Research, Society and Development, v. 13, n. 2, e5713244967, 2024
(CC BY 4.0) | ISSN 2525-3409 | DOI: http://dx.doi.org/10.33448/rsd-v13i2.44967

The effect of excess cement on peri-implantitis: A literature review

O efeito do excesso de cimento na peri-implantite: Uma revisão de literatura

El efecto del exceso de cemento en la peri-implantitis: Una revisión de la literatura

Received: 01/29/2024 | Revised: 02/11/2024 | Accepted: 02/12/2024 | Published: 02/15/2024

Pedro Rodrigues Minim
ORCID: https://orcid.org/0000-0002-8200-5088
University of São Paulo, Brazil
E-mail: Pedro.minim@usp.br
Kevin Alexis Supa Benavente
ORCID: https://orcid.org/0009-0002-4125-5504
University of São Paulo, Brazil
E-mail: Supa.benavente@gmail.com
Jackeline Eliana Aranda Rischmoller
ORCID: https://orcid.org/0000-0002-7086-5806
University of São Paulo, Brazil
E-mail: Jackie.ar.95@gmail.com
Vinicius Carvalho Porto
ORCID: https://orcid.org/0000-0002-6609-9934
University of São Paulo, Brazil
E-mail: vcporto@fob.usp.br
Joel Ferreira Santiago Junior
ORCID: https://orcid.org/0000-0003-1735-2224
Sacred Heart University, Brazil
E-mail: jf.santiagojunior@gmail.com

Abstract
Peri-implantitis (PI) is a major dental implantology challenge. Excess cement (EC) significantly impacts PI onset and progression. This review clarifies unremoved EC's effects on peri-implant tissue. A literature search from 2012 to 2024 was conducted. Eleven studies examining EC's impact on peri-implant health were included. Investigated parameters were cement type, implant diameter, EC duration, and oral microbiota-cement interaction. Studies show EC as a key PI risk, with better outcomes post-removal. Larger implant diameters correlated with higher EC risks. EC retention duration directly affected PI severity. Different cements, like methacrylate-based cement (MeC) and zinc oxide and eugenol-based cement (ZOEC), varied in affecting PI. ZOEC notably mitigated PI risks and lacked in EC cases. Early PI detection and prompt removal are crucial. Choosing ZOEC cement can significantly reduce PI risks. Dentists should use minimal cement for implant restorations. Developing standard research methods is key to validate findings and guide practice.
Keywords: Dental implants; Dental cements; Peri-implantitis.

Resumo
A peri-implantite (PI) é um grande desafio na implantodontia. O excesso de cimento (EC) impacta significativamente o início e a progressão da PI. Esta revisão esclarece os efeitos do EC não removido no tecido peri-implantar. Foi realizada uma busca na literatura de 2012 a 2024. Onze estudos que examinavam o impacto do EC na saúde peri-implantar foram incluídos. Os parâmetros investigados foram o tipo de cimento, diâmetro do implante, duração do EC e a interação da microbiota oral com diferentes tipos de cimento. Os estudos mostram que o EC é um risco-chave para a PI, com a melhora dos resultados após sua remoção. Diâmetros maiores de implantes correlacionaram-se com maiores riscos de EC. A duração da retenção do EC afetou diretamente a severidade da PI. Diferentes cimentos, como o cimento à base de metacrilato (MeC) e o cimento à base de óxido de zinco e eugenol (ZOEC), variaram nos efeitos sobre o início e a progressão da PI. O ZOEC mitigou notavelmente os riscos de PI e estava ausente em casos de EC. A detecção precoce da PI e a remoção pronta são cruciais. Escolher o cimento ZOEC pode reduzir significativamente os riscos de PI. Os dentistas devem usar o mínimo de cimento para restaurações de implantes. Desenvolver métodos de pesquisa padrão é chave para validar as descobertas e orientar a prática.
Palavras-chave: Implantes dentários; Cimentos dentários; Peri-implantite.

