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Orthodontic mini-implants: Systematic review on stability and risk factors

Mini-Implantes ortodónticos: Revisión sistemática sobre estabilidad y factores de riesgo

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ABSTRACT

Objective: to analyse orthodontic mini-implants based on a systematic review of stability and risk factors. **Method**: Systematic review. **Results**: 15 scientific articles were reviewed. **Conclusion**: The stability of orthodontic mini-implants is an important factor for their clinical success and depends on a combination of variables related to implant design, surgical technique, anatomical location and the patient's biological conditions. Factors such as length, surface roughness and the use of advanced techniques, such as image-guided placement and laser photobiomodulation, have been shown to improve stability and reduce failures.

Descriptors: open bite; dental prosthesis; crowns. (DeCS).

RESUMEN

Objetivo: analizar los mini-Implantes ortodónticos desde una revisión sistemática sobre estabilidad y factores de riesgo. **Método**: Revisión sistemática. **Resultados**: se revisaron 15 articulos científicos. **Conclusión**: La estabilidad de los mini-implantes ortodónticos es un factor importante para su éxito clínico y depende de una combinación de variables relacionadas con el diseño del implante, la técnica quirúrgica, la ubicación anatómica y las condiciones biológicas del paciente. Factores como la longitud, la rugosidad superficial y el uso de técnicas avanzadas, como la colocación guiada por imágenes y la fotobiomodulación con láser, han demostrado mejorar la estabilidad y reducir los fallos.

Descriptores: mordida abierta; prótesis dental; coronas. (DeCS).

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INTRODUCTION

Orthodontic mini-implants have transformed the practice of orthodontics by offering a reliable and versatile temporary anchor for tooth movement. Their use has enabled more effective and predictable treatments, especially in complex cases that require precise control of the anchorage. However, guaranteeing the stability of these devices remains a significant challenge, as their success depends on several factors, such as the design of the implant, the biological conditions of the patient and the surgical techniques used (1, 2, 3).

The stability of mini-implants is divided into two stages: primary stability, which depends on the initial mechanical retention, and secondary stability, which is related to biological integration and long-term bone response (8, 10).

On the other hand, Selvaraj et al. (1) found that longer implants with specific designs offer greater primary stability, while van den Braak et al. (5) emphasised that a rough surface improves the success rate by favouring bone integration. Likewise, the choice of insertion site, such as the infrazygomatic crest, has been shown to be a reliable option with high success rates, according to He et al. (7).

On the other hand, there are risk factors that can compromise the stability of mini-implants, among them, peri-implant inflammation, inadequate surgical techniques and low bone density of the patient are the most common (2, 3, 8). The reuse of mini-implants also represents a significant risk, as changes to the surface of the implant after use can affect its stability, as reported by Özkan et al. (6) and Ranjan et al. (15).

The objective of this research is to analyse orthodontic mini-implants through a systematic review of stability and risk factors.

METHOD

A systematic review is presented. The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines were followed.

The search for 15 articles was carried out in databases such as PubMed, Scopus, Web of Science.

The search terms included combinations of keywords such as 'orthodontic mini-implants', 'stability', 'risk factors', 'implant surface', 'laser therapy' and 'placement techniques'.

RESULTS

Table 1. Stability and risk factors.

