CODEN [USA]: IAJPBB ISSN : 2349-7750

INDO AMERICAN JOURNAL OF
PHARMACEUTICAL SCIENCES
SJIF Impact Factor: 7.187

Avalable online at: http://www.iajps.com *Research Article*

PRESENCE OR ABSENCE OF INFLAMMATION AND POOR ORAL HYGIENE IN ASSOCIATION WITH MINI IMPLANTS STABILITY: A SYSTEMATIC REVIEW AND META-ANALYSIS

Muhammad Kamran [1], Noor Alrefaei[2], Noura Alshahrani [3], Atheer Alghamdi[4], Fares Alharbi [5], Alhanoof Alesawi[6].

[1]Associate Professor, Department of Pediatric and Orthodontic Sciences, College of Dentistry, Khalid University, Abha, Saudi Arabia

[2]General Dentist, King Abdulaziz University, Jeddah, Saudi Arabia

[3]General Dentist, Khalid University, Abha, Saudi Arabia

[4] General dentist, King Abdulaziz University, Jeddah, Saudi Arabia

[5]General Dentist, King Abdulaziz University, Jeddah, Saudi Arabia

[6] General Dentist, King Abdulaziz University, Jeddah, Saudi Arabia

Article Received: August 2021 **Accepted:** September 2021 **Published:** October 2021

Abstract:

Introduction: *The causes of the biological instability of mini-implants are still a matter of discussion among dentistry clinicians. The aim of this systematic review and meta-analysis is to investigate inflammation of the soft tissue and poor oral hygiene as potential risk factors for mini-implant stability.* ***Methodology:*** *A systematic search of the literature of five major databases, PubMed, Web of Science, Science Direct, EBSCO, and Google Scholar, was carried out to include relevant and eligible literature.* ***Results:*** *Eight studies were included in this study, with a total of 1285 patients, and 316 of them were males. Inflammation and Poor oral hygiene were demonstrated as significant risk factors for mini-implants stability [OR, 2.37 (95% CI: 0.10, 4.65), P=0.04] and [OR, 5.7 (95% CI: 3.29, 8.1), P=0.000], respectively.* ***Conclusion:*** *We found that the presence of inflammation in the surrounding soft tissue of the mini-implants and poor oral hygiene are both significant risk factors for mini-implant stability.*

Keywords; *Mini-implant; orthodontics; stability; inflammation; oral hygiene.*

Corresponding author:

Muhammad Kamran,
Associate Professor,
Department of Pediatric and Orthodontic Sciences,
College of Dentistry, Khalid University, Abha, Saudi Arabia
E-Mial: mmuhammad@kku.edu.sa

QR code

Please cite this article in press Muhammad Kamran et al., ***Presence Or Absence Of Inflammation And Poor Oral Hygiene In Association With Mini Implants Stability: A Systematic Review And Meta-Analysis.,*** *Indo Am. J. P. Sci, 2021; 08(10).*

INTRODUCTION:

The increasing demand for adult orthodontic treatment and the necessity to use methods that need less patient co-operation has led, once they promote so-called skeletal anchorage, to generalized use of mini-implants [1, 2].

These devices were first introduced were into are in the orthodontics field by **Kanomi** for upper incisors and were initially used as bone fixation screws for orthognathic and facial reconstruction [3]. The mini-implants can be inserted into various areas of the oral cavity in order to provide skeletal anchorage due to their small size [4].

These anchorage devices were an important orthodontic component, particularly in challenging mechanical cases like tooth movement, severe overbite correction [5], anterior teeth retraction without moving anchorage teeth, molar intrusion for open bites, or even correction for control of vertical dimensions [6, 7].

Control of anchorage is a key factor for successful orthodontic treatment. In critical situations, skeletal anchoring can be very helpful. This was supported by dental implants [8], palatal implants [9], or mini-plates [10]. However, the main problem with this type of temporary anchoring device is the relatively high failure rates between 10 and 30% [11].