Resumen
La periimplantitis (PI) es un gran desafío en la implantología dental. El cemento excesivo (EC) impacta significativamente el inicio y la progresión de la PI. Esta revisión aclara los efectos del EC no removido en el tejido periimplantario. Se realizó una búsqueda de literatura de 2012 a 2024. Se incluyeron once estudios que examinaban el

impacto del EC en la salud periimplantaria. Los parámetros investigados fueron el tipo de cemento, diámetro del implante, duración del EC e interacción de la microbiota oral con diferentes tipos de cemento. Los estudios muestran que el EC es un riesgo clave para la PI, con mejores resultados tras su eliminación. Diámetros de implantes mayores se correlacionaron con mayores riesgos de EC. La duración de la retención del EC afectó directamente la severidad de la PI. Diferentes cementos, como el cemento a base de metacrilato (MeC) y el cemento a base de óxido de zinc y eugenol (ZOEC), tuvieron efectos variados en el inicio y la progresión de la PI. El ZOEC mitigó notablemente los riesgos de PI y faltó en casos de EC. La detección temprana de la PI y su eliminación oportuna son cruciales. Elegir el cemento ZOEC puede reducir significativamente los riesgos de PI. Se aconseja a los dentistas usar el mínimo de cemento para restauraciones de implantes. Desarrollar métodos de investigación estándar es clave para validar los hallazgos y guiar la práctica.
Palabras clave: Implantes dentales; Cementos dentales; Periimplantitis**.**

1. Introduction

Implant-supported cemented prostheses (ICP) have gained attention due to their potential advantages over implant-supported screwed prostheses (ISP). These advantages encompass manufacturing simplicity and enhanced aesthetics, particularly as ICPs lack the visible prosthesis fixation screw canal (Chee et al., 2013; Fiorellini et al., 2019). Certain studies indicate increased resistance to occlusal loads in ICPs, credited to advanced ceramic layering and a denser metallic mass (Reda et al., 2022; Zaugg et al., 2018). Additionally, the reduced number of prosthetic components in ICPs might simplify occlusion control and make it more cost-effective (Frisch et al., 2016; Quaranta et al., 2017). However, a significant concern with ICPs is the high incidence of excess cement (EC) leakage into peri-implant tissues, reported in up to 60% of cases (Korsch et al., 2018; Linkevicius et al., 2013; Zaugg et al., 2018). Such leakage can lead to peri-implant disease (PID) and, in extreme cases, implant loss (Burbano et al., 2015; Reda et al., 2022).

Several factors contribute to EC occurrences. Notable among them are the termination position of the prosthetic crown, the implant diameter (ID), and the cement type (Ayyadanveettil et al., 2021; Korsch & Walther, 2015; Rohr et al., 2018; Romanos, 2019; Rotim et al., 2021). The location of crown terminations is pivotal; a deeper subgingival positioning increases the challenge of identifying and removing EC (Linkevicius et al., 2013; Zeinabadi et al., 2020). The ID also plays a significant role, with the difficulty of EC removal increasing proportionally to the ID size. The choice of cement has garnered research attention due to factors such as its viscosity and radiolucency, which can impact EC formation, detection, and the potential for biofilm development near the peri-implant tissue (PIT) (Wadhwani & Piñeyro, 2009).

Recent research by Wilson et al. (2019) indicates a surge in peri-implant tissue inflammation—up to 81%—when EC is not thoroughly removed. This inflammation arises because the cement, as a foreign body, provides an ideal surface for plaque buildup (Zandim-Barcelos et al., 2019). Conversely, while numerous studies have highlighted the potential negative effects of EC on dental implants, excessive material has been linked to complications, including pain, aesthetic issues, bleeding on probing (BoP), suppuration (Su), and bone support loss (BL) (Fiorellini et al., 2019; Quaranta et al., 2017; Santiago Garzón et al., 2018).

This study aims to review the literature to elucidate the negative consequences of unremoved EC on PIT, with a goal of deepening clinicians' understanding of these effects.

2. Methodology

To conduct this review eligibility criteria were rigorously defined based on the PICOS (Participants, Interventions, Comparisons, Outcomes, and Study Design) framework.

2.1 Search strategy

This review was guided by the fundamental question: “What are the negative consequences of unremoved EC on PIT?” To address this inquiry, a comprehensive literature search was conducted across PubMed/Medline, Web of Sciences, Embase, Scopus, Cochrane Library, Lilacs, and Scopus databases, also a search on Google Scholar was conducted so gray literature could be included. The search strategy employed keywords such as 'cement', 'dental', 'implant', and 'effect' and was limited to articles published between 2012 and 2024. Additional studies were identified through hand-searching the reference lists of included articles and reviews.