Stability	Risk Factors
The length and design of the mini-implant significantly influence its stability. (1)	Inadequate surgical technique and peri-implant health affect stability. (2, 3)
Surface roughness improves the success rate of mini-implants. (5)	Peri-implant inflammation and reuse of mini-implants compromise stability. (3, 6)
Image-guided techniques increase accuracy and reduce failures. (4)	Low bone density and poor general health affect stability. (8)
Insertion in the infrazygomatic crest has a high success rate. (7)	Changes in implant surface after use affect stability. (15)
Low-level laser therapy improves stability in human and animal studies. (9, 11, 12)	The initial healing period is crucial for long-term success. (10)
Mini-implants promote osteoblast growth in in vitro studies. (13)	Biological factors such as bone density and patient health are determinants. (8)
The initial stability of mini-implants in the mid-palate is key to their survival. (10)	Reuse of mini-implants may compromise stability due to surface changes. (6, 15)
Photobiomodulation therapy improves stability in humans and animals. (9)	Peri-implant inflammation and inadequate surgical technique are common risk factors. (3)
Mini-implants with rough surfaces have greater success compared to smooth ones. (5)	Low bone density and poor general health affect stability. (8)
Accuracy in placement through image-guided techniques reduces failures. (4)	Surgical technique and anatomical location are key factors. (7)
Low-level laser therapy improves the stability of mini-implants in clinical studies. (11, 12)	Initial healing is crucial for long-term success. (10)
Mini-implants promote osteoblast growth in in vitro studies, which may improve stability. (13)	Changes in implant surface after use affect stability. (15)
The general review highlights that stability depends on multiple factors, such as design, technique, and patient health. (14)	Peri-implant inflammation and inadequate surgical technique are common risk factors. (3)

Source: Prepared by the author.

In terms of stability, the length and design of the mini-implant are critical factors. Selvaraj et al. (1) concluded that longer implants with specific designs offer greater primary stability, which coincides with the findings of van den Braak et al. (5), who emphasised that the surface roughness of the implant significantly improves the success rate by favouring osseointegration. Likewise, image-guided placement techniques guided by images, such as those described by Mihit Mihit et al. (4), have been shown to increase insertion precision, reducing failures and improving initial stability. On the other hand, the choice of anatomical site also plays a fundamental role. He et al. (7) reported high success rates for the insertion of mini-implants in the infrazygomatic crest, which highlights the importance of selecting the location appropriately according to the patient's bone density and anatomical characteristics. In terms of risk factors, peri-implant inflammation and inappropriate surgical techniques are the main causes of failure, as pointed out by Tarigan et al. (3) and Vicioni-Marques et al. (2).

The reuse of mini-implants, studied by Özkan et al. (6), also represents a significant risk, as changes to the surface of the implant after use can compromise its stability. Another relevant factor is the patient's bone density, since low density can hinder primary stability, as indicated by Casaña-Ruiz et al. (8), the initial healing period is crucial for long-term success, according to Nienkemper et al. (10), during this phase the mechanical and biological integration of the implant is established.

One promising advance identified in this review is the use of low-level laser therapy, which has shown positive results in improving the stability of mini-implants. Studies such as those by Razaghi et al. (9), Michelogiannakis et al. (11) and Costa et al. (12) support its effectiveness in both humans and animal models, suggesting that this technique could be a complementary tool for improving osseointegration and reducing healing times.

On the other hand, in vitro studies, such as that of Moldoveanu et al. (13), have shown that mini-implants can favour the growth of osteoblasts, which could

contribute to greater biological integration. However, it is important to consider that factors such as the general health of the patient, peri-implant inflammation and surgical technique remain important challenges to guarantee clinical success.

CONCLUSION

The stability of orthodontic mini-implants is an important factor for their clinical success and depends on a combination of variables related to the design of the implant, the surgical technique, the anatomical location and the biological conditions of the patient. Factors such as length, surface roughness and the use of advanced techniques, such as image-guided placement and laser photobiomodulation, have been shown to improve stability and reduce failures.