Stability refers to the reactive force resistance, which can result in unwanted movements from the teeth or other oral or extraoral structures [12]. Two types of stability can be identified in the case of mini-implants: primary and secondary. Mechanical stability is primarily achieved by compressing the bone with a mini-implant during an insert. At the moment of placement, secondary or biological stability is established and increases during bone reshaping or cure [13].

It takes at least 8 weeks to move between primary and secondary stability. Mini-implant failure may occur during this time. The appearance of mobility (eventual loss), inflammation, or infection is considered a mini-implant failure. Although orthodontic mini-implants achieve biological stability, osseointegration in this type of implant does not occur as they are temporary devices [13].

However, temporary anchorage devices (TADs) have several drawbacks. Soft tissue inflammations can cause poor osteointegration and loss of primary stability in surrounding tissues. Therefore, good oral hygiene is essential to maintain TAD stability because it is usually caused by low oral hygiene [14]. This systematic review and meta-analysis aim to investigate the presence or absence of inflammation and poor oral hygiene in association with mini-implant stability. The success rate will also be estimated.

Kuroda *et al.* reported that inflammation is possible because of the location of the mini-implant above the mucosal-gingival junction. Mini implants in this region tend to develop inflammation more generally [15]. **Chen *et al.*** and **Lee *et al.*** have reported that several other factors may affect the rate of failure/success, but the present review could not analyze them due to the lack of published papers. These include poor hygiene, surrounding tissue inflammation, and bone density, all of which were thought to play a role in the failure of the treatment [16, 17].

METHODOLOGY:

Study design and duration

This systematic review and meta-analysis were implemented between October 10, 2021, and November 10, 2021.

Study condition

This study investigated the published literature regarding the presence or absence of inflammation and oral hygiene in association with mini-implant stability. The success rate was also estimated.

Search strategy

A systematic electronic search of the literature of five major databases, PubMed, Web of Science, Science Direct, EBSCO, and Google Scholar, was conducted to include relevant and eligible literature. Our search process was limited to the English language and specialized for each database as necessary. The relevant study articles were defined through the following keywords that adjusted into Mesh terms in PubMed or subject terms as in Scopus; "Mini-implants," "micro-implants," "mini-screws," "skeletal anchorage," "inflammation," "inflammatory reaction," "oral hygiene," "success rate," "failure," and "stability." The appropriate keywords will be combined with Boolean operators such as "OR" and "AND." The search results were limited to full texts, accessible articles, human trials, and English.

Selection criteria

Our review included the studies with the following criteria:

- Study designs that provide the success rate of mini-implant intervention and its

associated factors, including inflammation and oral hygiene.
- Adult patients are aging >18 years.

Exclusion criteria comprised the following:
- Studies with patients younger than 18 years.
- Studies not conducted in the English language.
- Studies with no free access.
- Case reports or case series.

Data extraction

Rayyan (QCRI) [19] was used to determine the duplicate evaluation aspects of the search strategy outcomes. The researchers investigated titles and abstracts for convenience by screening the pooled search results using a set of inclusion/ exclusion criteria. The reviewers assessed the full text of the papers that met the inclusion criteria. The authors overcame any disagreements through debate and discussion. To include the eligible research, a data extraction form was created. The authors extracted information about the study titles, authors, study year, study design, population type, participant number, participant age (age range and mean age), gender, the success rate of mini-implant treatment, duration of observation, and the presence or absence of inflammation and oral hygiene.

Risk of bias assessment

To evaluate the quality of the included studies, the Newcastle-Ottawa scale (NOS) [20] was utilized for qualitative and quantitative data synthesis for cohort study articles.