2.2 Eligibility criteria

Studies were imported into Mendeley (Reference Manager Software, Elsevier) for de-duplication. Inclusion and exclusion criteria were defined as follows based on the PICOS framework:

- **Participants**: Human participants with implant-supported cemented prostheses.
- **Interventions**: Any type of cement used in dental implants.
- **Comparisons**: Comparisons between different types of cement or cemented vs. screw-retained prostheses.
- **Outcomes**: Measures of efficacy, longevity, or complications.
- **Study Design**: Randomized and non-randomized clinical trials published in peer-reviewed journals.

Exclusion criteria included in vitro studies, animal studies, case reports, reviews, and studies focusing on other types of prostheses.

2.3 Data extraction

Two investigators (K.A.S.B and J.E.A.R) independently screened titles and abstracts against the eligibility criteria. Full-text articles were then assessed for final inclusion. Data extracted from the studies included sample size, interventions applied, outcomes observed, and study design. Discrepancies at any stage were resolved through discussion, and a third investigator (P.R.M) was consulted when consensus could not be reached.

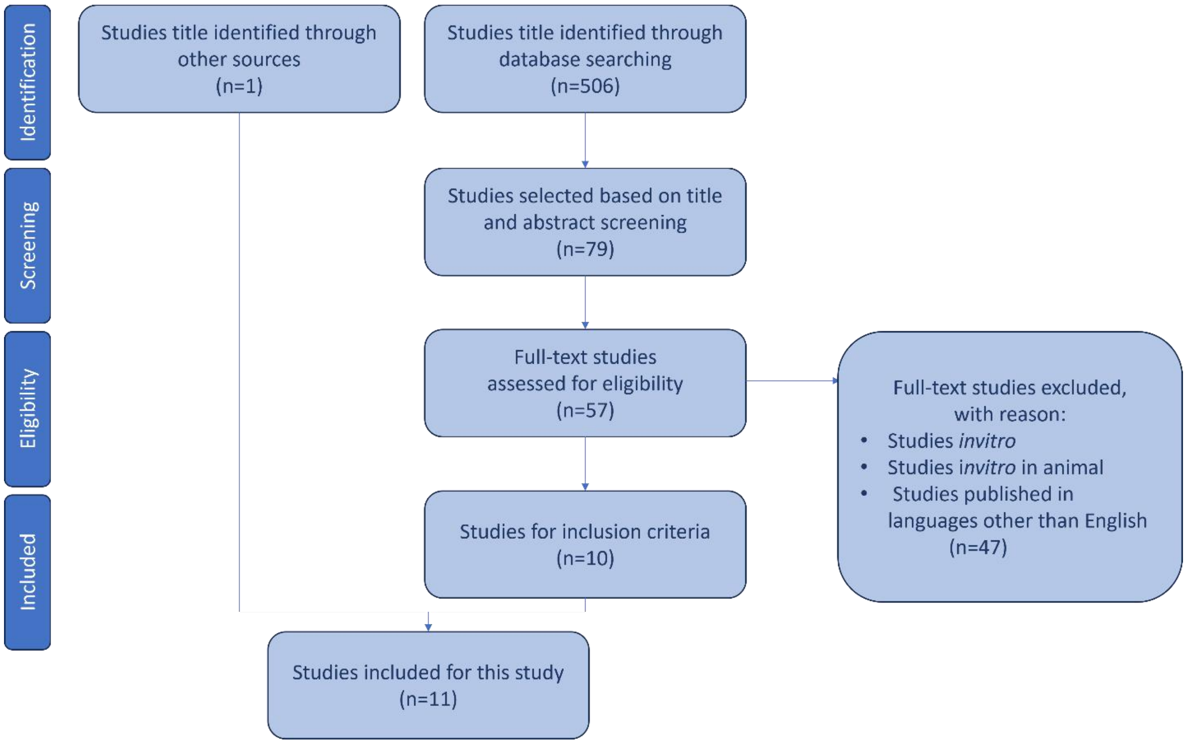
3. Results

3.1 Article selection

The article screening process is visualized in Figure 1, which outlines the reasons for exclusions during each step. An initial set of 506 studies was retrieved from the database search. After reviewing titles and abstracts, 68 studies were identified as relevant and cataloged in Mendeley software. Following this, KS and JA closely examined the 68 studies, scrutinizing their abstracts and applying the predefined inclusion and exclusion criteria. This in-depth evaluation resulted in the selection of 10 articles suitable for this review. Each of these articles then underwent a quality assessment.

