk of peri-implantitis. Nonetheless, further data are required.

Key Words: keratinized mucosa, dental implants, mucosal recession, umbrella review

Introduction

Since Brånemark et al[1] introduced osseointegration in dentistry, dental implants are now a commonly embraced option for substituting lost teeth. Significantly, the increasing adoption of dental implants among individuals aged 65 to 74, coupled with the aging population, suggests that the prevalence of dental implants could rise to 23% by 2026.[2]

With the growing popularity of dental implants, there has also been a notable increase in inflammatory conditions affecting the mucosa surrounding these implants. Research indicates that peri-implant mucositis occurs in nearly 48 percent of implant cases; in contrast, approximately 22% of individuals with dental implants are affected by peri-implantitis within 5 to 10 years of placement.[2,3]

The oral mucosa is a protective barrier for the underlying tissues, shielding them from various irritants. Keratinized mucosa (KM) is part of the masticatory mucosa surrounding teeth and dental implants, extending to the hard palate.[4,5]

Many studies have attempted to determine if there is a correlation between the absence or presence of KM and the development of peri-implantitis. However, the literature presents highly varied findings. Some studies suggest that inadequate KM correlates with a higher prevalence of peri-implantitis, while others find no significant relationship; a few even propose that the presence of KM may increase the risk of peri-implantitis.[6–8]

Furthermore, earlier review studies examining the effect of KM on implants have frequently merged data from different clinical settings and patients under various conditions. This broad methodology can make it challenging to draw clear conclusions due to confounding factors.[3,9,10]

As highlighted in the 2017 World Workshop report, the evidence surrounding the impact of KM width on peri-implantitis is still inadequate. Although some studies suggest that keratinized mucosa is crucial for preserving the health of peri-implant tissues, a direct link between the lack of keratinized mucosa and the development of implantitis remains unclear, mainly due to the absence of focused analyses on this issue.[11,12]

Keratinized mucosa width (KMW) is typically about 1 mm narrower in healthy implant sites compared to the KMW found in corresponding natural teeth. Generally, it is established that a KMW of at least 2 mm around dental implants is critical, as this dimension aids in preventing bone loss and soft-tissue recession while promoting effective oral hygiene. Therefore, ensuring adequate KMW at the intended implant locations is advisable.[13]

Although several observational studies support this perspective, the overall quality of evidence does not definitively pinpoint insufficient keratinized mucosa width as a risk factor for implantitis. Long-term studies focused on interventions are necessary to

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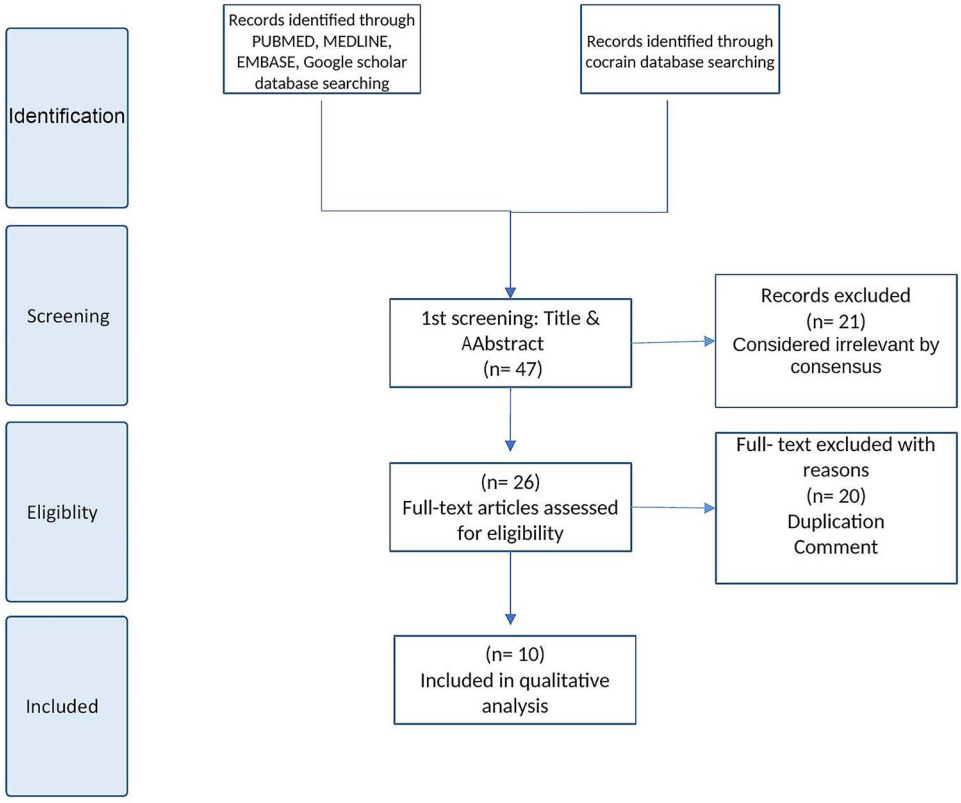