Strategy for data synthesis

Summary tables comprising the eligible studies' collected details were presented to generate a qualitative overview of the included research features and outcome data. The extent of the recommended pooled analyses was examined once the data processing was assessed. After completing data extraction in this meta-analysis, decisions were taken on how to better use case and control data. Independent of the viability of the pooled meta-analyses, a qualitative synthesis of the determined data was carried out. Studies that meet the full-text inclusion requirements but did not provide numerical data on inflammation and oral hygiene as potential risk factors for mini-implants stability were excluded. The authors used Review Manager 5.4 [21] to perform quantitative data synthesis for the condition of interest analyses. The presence or absence of inflammation or oral hygiene as potential risk factors for mini-implants stability was evaluated using random-effects meta-analysis. As part of the pooled meta-analysis, heterogeneity was assessed using an I-square statistic. The funnel-plot and funnel-plot symmetry measurements were used to estimate publication bias.

RESULTS:

Search results

A total of 523 study articles have resulted from the initial systematic search. Rayyan (QCRI) identified and deleted 53 duplicates from these results. After the title and abstract screening, 426 studies were deleted either due to irrelevant findings or study design, followed by the full-text assessment and removal of an additional 36 studies due to irrelevant analysis, wrong outcome, wrong population, or not available numerical data on the success rate of mini-implant intervention and its associated factors, including inflammation and oral hygiene. This eventually resulted in a total of 8 eligible and unique study articles. The selection process and identification are presented in **Figure (1).**