Separately, JS conducted a manual search, identifying an additional article that met the inclusion criteria. As a result, the total number of studies included in this review stands at 11.

Figure 1 - Screening of the studies.



Source: Authors.

Table 1 - Screening of the studies.

STEP	DESCRIPTION	ARTICLES COUNT
DATABASE SEARCHING	Initial literature search conducted in databases	506
Title and Abstract Screening	Studies screened based on title and abstract	79
Full-Text Assessment	Full-text articles assessed for eligibility	57
Excluded Studies	Full-text studies excluded (in vitro, animal studies, non-English)	47
Studies for Inclusion	Studies meeting inclusion criteria	10
Additional Sources	Studies title identified through other sources	1
Total Studies Included	Total number of studies included in this study	11

Source: Authors.

3.2 Literature review

3.2.1 Relationship between screw-retained and cement-retained prostheses and peri-implant disease

In a study by Kotsakis et al. (2016), the relationship between the type of ICP and PID was explored through an examination of 135 participants. Of this group, 31 had partial coverage restorations using zinc oxide and eugenol-based cement (ZOEC), while 83 opted for full-coverage ICPs. An intraoral clinical examination (ICE) assessed the presence of BoP, probing depth (PD), and the oral hygiene index (OHI). Based on these findings, participants were divided into two groups: those with healthy PIT and those showing signs of diseased PIT.

Among the ISP users, 64 individuals (77.11%) showed signs of PID. Conversely, in the ZOEC group, 25 participants, or 80.65%, displayed PID symptoms. However, despite these high percentages, there was no statistically significant difference between the ISP and ZOEC groups in the prevalence of PID. Kotsakis et al. (2016) suggested that, with thorough removal of excess cement, the use of partial coverage restorations does not compromise patients' peri-implant health.

3.2.2 Relationship between the presence of residual cement and peri-implant disease.

Numerous studies have investigated the link between residual EC in ICP and the development of PID. In this review, nine out of eleven articles specifically examined this relationship. Across these studies, 777 crowns were removed from implants, with EC identified in an average of 61.5% (± 2.95%) of these cases. Afterward, these crowns were disinfected with chlorhexidine and cemented using zinc oxide and ZOEC.

A key finding from this collective review is that 84.9% (ranging between 80% and 100%) of crowns with residual EC also showed signs of PID, from BoP to significant BL. This relationship has been consistently highlighted analyzed studies (Korsch et al., 2015a, 2015b, 2017, 2018; Korsch, Obst, et al., 2014; Korsch, Walther, et al., 2014; Kotsakis et al., 2016; Linkevicius, et al., 2013; Terra et al., 2019).

3.2.3 Relationship between the implant diameter and the presence of excess cement.

Several factors can influence the presence of EC in PCIs. Exploring this, Korsch et al. (2015a) examined 126 PCIs, assessing for EC, BoP, Su, IL, BL, ID, and the specific cement type used. When comparing implant diameters, EC was found in 66.8% of larger-diameter implants. In contrast, regular and narrow-diameter implants showed EC rates of 59.1% and 45.2%, respectively. Based on these observations, the study suggests that an increase in ID is linked to heightened risks of EC, PID, and potential implant failure.

3.2.4 Relationship between the residence time of excess cement and the severity of pid.

The duration of EC retention within the PIT plays a role in PID progression. To explore this, Korsch and Walther (2015) studied 171 ICPs, all cemented using methacrylate-based cement (MeC). The sample was divided based on the intraoral duration of the cement: one group had shorter residence times and the other had longer residence times. During the ICE for each prosthesis, the presence of EC, BoP, and Su was recorded. Initial findings for the shorter duration group showed 60 cases (47.6%) with both BoP and EC and 16 cases (12.6%) with Su alongside EC. For the longer duration group, 28 cases (62.2%) displayed BoP and EC, while 25 cases (55.5%) showed Su in association with EC. The study concluded that the clinical inflammation indicators were related either to the duration of EC retention or its mere presence.