Figure. Flow Charts For The Studies were identified, displayed, and included in The Study.

accurately identify key risk factors for such conditions. In contrast, observational, cross-sectional, and retrospective studies may suggest potential risks but fail to establish a clear cause-and-effect relationship.[11]

The current literature remains ambiguous regarding the necessity of a minimum KMW to maintain the stability of implant tissues. Therefore, this umbrella review aims to thoroughly evaluate the evidence on whether insufficient KM increases the risk of peri-implantitis.

Methods

This review comprised systematic/meta-analytic studies and various resources that explored the presence of keratinized mucosal width (KMW) and its potential impact on peri-implant health. Notably, only 10 studies directly examined the significance of KM concerning implant health. Therefore, this umbrella study incorporated additional randomized and non-randomized comparative studies focusing on KMW and implant health outcomes.

Utilizing the PICO framework, the following question was formulated: "Does the presence of peri-implant KMW contribute to peri-implant health and stability in adult human subjects?" The "Population" included adult individuals undergoing dental implant placement. The "Intervention" involved evaluating cases with less than 2 mm of KMW at implant placement. The "Comparison" was made by assessing instances with 2 mm or more of KMW during the same procedure. The "Outcome" measures consisted of evaluating changes in probing depth (PD), soft-tissue recession, mean gingival index (mGI), the incidence of peri-implantitis, as well as marginal bone loss (MBL).

A search was conducted in electronic databases, including PubMed, MEDLINE, EMBASE, Cochrane Library, and Google Scholar, up to August 2024. This search adhered to language restrictions and followed PRISMA guidelines. The search strategy utilized both MeSH and non-MeSH terms: ("dental implant" OR "dental implantation" OR "oral implant" OR "implant" OR "dental implants") AND ("gingival height" OR "tissue thickness" OR "tissue biotype" OR "tissue phenotype" OR "tissue width" OR "keratinized mucosa") AND (systematic review OR meta-analysis).

Figure and Table 1 illustrate the data extraction procedure, which presents the key characteristics of the 10 studies included. Papers were deemed eligible for inclusion if they were "clearly comparative analyses of the significance of keratinized mucosa on implant health" and published in English. Papers were excluded from this review if they were review articles, abstracts, editorials, guidelines, protocols, or did not provide relevant clinical outcomes in a comparative analysis of KM on implant health.

Two reviewers (Q.P. and M.R.) evaluated the studies that qualified for analysis (Kappa = 1.0). One researcher (Q.P.) gathered qualitative data from the studies, whereas the second researcher (M.R.) confirmed all the verified information.