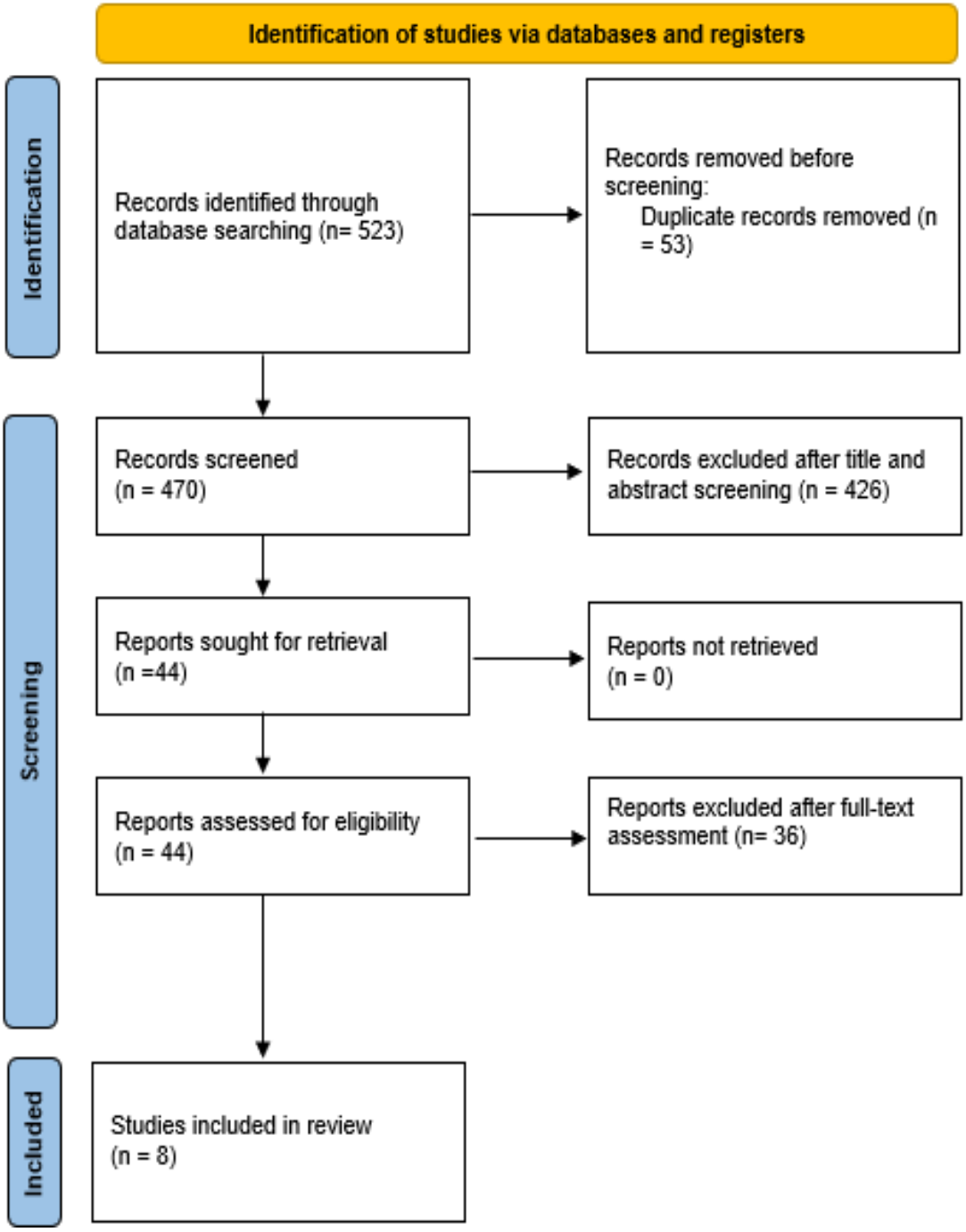


Figure (1): PRISMA flow chart presenting a summary of the study selection process.

Characteristics of the included studies

A total of 8 studies were included in this systematic review and meta-analysis, with 1285 patients, and 316 of them were males. Their mean ages ranged from (15.5 ± 8.3) [27] to (25.1 ± 8.7) [26]. Most studies were retrospective cohort studies [22-26, 29], one was a clinical trial [27], and one was a prospective study [28]. Two studies were conducted in Taiwan [23, 26], one in Korea [27], one in India [29], one in Japan [25], one in Pakistan [22], one in the USA [24], and one in Egypt [28]. The observation time ranged from 15 months [27] to 6 years [24].

Table (1): Summary of the characteristics of the included studies.

Study	Study design	Country	Total participants	Mean age	Males (%)	Condition	Treatment / observation time (years)	NOS
Azeem et al., 2019 [22]	Retrospective cohort study	Pakistan	110	18.6 ± 5.2	59 (19.5)	Mini-implants inserted in the retromolar (RM) area	5	7
Yao et al., 2015 [23]	Retrospective cohort study	Taiwan	643	29.3	113 (17.6)	Patients with Class I, II, or III malocclusions with titanium mini-implants	5	7
Uribe et al., 2015 [24]	Retrospective cohort study	USA	55	22.2 ± 11	13 (38.5)	Mini-implants in the infra-zygomatic (IZ) crest	6	8
Miyawaki et al., 2003 [25]	Retrospective cohort study	Japan	41	21.8 ± 7.8	5 (12.2)	Mini-implants inserted in the buccal alveolar bone of the posterior region	4	7
Chen et al., 2008 [26]	Retrospective cohort study	Taiwan	194	25.1 ± 8.7	42 (21.6)	Patients with Class I, II, or III malocclusions with mini-implants as TADs	3	9
Park et al., 2006 [27]	Clinical trial	Korea	87	15.5 ± 8.3	35 (41.7)	Patients with micro-screw implants as orthodontic anchorage	15 months	7
Aly et al., 2018 [28]	Prospective clinical trial	Egypt	82	NA	24 (29.3)	Patients with class I canine with inserted TADs	2	8
Sharma et al., 2011 [29]	Retrospective cohort study	India	73	22.45 ± 6	25 (34.2)	Patients with Class I, II, or III malocclusions with micro-implants	2	8

Inflammation as a risk factor for mini-implants stability

Five studies investigated the mini-implants stability in the presence of inflammation. Inflammation was demonstrated as a significant risk factor from mini-implants stability [OR, 2.37 (95% CI: 0.10, 4.65), P=0.04]. No significant inter-heterogeneity between studies was detected (I^2=0%, P=0.85) **Figure (2)**.