3.2.5 Types of cement and their behavior in pit

Following their initial ICE, Korsch and Walther (2015) proceeded with a non-surgical peri-implant treatment for all studied implants. All MeC residues were meticulously removed from the PCIs, which were then cemented with zinc oxide and ZOEC. A subsequent ICE showed a decline in BoP cases: nine implants in group 1 and eight in group 2. When compared with initial ICE findings, this represented a reduction of 74% and 71% in BoP manifestations for the respective groups. As for Su, group 1 showed a total reduction (100%), while group 2 had a decline of 88%. Based on these results, the study concluded that the presence of MeC was directly related to the onset of clinical symptoms indicative of PID.

3.2.6 Relationship between the oral microbiota and the different types of cement.

The influence of oral microbiota on different dental cements was investigated in two selected studies. In both studies, prostheses initially cemented with MeC were detached, and the presence of EC and Su was noted. After collecting a gingival fluid sample for analysis, the prostheses were recemented with ZOEC and later reassessed.

With the application of ZOEC, no instances of EC were observed. However, when MeC was used, Korsch et al. (2017) found EC in 40% (n =24) of their samples, and Korsch et al. (2018) reported a 60% (n=12) prevalence. Given ZOEC's lack of EC, determining its potential impact on the PIT became difficult. Still, the authors concluded that ZOEC, with its beneficial properties, appears suitable as a permanent cement for fixed dental restorations on implants.

4. Discussion

PI represents a significant challenge in contemporary dental practice due to its prevalence among dental implant patients (Kotsakis et al., 2016). This review sought to clarify the role of EC in the onset of PI and the correlation between EC presence and PI severity. Of the literature explored, studies consistently highlighted EC as a pronounced risk factor for PI, with its removal often leading to improved clinical outcomes (Korsch et al., 2015a; Korsch et al., 2015b; Korsch et al., 2017; Korsch et al., 2018). This underscores the clinical imperative: when cementing restorations to implants, the use of minimal cement is advised to reduce PI risks (Korsch & Walther, 2015).

Furthermore, the relationship between the duration of EC retention and PI severity emerged as a focus. One study suggested that clinical markers of inflammation are associated with either the revision time or the presence of EC, highlighting the importance of swift EC revision and removal for effective PI management (Korsch & Walther, 2015). The preference for cements that allow seamless removal without damaging the implant or adjacent tissues is evident (Korsch et al., 2015a).

The cement type is pivotal in PI's onset. Comparisons between MeC and ZOEC highlighted distinct outcomes. The utilization of MeC was integral to the clinical symptoms indicative of PI, while ZOEC's adoption correlated with a marked reduction in PI severity (Korsch et al., 2017; Korsch et al., 2018). Given this distinction, dental practitioners are advised to prefer ZOEC to mitigate PI risks (Linkevicius, et al., 2013).

Additionally, the interplay between oral microbiome and cement type in PI's development was assessed. Findings from two studies revealed the absence of EC when ZOEC was used, contrasting with its presence in MeC cases (Korsch et al., 2017; Korsch et al., 2018). The nonexistence of EC with ZOEC suggests its benign nature regarding implant health, although further investigations are needed for a definitive stance. Nonetheless, ZOEC's adoption as a favored permanent cement is recommended, given its efficacy in fixed dental implant restorations (Terra et al., 2019).

It's paramount to acknowledge this review's constraints. Solely focusing on English-language publications might omit significant studies in other languages. Furthermore, the variability in sample sizes, longitudinal follow-ups, and treatment protocols across the studies might introduce outcome disparities. This highlights the need for future research with standardized methodologies to validate the insights presented (Page et al., 2021).

5. Conclusion

To conclude, this review illuminates the salient role of EC as a key risk determinant for PI onset, underscoring the clinical benefits of its timely removal. Both the cement's classification and the duration of EC presence significantly influence PI's evolution. Dental practitioners are advised to use minimal cement quantities during implant restoration procedures and to give preference to ZOEC to reduce PI susceptibility. Further rigorous investigations are paramount to reaffirming these conclusions and crafting standardized modalities for efficacious PI management.

Therefore, to advance PI research, future studies should focus on:

- Multi-center trials to assess the long-term effects of cement types on peri-implant health.
- Development and evaluation of new cements and removal techniques to prevent peri-implantitis.
- Creation of standardized clinical guidelines for optimal cement use in implantology.