There are notable differences among the eligible papers (Table 1), demonstrating high heterogeneity between studies. Thus, assuming that all studies evaluated the same treatment effect is inappropriate. This review specifically focused on

TABLE 1

Baseline characteristics of systematic reviews assessing the significance of keratinized mucosa on implant health*

	Author (Year)	Types/No. of Studies Included	Patients No.	Method of Analysis	Search Period	Population	Interventions
1	Oh et al 2024[2]	11 RCTs	290	SR/MA	Up to 2020	keratinized mucosa augmentation using autogenous soft tissue grafts	KM augmentation using autogenous soft tissue grafts
2	Atieh et al 2024[16]	3 RCT 1 CS 1 RS 1 CCT	174	SR/MA	Up to August 10, 202	implants that were planned for second-stage implant surgery	Apically positioned flap with XCM.
3	Mahardawi et al 2023[8]	22	4044	16SM/ 6MA	2006–2021	Partially or fully edentulous patients, in need of the replacement of their missing teeth and lack an adequate width of keratinized mucosa in their edentulous sites	The placement of dental implants to support fixed or removable prosthesis.
4	Ravidà et al 2022[11]	7 PP 2 RCT	220	5 S/4 M	Up to 2021	–	The presence of < 2 mm of keratinized mucosa width at the time of implant placement.
5	Ramanauskaite et al, 2022[12]	15 CS, 5 comparative, 2 CS	1076	22S/15M	Up to 2021	Patients with dental implants;	Surgical procedure combined with any type of soft tissue substitute aimed to augment the width of KM
6	Montero et al 2022[17]	22 CC CS PP RT	—	15 S/7 M	November 13, 2022	Patients with dental implants;	Presence of KT < 2 mm
7	Moraschini et al 2020[18]	8 RCT 3 PP	304	11 S	2009–2019	Patients with dental implants	Relative to different soft tissue augmentation methods the clinical effects of XCM
8	Longoni et al 2019[10]	15 RCT	1031	15S/8M	Up to 2019	Systemically healthy adult human subjects undergoing implant therapy	The presence of< 2 mm of keratinized mucosa width at the time of implant placement.
9	Moraschini et al 2017[19]	4 RCT	—	4S	Up to 2015	Systemically healthy adult human subjects undergoing implant therapy	The presence of< 2 mm of keratinized mucosa width at the time of implant placement.
10	Thoma et al 2014[20]	4 RCT 6 RT		10 S	2011– 2016	Systemically healthy patients with dental implants.	Soft tissue grafting procedures to increase the keratinized tissue or the mucosal thickness at dental implant site

*CC, case-control; CCT, cohort control trial; CS, cross-sectional, cohort; CTG, connective tissue graft; FGG, free gingival graft; KM, keratinized mucosa; KT, keratinized tissue; MR, mucosal recession; PAS, percentage of attached soft tissue; PD, probing depth; PP, prospective; RCT, randomized controlled trial; RT, retrospective; XCM, xenogeneic collagen matrix.

comparing the reported outcomes from systematic/meta-analytic studies related to various interventions. Additionally, we employed the AMSTAR 2 tool to evaluate the risk of bias in systematic and meta-analytic studies across all study types.

To assess the quality of review articles, we employed a risk of bias assessment based on 16 questions from the AMSTAR 2 framework[14] (see Table 2). Each article was ultimately assigned a score reflecting its risk of bias. A score