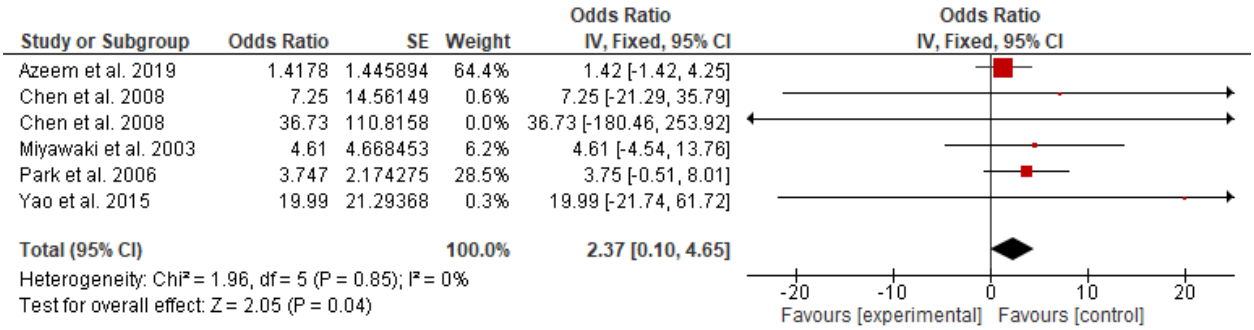


Figure (2): Forest plot of the effect of inflammation on mini-implants stability.

Poor oral hygiene as a risk factor for mini-implants stability

Five studies investigated the mini-implants stability in the presence of poor oral hygiene. Poor oral hygiene was found as a significant risk factor from mini-implants stability [OR, 5.7 (95% CI: 3.29, 8.1), P=0.000]. A significant inter-heterogeneity between studies was detected (I^2=85%, P=0.000) **Figure (3)**.

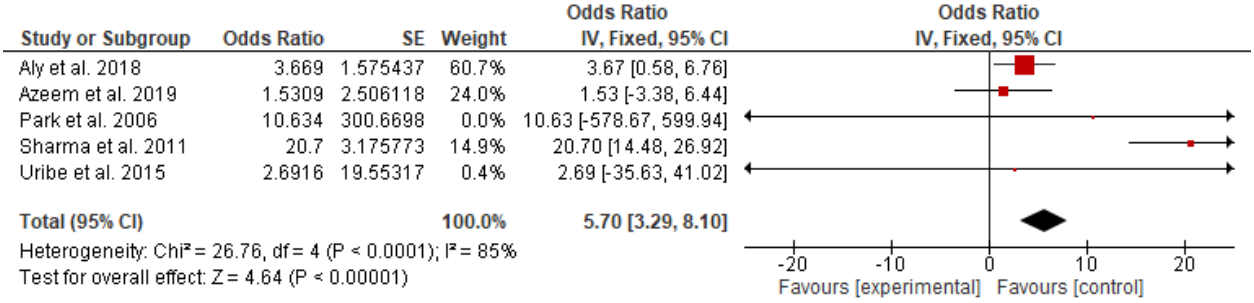
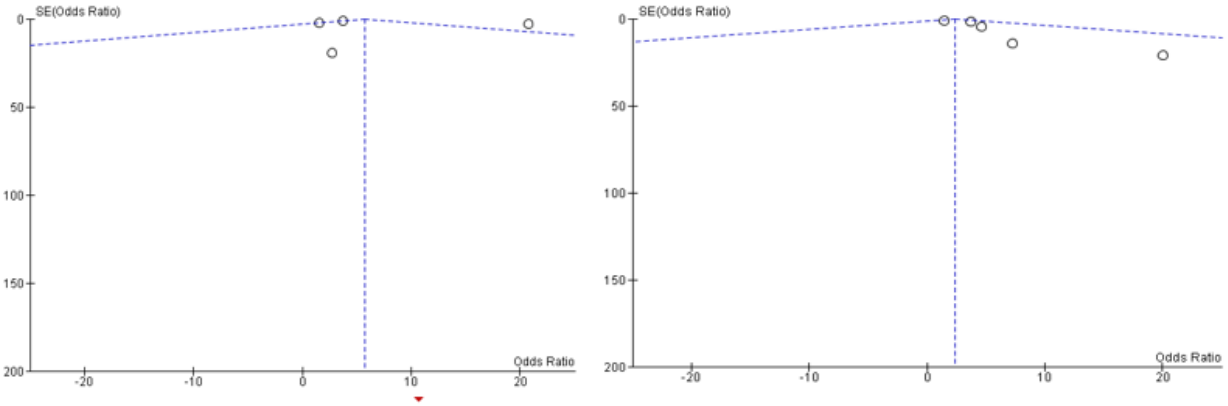