References

Ayyadanveettil, P., Thavakkara, V., Koodakkadavath, S., & Thavakkal, A. (2021). Influence of collar height of definitive restoration and type of luting cement on the amount of residual cement in implant restorations: A clinical study. *Journal of Prosthetic Dentistry*, 1–7. https://doi.org/10.1016/j.prosdent.2021.03.032

Burbano, M., Wilson, T., Valderrama, P., Blansett, J., Wadhwani, C., Choudhary, P., Rodriguez, L., & Rodrigues, D. (2015). Characterization of Cement Particles Found in Peri-implantitis–Affected Human Biopsy Specimens. *The International Journal of Oral & Maxillofacial Implants*, 30(5), 1168–1173. https://doi.org/10.11607/jomi.4074

Chee, W. W. L., Duncan, J., Afshar, M., & Moshaverinia, A. (2013). Evaluation of the amount of excess cement around the margins of cement-retained dental implant restorations: The effect of the cement application method. *Journal of Prosthetic Dentistry*, 109(4), 216–221. https://doi.org/10.1016/S0022-3913(13)60047-5

Fiorellini, J., Luan, K., Chang, Y.-C., Kim, D., & Sarmiento, H. (2019). Peri-implant Mucosal Tissues and Inflammation: Clinical Implications. *The International Journal of Oral & Maxillofacial Implants*, 34, s25–s33. https://doi.org/10.11607/jomi.19suppl.g2

Frisch, E., Ratka-Krüger, P., Weigl, P., & Woelber, J. (2016). Extraoral Cementation Technique to Minimize Cement-Associated Peri-implant Marginal Bone Loss: Can a Thin Layer of Zinc Oxide Cement Provide Sufficient Retention? *The International Journal of Prosthodontics*, 29(4), 360–362. https://doi.org/10.11607/ijp.4599

Korsch, M., Marten, S. M., Walther, W., Vital, M., Pieper, D. H., & Dötsch, A. (2018). Impact of dental cement on the peri-implant biofilm-microbial comparison of two different cements in an in vivo observational study. *Clinical Implant Dentistry and Related Research*, 20(5), 806–813. https://doi.org/10.1111/CID.12650

Korsch, M., Obst, U., & Walther, W. (2014). Cement-associated peri-implantitis: a retrospective clinical observational study of fixed implant-supported restorations using a methacrylate cement. *Clinical Oral Implants Research,* 25(7), 797–802. https://doi.org/10.1111/CLR.12173

Korsch, M., Robra, B. P., & Walther, W. (2015a). Predictors of excess cement and tissue response to fixed implant-supported dentures after cementation. *Clinical Implant Dentistry and Related Research*, 17(S1), e45–e53. https://doi.org/10.1111/cid.12122

Korsch, M., Robra, B.-P., & Walther, W. (2015b). Cement-Associated Signs of Inflammation: Retrospective Analysis of the Effect of Excess Cement on Peri-implant Tissue. *The International Journal of Prosthodontics*, 28(1), 11–18. https://doi.org/10.11607/ijp.4043

Korsch, M., & Walther, W. (2015). Peri-Implantitis Associated with Type of Cement: A Retrospective Analysis of Different Types of Cement and Their Clinical Correlation to the Peri-Implant Tissue. *Clinical Implant Dentistry and Related Research*, 17, e434–e443. https://doi.org/10.1111/cid.12265

Korsch, M., Walther, W., & Bartols, A. (2017). Cement-associated peri-implant mucositis. A 1-year follow-up after excess cement removal on the peri-implant tissue of dental implants. *Clinical Implant Dentistry and Related Research,* 19(3), 523–529. https://doi.org/10.1111/cid.12470

Korsch, M., Walther, W., Marten, S. M., & Obst, U. (2014). Microbial analysis of biofilms on cement surfaces: An investigation in cement-associated peri-implantitis. *Journal of Applied Biomaterials and Functional Materials*, 12(2), 70–80. https://doi.org/10.5301/jabfm.5000206

Kotsakis, G. A., Zhang, L., Gaillard, P., Raedel, M., Walter, M. H., & Konstantinidis, I. K. (2016). Investigation of the Association Between Cement Retention and Prevalent Peri-Implant Diseases: A Cross-Sectional Study. *Journal of Periodontology*, 87(3), 212–220. https://doi.org/10.1902/jop.2015.150450

Linkevicius, T., Puisys, A., Vindasiute, E., Linkeviciene, L., & Apse, P. (2013). Does residual cement around implant-supported restorations cause peri-implant disease? A retrospective case analysis. *Clinical Oral Implants Research*, 24(11), 1179–1184. https://doi.org/10.1111/j.1600-0501.2012.02570.x

