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The Influence of Hypothyroidism on Bone Healing and Peri-Implantitis in Dental Implants

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تأثير قصور الغدة الدرقية على التئام العظام والتهاب المنطقة المحيطة بالزرعات السنية

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Abstract:
Thyroid disorders have been linked to peri-implantitis, a debilitating inflammatory disease that affects implant-bearing dental prostheses. These are conditions such as hypothyroidism (underactive thyroid), hyperthyroidism (overactive thyroid), and autoimmune diseases affecting the thyroid. This review summarizes the most recent research that sheds light on the complicated link between thyroid dysfunction and peri-implantitis. It focuses on the possible underlying pathogenic pathways that could make these people more likely to have their implants fail after surgery due to immune system dysregulation, hormonal imbalance, and worse treatment outcomes. The paper discusses the clinical implications for peri-implant health, including a higher risk of implant inflammation, lower healing ability, and poorer treatment outcomes. The second idea is to apply the implant concept to two different areas of dentistry. We will look at whether thyroid disease and dysfunction have an effect by ignoring the oral cavity and peri-implant disease or taking joint clinical involvement into account. Then we will consider the therapeutic considerations, and the management of patients affected by thyroid disease and suffering from periimplantitis, stressing the pivotal role of dental teamwork and the multifaceted approach to customized treatment. We aim to enhance our understanding of the impact of thyroid pathology and dysfunction. Suppose we include the implant in the generalized oral-systemic association. In that case, we can now broaden the concept to include two topics that are not commonly associated in the dental field: we inquire whether the presence of thyroid pathology and dysfunction influences the decision to ignore the oral cavity and its associated peri-implant disease or to consider joint clinical involvement. Then, we discuss specific therapeutic considerations and the management of patients with thyroid disease associated with peri-implantitis, emphasizing the critical role of dental teamwork and the multipronged approach to customized treatment. We aim to enhance our understanding of the effects of thyroid pathology and dysfunction. In planning this study, the group set out to describe the characteristics of peri-implantitis as a periodontal disease. The group aimed to synthesize knowledge on peri-implantitis and current treatment alternatives. To improve patient outcomes, and support clinical decision-making with current knowledge.

Keywords: autoimmune thyroid diseases, peri-implantitis, dental implants, inflammation, risk factors, treatment strategies, bone metabolism, thyroid disorders, hypothyroidism.

الملخص
تم ربط اضطرابات الغدة الدرقية بالتهاب حول الغرسة، وهو مرض التهابي منهك يؤثر على أطقم الأسنان التي تحمل الزرعات. وتشمل هذه الحالات قصور الغدة الدرقية، وفرط نشاط الغدة الدرقية، وأمراض المناعة الذاتية التي تؤثر على الغدة الدرقية .تلخص هذه المراجعة أحدث الأبحاث التي تلقي الضوء على العلاقة المعقدة بين خلل الغدة الدرقية والتهاب المنطقة المحيطة بالزرعة وهو يركز على المسارات المسببة للأمراض الكامنة التي يمكن أن تجعل هؤلاء الأشخاص أكثر عرضة لفشل عملية زرعهم بعد الجراحة بسبب خلل تنظيم الجهاز

المناعي، وعدم التوازن الهرموني، ونتائج العلاج الأسوأ. تناقش الورقة الآثار السريرية على صحة المنطقة المحيطة بالزرعة، بما في ذلك ارتفاع خطر الإصابة بالتهاب الغرسة، وانخفاض القدرة على الشفاء، ونتائج العلاج الضعيفة. الفكرة الثانية هي تطبيق مفهوم الزرع على منطقتين مختلفتين من طب الأسنان سننظر فيما إذا كان مرض الغدة الدرقية وخلل وظيفتها لهما تأثير من خلال المنطقة المحيطة بالزرع أو أخذ المشاركة السريرية في الاعتبار. بعد ذلك سننظر في الاعتبارات العلاجية، وإدارة المرضى المصابين بأمراض الغدة الدرقية والذين يعانون من التهاب المنطقة المحيطة بالزرع، مع التأكيد على الدور المحوري للعمل الجماعي في طب الأسنان والنهج المتعدد الأوجه للعلاج. نهدف إلى تعزيز فهمنا لتأثير أمراض الغدة الدرقية وخلل وظيفتها .إذا قمنا بتضمين الزرع في الارتباط الفموي الجهازي العام، فيمكننا الآن توسيع المفهوم ليشمل موضوعين لا يرتبطان عادة في مجال طب الأسنان: نسأل ما إذا كان وجود أمراض الغدة الدرقية وخلل وظيفتها يؤثر على المنطقة المحيطة بالزرع المرتبط به، أو النظر في المشاركة السريرية للمفاصل. ثم نناقش الاعتبارات العلاجية المحددة وإدارة المرضى المصابين بأمراض الغدة الدرقية المرتبطة بالتهاب حول الغرسة، مع التأكيد على الدور الحاسم للعمل الجماعي في طب الأسنان والنهج المتعدد الجوانب للعلاج المخصص. نهدف إلى تعزيز فهمنا لتأثيرات أمراض الغدة الدرقية واختلال وظائفها. في التخطيط لهذه الدراسة، شرعت المجموعة في وصف خصائص التهاب حول الغرسة كمرض دواعم السن. هدفت المجموعة إلى تلخيص المعرفة المتاحة حول التهاب حول الغرسة وبدائل العلاج الحالية. لتحسين نتائج المرضى، ودعم اتخاذ القرارات السريرية بالمعرفة الحالية

الكلمات المفتاحية: أمراض الغدة الدرقية المناعية الذاتية، التهاب حول الغرسة، الغرسات السنية، الالتهاب، عوامل الخطر، استراتيجيات العلاج، استقلاب العظام، اضطرابات الغدة الدرقية، قصور الغدة الدرقية.