Figure (2): Forest plot of the effect of poor oral hygiene on mini-implants stability.

Publication bias

Visual inspection of the funnel plot reveals the asymmetrical distribution of presence or absence of inflammation and poor oral hygiene between studies as potential risk factors for mini-implants stability **Figure (3).**



a) Oral hygiene *b) Inflammation*

Figure (4): Funnel plot of publication bias detection.

DISCUSSION:

Bone anchorage is becoming increasingly widespread in orthodontic treatments [11]. As the literature demonstrates repeatedly, the advantages presented by mini-implants are numerous, and the technique reveals a success rate of over 80%. But when mini-implants fail, they do so within the first 8 weeks following placement, the period when implant stability varies from mechanical to biological stability [13].

This systematic review and meta-analysis have investigated inflammation and poor oral hygiene as potential risk factors for mini-implant stability. We found that inflammation and oral hygiene are significant risk factors for mini-implant stability with pooled ORs of (2.37) and (5.7), respectively. In contrast, a case series conducted by **Upadhyay *et al.*** demonstrated no significant difference concerning oral hygiene, but local inflammation had a prominent role in the success rate [18]. **Park *et al.*** also found that success rate was not affected by oral hygiene, but inflammation around the mini-implant did [27]. **Chen *et al.*** showed that soft tissue inflammation around the mini-implant was the most significant predictor of mini-implant failure [29]. Therefore, to improve stability, we should be instructed to meticulously control plaque of the soft tissue surrounding the mini-implants.

After 3 weeks of healing for TADs, stability, prevention of inflammation, and loading avoidance cannot be overemphasized even though osseointegration is not required. The importance of avoiding loading was first recognized for improved retention of TADs in the first 3 weeks when primary stability is established. This supports the fact that when primary bone contact decreased during the healing phase, the stability of the bone-implant was measured using resonance frequency (RF) in 3 weeks after placement [30].

Inflammation can result in the early destruction of the surrounding bone tissue, an essential element for the mechanical interdigitation of the mini-screw threads. Thus, TAD placing in the attached gingiva and meticulous oral hygiene should remain in place to ensure TAD stability throughout treatment to prevent inflammation of the surrounding tissues. Moreover, loading is only recommended after 3 weeks so that the main cure of the surrounding bone is not disturbed [26].

Oral hygiene was a significant factor in the success rate when the success rate was far better compared with those with poor oral hygiene in patients with good oral hygiene. Poor oral hygiene could result in food accumulation and gingival inflammation around TAD, leading to a failure in turn [28]. **Sharma *et al.*** found that the main factor affecting the success rate of TAD is oral hygiene and gingival inflammation [29]. **Melsen *et al.*** assessed the success rate of micro-implants among Asian patients. They reported that poor oral hygiene, high mandible angle, moving gingival position, and inflammation were associated with the micro-implant's failure. Therefore, the correct selection of cases and the recommended protocol are extremely important to prevent failures [31].

Limitations

The small number of studies investigating the variables analyzed in this study may lead to estimation errors or even fail to detect their importance. Further prospective studies could produce better information and better orthodontic treatment results with the use of mini-implants under controlled conditions.