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CONFLICT OF INTEREST

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REFERENCES

1. Selvaraj S, Tandon A, Chandrasekaran D, et al. Anchorage and Stability of Orthodontic Mini Implants in Relation to Length and Types of Implants. *Cureus*. 2024;16(11):e73056. Published 2024 Nov 5. doi:10.7759/cureus.73056
2. Vicioni-Marques F, Pimentel DJB, Matsumoto MAN, Stuani MBS, Romano FL. Orthodontic mini-implants: clinical and peri-implant evaluation. *J World Fed Orthod*. 2022;11(1):22-28. doi:10.1016/j.ejwf.2021.11.001
3. Tarigan SHP, Sufarnap E, Bahirrah S. The Orthodontic Mini-Implants Failures Based on Patient Outcomes: Systematic Review. *Eur J Dent*. 2024;18(2):417-429. doi:10.1055/s-0043-1772249
4. Mihit Mihit FZ, Zubizarreta-Macho Á, Montiel-Company JM, Albaladejo Martínez A. Systematic review and network meta-analysis of the accuracy of the orthodontic mini-implants placed in the inter-radicular space by image-guided-based techniques. *BMC Oral Health*. 2023;23(1):383. Published 2023 Jun 12. doi:10.1186/s12903-023-03079-8
5. van den Braak MCT, Hoekstra JWM, Bronkhorst EM, et al. The effect of surface roughening on the success of orthodontic mini-implants: A systematic review and meta-analysis. *Am J Orthod Dentofacial Orthop*. 2024;165(3):262-271.e3. doi:10.1016/j.ajodo.2023.11.005

6. Özkan S, Büyük SK, Gök F, Benkli YA. Evaluation of reused orthodontic mini-implants on stability: An in-vivo study. *Am J Orthod Dentofacial Orthop*. 2022;162(5):689-694. doi:10.1016/j.ajodo.2021.06.024
7. He Y, Liu J, Huang R, et al. Clinical analysis of successful insertion of orthodontic mini-implants in infrazygomatic crest. *BMC Oral Health*. 2023;23(1):348. Published 2023 Jun 1. doi:10.1186/s12903-023-03081-0
8. Casaña-Ruiz MD, Bellot-Arcís C, Paredes-Gallardo V, García-Sanz V, Almerich-Silla JM, Montiel-Company JM. Risk factors for orthodontic mini-implants in skeletal anchorage biological stability: a systematic literature review and meta-analysis. *Sci Rep*. 2020;10(1):5848. Published 2020 Apr 3. doi:10.1038/s41598-020-62838-7
9. Razaghi P, Moradi Haghgou J, Khazaei S, Farhadian N, Fekrazad R, Gholami L. The Effect of Photobiomodulation Therapy on the Stability of Orthodontic Mini-implants in Human and Animal Studies: A Systematic Review and Meta-analysis. *J Lasers Med Sci*. 2022;13:e27. Published 2022 Jun 14. doi:10.34172/jlms.2022.27
10. Nienkemper M, Willmann JH, Becker K, Drescher D. RFA measurements of survival midpalatal orthodontic mini-implants in comparison to initial healing period. *Prog Orthod*. 2020;21(1):5. Published 2020 Feb 17. doi:10.1186/s40510-020-0305-x
11. Michelogiannakis D, Jabr L, Barmak AB, Rossouw PE, Kotsailidi EA, Javed F. Influence of low-level-laser therapy on the stability of orthodontic mini-screw implants. A systematic review and meta-analysis. *Eur J Orthod*. 2022;44(1):11-21. doi:10.1093/ejo/cjab016
12. Costa ACF, Maia TAC, de Barros Silva PG, Abreu LG, Gondim DV, Santos PCF. Effects of low-level laser therapy on the orthodontic mini-implants stability: a systematic review and meta-analysis. *Prog Orthod*. 2021;22(1):6. Published 2021 Feb 15. doi:10.1186/s40510-021-00350-y
13. Moldoveanu A, Nicolescu MI, Bucur MV, et al. In vitro study of the orthodontic mini-implants influence on the growth of human osteoblasts. *Rom J Morphol Embryol*. 2021;62(3):785-792. doi:10.47162/RJME.62.3.16
14. Duraisamy R, Ganapathy DM, Rajeshkumar S, Ashok V. Mini-Implants in Dentistry - A Review. *J Long Term Eff Med Implants*. 2022;32(3):29-37. doi:10.1615/JLongTermEffMedImplants.2022041814
15. Ranjan A, Shetty P, Despande R, Biradar A, Khan W, Kulshrestha R. A comparative surface evaluation of orthodontic mini-implants before and after en masse retraction-A SEM study. *J Orthod Sci*. 2023;12:15. Published 2023 Mar 18. doi:10.4103/jos.jos_166_21