Table 1

Extended

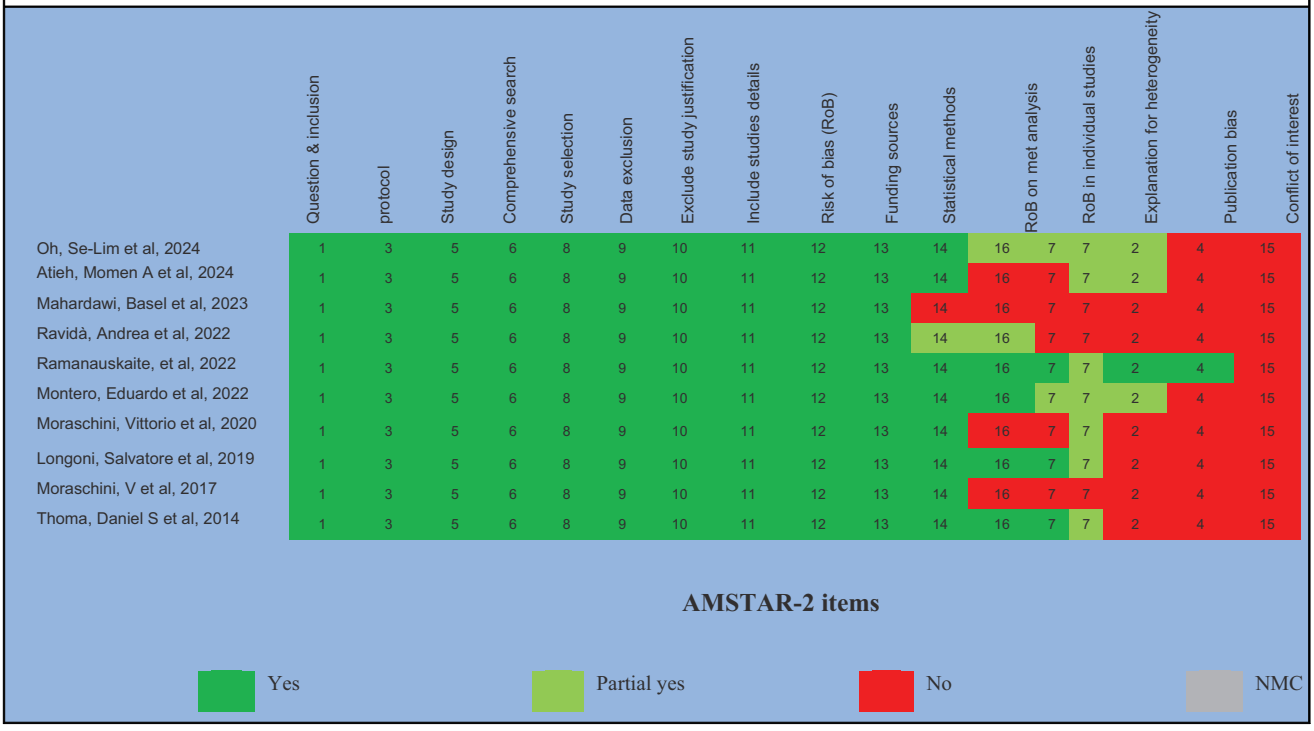
Comparison	Outcome's access	Main results	Risk of Bias	Review Quality
For dental implants retaining prostheses	A lack of KM, FGG, CTG, MR	A lack of KM negatively affects soft tissue health around dental implants. FGG was effective in increasing KM and reducing mucosal inflammation, whereas CTG was effective in decreasing MR		
Apically positioned flap with FGG.	Changes in width and thickness of keratinized mucosa, periodontal parameters, aesthetic outcomes, patient-reported outcome measures, and operating time	The augmentation of keratinized mucosa using FGG before the placement of the final prosthesis may have short-term positive effects on soft tissue	7 low/3 high	low
Partially- or fully-edentulous patients with adequate keratinized mucosa	occurrence of peri-implantitis	Peri-implantitis and should be accounted for when placing dental implants		
The presence of $\geq$2 mm of keratinized mucosa width at the time of implant placement	Implant survival rate, changes in probing depth, soft-tissue recession, clinical attachment level, mean gingival index, mean plaque index, and incidence of peri-implantitis 2. Radiographic: Marginal bone loss 3. Patient-reported outcomes	The impact of the amount of KMW (either$<$ 2 mm or $\geq$ 2 mm) as a risk factor for developing peri-implant disease remains low. Future control studies with proper sample size and longer follow-up are needed to further validate current findings		Low
The use of epithelized FGG or connective tissue grafts (CTG) to increase the width of KM	Changes in the width of KM	Free gingival grafts (FGG) are more effective in the augmentation of KM mucosa around dental implants than soft tissue substitutes. However, substitutes of xenogeneic origin may be an alternative to autogenous tissues		
Presence of KT $\geq$ 2 mm	Occurrence of peri-implant mucositis and/or peri-implantitis based on case definitions used in respective studies	Reduced KT width is associated with an increased prevalence of peri-implantitis, plaque accumulation, soft-tissue inflammation, mucosal recession, marginal bone loss, and greater patient discomfort	13 H/8 L	
The clinical effects of XCM on improving KMW	The change in percentage of KMW and GT	The use of XCM improved KMW and PD with rates comparable to those for CTG. XCM showed lower results for GT when compared to CTG. XCM presented similar results in terms of PAS when compared to CTG	2 H/9 L	
The presence of $\geq$2 mm of keratinized mucosa width at the time of implant placement	Changes in the width of KM	Adequate KT was significantly associated with less peri-implant inflammation, evaluated qualitatively with mGI/GI. No difference was found for plaque accumulation and bleeding, but a positive trend favoring implants with adequate KT was found.		
The presence of $\geq$2 mm of keratinized mucosa width at the time of implant placement	Changes in the width of KM	All systematic reviews included reported a positive association between an adequate KM width (2 mm) and peri-implant health.		
Implant sites without soft tissue grafting procedures or with (a) different grafting materials/transplants.	Peri-implant health is measured by a bleeding index or gingival index.	For gain of keratinized mucosa using autogenous grafts with a greater improvement of bleeding indices peri-implant health measured by a bleeding index or gingival index.	1 L/19 H	Low