CONCLUSION:

This systematic review and meta-analysis reported that the presence of inflammation in the surrounding soft tissue of the mini-implants and poor oral hygiene are both significant risk factors for mini-implant stability. The conclusions of this study were stated regarding the failure and success rates in association with the stability of the anchorage; therefore, more prospective clinical studies are required to investigate the associated factors with mini-implant stability.

REFERENCES:

1. Favero, L., Brollo, P., & Bressan, E. (2002). Orthodontic anchorage with specific fixtures: related study analysis. *American Journal of Orthodontics and Dentofacial Orthopedics*, *122*(1), 84-94.
2. Nojima, L. I., Nojima, M. G., Melgaço, C. A., Costa, L. F. M., & Neves, J. B. (2006). Temporary anchorage devices in orthodontics. *Esthetics in implantodology. Quintessence, São Paulo*, 269-282.
3. Kanomi, R. (1997). Mini-implant for orthodontic anchorage. *J. clin. Orthod.*, *31*, 763-767.
4. Roberts, W. E., Marshall, K. J., & Mozsary, P. G. (1990). Rigid endosseous implant utilized as anchorage to protract molars and close an atrophic extraction site. *The Angle Orthodontist*, *60*(2), 135-152.
5. Ohnishi, H., Yagi, T., Yasuda, Y., & Takada, K. (2005). A mini-implant for orthodontic anchorage in a deep overbite case. *The Angle Orthodontist*, *75*(3), 444-452.