Linkevicius, T., Vindasiute, E., Puisys, A., Linkeviciene, L., Maslova, N., & Puriene, A. (2013). The influence of the cementation margin position on the amount of undetected cement. A prospective clinical study. *Clinical Oral Implants Research*, 24(1), 71–76. https://doi.org/10.1111/j.1600-0501.2012.02453.x

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., & Moher, D. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*, n71. https://doi.org/10.1136/bmj.n71

Quaranta, A., Lim, Z. W., Tang, J., Perrotti, V., & Leichter, J. (2017). The Impact of Residual Subgingival Cement on Biological Complications Around Dental Implants: A Systematic Review. In Implant Dentistry. 26(3), 465–474. Lippincott Williams and Wilkins. https://doi.org/10.1097/ID.0000000000000593

Reda, R., Zanza, A., Cicconetti, A., Bhandi, S., Guarnieri, R., Testarelli, L., & Di Nardo, D. (2022). A Systematic Review of Cementation Techniques to Minimize Cement Excess in Cement-Retained Implant Restorations. *Methods and Protocols,* 5(1). https://doi.org/10.3390/MPS5010009

Rohr, N., Märtin, S., & Fischer, J. (2018). Correlations between fracture load of zirconia implant supported single crowns and mechanical properties of restorative material and cement. *Dental Materials Journal*, 37(2), 222–228. https://doi.org/10.4012/dmj.2017-111

Romanos, G. (2019). A Simplified Technique to Control Excess Cement Material Underneath Cement-Retained Implant Restorations: Technical Note. *The International Journal of Oral & Maxillofacial Implants,* 34(2), e17–e19. https://doi.org/10.11607/jomi.7492

Rotim, Ž., Pelivan, I., Sabol, I., Sušić, M., Ćatić, A., & Bošnjak, A. P. (2021). The effect of local and systemic factors on dental implant failure-analysis of 670 patients with 1260 implants. *Acta Clin Croat,* 60(3), 2021. https://doi.org/10.20471/acc.2021.60.03.05

Santiago Garzón, Hernan, Alfonso C, Tocora C, Castro J, Cifuentes J, Cuellar J, T. N. (2018). relationship between dental cement materials of implant - supported crowns with peri-implantitis development in humans: a sistematic review of literature. Journal of Long-Term Effects of Medical Implants, 28(3), 223–232.
Terra, E., Berardini, M., & Trisi, P. (2019). Nonsurgical Management of Peri-implant Bone Loss Induced by Residual Cement: Retrospective Analysis of Six Cases. *The International Journal of Periodontics & Restorative Dentistry,* 39(1), 89–94. https://doi.org/10.11607/PRD.3075

Wadhwani, C., & Piñeyro, A. (2009). Technique for controlling the cement for an implant crown. *Journal of Prosthetic Dentistry*, 102(1), 57–58. https://doi.org/10.1016/S0022-3913(09)60102-5

Wilson, T. G. (2019). A New Minimally Invasive Approach for Treating Peri-Implantitis. *Clinical Advances in Periodontics*, 9(2), 59–63. https://doi.org/10.1002/cap.10052

Zandim-Barcelos, D. L., Carvalho, G. G. De, Sapata, V. M., Villar, C. C., Hämmerle, C., & Romito, G. A. (2019). Implant-based factor as possible risk for peri-implantitis. *Brazilian Oral Research,* 33. https://doi.org/10.1590/1807-3107BOR-2019.VOL33.0067

Zaugg, L. K., Zehnder, I., Rohr, N., Fischer, J., & Zitzmann, N. U. (2018). The effects of crown venting or pre-cementing of CAD/CAM-constructed all-ceramic crowns luted on YTZ implants on marginal cement excess. *Clinical Oral Implants Research*, 29(1), 82–90. https://doi.org/10.1111/clr.13071

Zeinabadi, Z., Nami, M., Naserkhaki, M., & Tavakolizadeh, S. (2020). Effect of Cement Type and Cementation Technique on the Retention of Implant-Supported Restorations. *Journal of Long-Term Effects of Medical Implants,* 30(1), 61–67. https://doi.org/10.1615/JLONGTERMEFFMEDIMPLANTS.2020035290