with 8 to 11 affirmative responses indicated a low risk of bias; a score with 4 to 7 indicated a moderate risk; and a score with fewer than 3 affirmative responses signified a high risk of bias.[15]

Two qualified investigators assessed the articles, achieving a kappa value of 0.9. In cases where issues remained unresolved, a third investigator was brought in to assist in concluding.

TABLE 2

AMSTAR 2 Tool



RESULTS

A comprehensive search (PubMed, MEDLINE, EMBASE, Cochrane Library, and Google Scholar) databases identified 47 articles. After deleting duplicate entries, 26 papers remained to examine their titles/abstracts further. Upon careful evaluation, 21 studies met the eligibility criteria, leading to a thorough review of their full papers. Ten review articles[2,8,10–12,16–20] were selected for data extraction for this study (Figure; Table 1).

The risk of bias (ROB) was assessed using the AMSTAR 2 tool, which applies to diverse studies. The ROB was low across all systematic and meta-analysis reviews in this investigation. Articles with a low ROB were deemed to provide clinical evidence (Table 2).

Oh et al[1] conducted a study to assess the therapeutic effectiveness of enhancing KM for functional dental implants, focusing on the impact of a xenogeneic collagen matrix (XCM) in increasing the KMW around dental implants. They performed an electronic search across four databases for articles published before or during April 2020 without restrictions on the publication date or language. The review included eleven articles published between 2009 and 2019. Comparisons between XCM and connective tissue grafts (CTG) revealed no differences in the increase of KMW. However, the GT increase was significantly more significant when CTG was used ($P = .001$).[2]

Atieh et al[16] evaluated clinical outcomes and patient-reported results associated with enhancing KM around implants using free gingival grafts (FGGs) compared with XCM before prosthetic implant treatment. The review encompassed six studies with 174 participants—87 individuals received FGG, while the remaining were treated with XCM. At the 6-month follow-up, areas augmented with FGG exhibited fewer changes in the width of KM than those treated with XCM ($P = .05$). However, this difference reached only marginal significance.[16]

The research conducted by Mahardawi et al[8] in 2023 investigated the effect of the absence of KM on the risk of implantitis. The findings indicated a correlation between a KM deficiency and an increased peri-implantitis occurrence (OR = 2.78).[8]

Ravidà et al[11] conducted a study to assess whether the lack of a minimum KMW of 2 mm poses a risk for peri-implant diseases. The study included an analysis of implants placed in areas with a KMW of $\leq$2 mm. Notably, a significant advantage was observed for KMW of $\geq$2 mm, with a reduced mean plaque index ($P = .002$).[11]

In 2022, Ramanauskaite et al[12] conducted a review that included 10 published studies alongside 1 unpublished study that KM was significantly greater with autogenous grafts ($P = .001$).