6. Park, H. S., Bae, S. M., Kyung, H. M., & Sung, J. H. (2001). Micro-implant anchorage for treatment of skeletal Class I bialveolar protrusion.
7. Umemori, M., Sugawara, J., Mitani, H., Nagasaka, H., & Kawamura, H. (1999). Skeletal anchorage system for open-bite correction. *American Journal of Orthodontics and Dentofacial Orthopedics*, *115*(2), 166-174.
8. Kokich, V. G. (1996, June). Managing complex orthodontic problems: the use of implants for anchorage. In *Seminars in orthodontics* (Vol. 2, No. 2, pp. 153-160). WB Saunders.
9. Triaca, A., Antonini, M., & Wintermantel, E. (1992). Ein neues titan-Flachschrauben-Implantat zur orthodontischen Verankerung am anterioren Gaumen. *Inf Orthod Kieferorthop*, *24*, 251-257.
10. Umemori, M., Sugawara, J., Mitani, H., Nagasaka, H., & Kawamura, H. (1999). Skeletal anchorage system for open-bite correction. *American Journal of Orthodontics and Dentofacial Orthopedics*, *115*(2), 166-174.
11. Reynders, R., Ronchi, L., & Bipat, S. (2009). Mini-implants in orthodontics: a systematic review of the literature. *American Journal of Orthodontics and Dentofacial Orthopedics*, *135*(5), 564-e1.
12. LA FUNDACION, R. E., DEL MTA, F. D. U. C., ENCARGADOS, C. D. S. P. O., POR, F. D. P. D. E., & LA, M. O. E. (2019). Paraguay Oral Research.
13. Cadavid, D., Duque, L., Correa, S., H Buschang, P., & Roldan, S. (2014). Miniimplant stability in Orthodontics. "Bone Biology and Biomechanics". *CES Dentistry* , *27* (2), 93-103.
14. Deguchi, T., Takano-Yamamoto, T., Kanomi, R., Hartsfield Jr, J. K., Roberts, W. E., & Garetto, L. P. (2003). The use of small titanium screws for orthodontic anchorage. *Journal of dental research*, *82*(5), 377-381.
15. Kuroda, S., Sugawara, Y., Deguchi, T., Kyung, H. M., & Takano-Yamamoto, T. (2007). Clinical use of miniscrew implants as orthodontic anchorage: success rates and postoperative discomfort. *American Journal of Orthodontics and Dentofacial Orthopedics*, *131*(1), 9-15.
16. Chen, Y. J., Chang, H. H., Huang, C. Y., Hung, H. C., Lai, E. H. H., & Yao, C. C. J. (2007). A retrospective analysis of the failure rate of three different orthodontic skeletal anchorage systems. *Clinical oral implants research*, *18*(6), 768-775.
17. Lee, M. Y., Park, J. H., Kim, S. C., Kang, K. H., Cho, J. H., Cho, J. W., ... & Chae, J. M. (2016). Bone density effects on the success rate of orthodontic microimplants evaluated with cone-beam computed tomography. *American Journal of Orthodontics and Dentofacial Orthopedics*, *149*(2), 217-224.
18. Upadhyay, M., Yadav, S., & Nanda, R. (2010). Vertical-dimension control during en-masse retraction with mini-implant anchorage. *American journal of orthodontics and dentofacial orthopedics*, *138*(1), 96-108.
19. Ouzzani, M., Hammady, H., Fedorowicz, Z., & Elmagarmid, A. (2016). Rayyan—a web and mobile app for systematic reviews. Systematic reviews, 5(1), 1-10.
20. Wells, G. A., Shea, B., O'Connell, D. A., Peterson, J., Welch, V., Losos, M., & Tugwell, P. (2000). The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses.
21. Review Manager (RevMan) [Computer program]. Version 5.4, The Cochrane Collaboration, 2020.
22. Azeem, M., Saleem, M. M., Liaquat, A., Haq, A. U., Hamid, W. U., & Masood, M. (2019). Failure rates of mini-implants inserted in the retromolar area. International orthodontics, 17(1), 53-59.
23. Yao, C. C. J., Chang, H. H., Chang, J. Z. C., Lai, H. H., Lu, S. C., & Chen, Y. J. (2015). Revisiting the stability of mini-implants used for orthodontic anchorage. Journal of the Formosan Medical Association, 114(11), 1122-1128.
24. Uribe, F., Mehr, R., Mathur, A., Janakiraman, N., & Allareddy, V. (2015). Failure rates of mini-implants placed in the infrazygomatic region. Progress in orthodontics, 16(1), 1-6.
25. Miyawaki, S., Koyama, I., Inoue, M., Mishima, K., Sugahara, T., & Takano-Yamamoto, T. (2003). Factors associated with the stability of titanium screws placed in the posterior region for orthodontic anchorage. *American journal of orthodontics and dentofacial orthopedics*, *124*(4), 373-378
26. Chen, Y. J., Chang, H. H., Lin, H. Y., Lai, E. H. H., Hung, H. C., & Yao, C. C. J. (2008). Stability of miniplates and miniscrews used for orthodontic anchorage: experience with 492 temporary anchorage devices. Clinical oral implants research, 19(11), 1188-1196.
27. Park, H. S., Jeong, S. H., & Kwon, O. W. (2006). Factors affecting the clinical success of screw implants used as orthodontic anchorage. *American Journal of Orthodontics and Dentofacial Orthopedics*, *130*(1), 18-25.
28. Aly, S. A., Alyan, D., Fayed, M. S., Alhammadi, M. S., & Mostafa, Y. A. (2018). Success rates and factors associated with failure of temporary anchorage devices: a prospective clinical

trial. Journal of investigative and clinical dentistry, 9(3), e12331.
29. Sharma, P., Valiathan, A., & Sivakumar, A. (2011). Success rate of microimplants in a university orthodontic clinic. International Scholarly Research Notices, 2011.
30. Barewal, R. M., Oates, T. W., Meredith, N., & Cochran, D. L. (2003). Resonance frequency measurement of implant stability in vivo on implants with a sandblasted and acid-etched surface. *International Journal of Oral & Maxillofacial Implants*, *18*(5).
31. Melsen, B., & Verna, C. (2005, March). Miniscrew implants: the Aarhus anchorage system. In Seminars in Orthodontics (Vol. 11, No. 1, pp. 24-31). WB Saunders.