Montero et al[17] aimed to evaluate how the width of KT influences the occurrence of peri-implant diseases. The authors calculated the weighted mean difference that accounted for varying widths of KT (notably, 0 mm, where the prevalence ranged from 20.5% to 53% and from 5.1% to 8%, respectively). Significant differences were identified between implants with KT $<$ 2 mm and those with KT $\geq$ 2 mm, indicating a clear preference for implants with a KT width of $\geq$ 2 mm.[17]

The 2020 study conducted by Moraschini et al[18] aimed to evaluate the clinical effects of XCM on the KMW surrounding dental implants. A thorough search was performed in 4 databases for articles published up to April 2020, with no restrictions on the

date or language, alongside a manual search of established journals. The results indicated no significant differences in the increase of KMW ($P = .14$) and reduction in PD when comparing XCM to connective tissue graft.

Maraschino et al[19] evaluated the review to assess the significance of KM in maintaining the health of peri-implant tissues. Each systematic review revealed a positive correlation between adequate width of KM ($\geq$ 2 mm) and the health of peri-implant tissues.

Discussion

This umbrella review study included 10 systematic/meta-analytic articles, encompassing 7139 participants and 132 articles (RCTs and non-RCTs). The outcomes evaluated across these umbrella studies were correlated with several key metrics. Research suggests that a narrower width of KT is associated with an increased risk of peri-implantitis, more significant plaque accumulation, heightened soft tissue inflammation, gum recession, loss of marginal bone, and higher levels of discomfort for patients. In a review conducted by Longoni et al,[10] the importance of having adequate KT width around dental implants was emphasized. Their findings indicated that sufficient KT is linked to a reduction in peri-implant inflammation. Although no significant differences were found regarding plaque accumulation or bleeding, a favorable trend was observed for implants surrounded by adequate KT.[10]

According to research by Ravidà et al,[11] the size of KM width (less than 2 or 2 mm and above) is a relatively minor risk factor for developing peri-implant disease. Conversely, Mahardawi et al[8] highlight that a deficiency in KM significantly increases the risk of peri-implantitis, an essential consideration during dental implant placement. Furthermore, Moraschini et al[19] found that all systematic studies demonstrated a positive correlation between adequate keratinized mucosa (with a minimum of 2 mm) and the health of peri-implant tissues.

Oh et al[2] and Moraschini et al[18] have demonstrated that the application of XCM results in improvements in keratinized mucosal width (KMW) and probing depth (PD) that are comparable to those achieved with connective tissue grafts (CTG). However, XCM exhibits reduced effectiveness in enhancing gingival thickness (GT) compared with CTG. Regarding the percentage of attached soft tissue (PAS), the outcomes for XCM are similar to those observed with CTG. Importantly, having keratinized mucosa surrounding dental implants is linked to improved health of peri-implant tissues.[1,21]

Consequently, XCM presents a viable option for implant sites where aesthetic considerations are critical or patient comfort and reduced surgical time are prioritized.

Atieh et al[16] propose that enhancing keratinized mucosa through applying FGG may lead to favorable outcomes in short-term soft tissue thickness.

It is indicated that FGGs are more effective than soft tissue substitutes in promoting KM around dental implants; however, xenogeneic-derived substitutes might present a viable alternative to autogenous tissues.[12]

Thoma et al[20] acknowledge that, despite the limitations of their review, soft tissue grafting procedures can enhance peri-implant health by (1) improving keratinized mucosa with autogenous grafts, resulting in better marginal bone levels and (2) increasing mucosal thickness with autogenous grafts.

Conclusion

The presence of keratinized mucosa around dental implants correlates with improved health of peri-implant tissues and a lower risk of peri-implantitis. The XCM is a viable option for aesthetically demanding sites, capable of enhancing the KMW and PD; however, it is less effective than connective tissue grafts (CTG) in increasing gingival thickness (GT). Adequate KT width is significantly associated with reduced peri-implant inflammation, though findings regarding plaque accumulation and bleeding are inconclusive. Grafting procedures, especially those utilizing autogenous grafts, demonstrate more significant advantages in enhancing peri-implant health, including improved bleeding indices and decreased marginal bone loss. However, there remains a lack of sufficient data regarding dental implants' long-term survival and success rates.

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