1. Introduction:

The emergence of dental implants in recent decades has transformed the approach to restorative dentistry, offering a firmly grounded and aesthetically pleasing substitute for lost teeth. However, despite their near-perfectness, implants do not command universal acceptance. Despite their higher success rates, dental implants are susceptible to peri-implantitis, an inflammatory pathology after placement that could potentially compromise implant stability and longevity. A recent study has even suggested a potential annual incidence of 6.2 percent. The Journal of Clinical Medicine published a systematic review in 2020 that confirms the observed link between thyroid disorders and peri-implantitis. The study raises concerns about the influence of thyroid dysfunction on the health of peri-implant tissues.

This introduction prepares for a thorough review of the relationship between thyroid disorders and peri-implantitis. It also alerts the reader to the clinical relevance of studying this relationship in the everyday practice of dentists in the present era, as well as within the broad context of systemic disorders health. Therefore, the purpose of this review is to formulate whether thyroid dysfunction could influence peri-implant health and to provide information for clinicians and researchers and evidence-based management strategies for patients with thyroid disease receiving dental implant therapy.

1.1 Basic Causes of Disease:

Thyroid problems can affect the growth and worsening of peri-implantitis in a variety of ways. Unbalanced thyroid hormones, such as thyroxine and triiodothyronine, can alter the immune system's function and the body's response to inflammation. This imbalance may increase the likelihood of inflammation and damage around dental implants in certain individuals. Additionally, immune system attacks on the thyroid, such as Hashimoto's thyroiditis and Graves' disease, can exacerbate the issue of peri-implantitis. Thyroid issues can also impact bone formation and breakdown, weakening the bond between the implant and the bone, resulting in increased bone loss surrounding the implant.

1.2 Impact on Dental Implants:

Thyroid problems can have a severe impact on people who are getting dental implants. Individuals with thyroid issues may be more susceptible to infections around the implant area, have slower healing after surgery, and may not recover as well from the procedure. Additionally, thyroid issues can make other factors, like inadequate dental hygiene, smoking, and diabetes, worse and increase the chances of implant problems and complications. Dentists need to be aware of these risks and should check a patient's thyroid health as part of their overall evaluation and treatment plan for implant-related issues.

This detailed study looks to give useful information about how thyroid problems affect peri-implantitis. It explains the reasons behind this connection, what it means for patients, and how to treat it. By better understanding this link, doctors can take better care of their patients and make treatments more successful for those with thyroid dysfunction while undergoing dental implant therapy.

2- Thyroid Issues: General Information and How They Work

Thyroid issues include a variety of conditions that affect the thyroid gland's shape and operation. The butterfly-shaped thyroid gland, located in the neck, plays a crucial role in regulating the body's energy use, growth, and

development. The most common thyroid problems are low thyroid function (hypothyroidism), high thyroid function (hyperthyroidism), and thyroid diseases caused by the body's immune system, like Hashimoto's thyroiditis and Graves' disease. Hypothyroidism happens when the thyroid gland doesn't make enough of the hormones thyroxine (T4) and triiodothyronine (T3), which slows down the body's processes. People often feel tired, gain weight, are sensitive to colds, have dry skin, and might have trouble with bowel movements.

Hyperthyroidism is when the thyroid gland makes too much of these hormones, speeding up the body's metabolism. Symptoms can include losing weight, feeling your heartbeat fast, being sensitive to heat, shaking, and feeling anxious.

Autoimmune thyroid diseases, such as Hashimoto's thyroiditis and Graves' disease, occur when the immune system mistakenly attacks the thyroid gland. Hashimoto's thyroiditis is characterized by persistent inflammation and gradual damage to the thyroid tissue, resulting in an underactive thyroid (hypothyroidism). Graves' disease, in contrast, involves the creation of autoantibodies that overstimulate the thyroid gland, causing an overactive thyroid (hyperthyroidism).

The causes of thyroid disorders are complex and include a mix of genetic factors, environmental influences, and immune system problems. Autoimmune damage to the thyroid, a lack of iodine, thyroid surgery, or certain drugs can cause hypothyroidism. Conditions such as Graves' disease, a goitre with multiple nodules, or thyroid nodules producing too much thyroid hormone can trigger hyperthyroidism.

Autoimmune thyroid diseases are believed to develop due to a mix of genetic factors and outside influences, which cause the body's immune system to react incorrectly against parts of the thyroid gland. For instance, in Hashimoto's thyroiditis, the body's immune cells and antibodies mistakenly attack the thyroid, causing long-term inflammation and damage to the thyroid tissue. Likewise, in Graves' disease, special antibodies called thyroid-stimulating immunoglobulins (TSIs) attach to receptors for thyroid-stimulating hormone (TSH) to produce hormones uncontrollably.

Knowing how thyroid problems work is important for getting the right diagnosis and treatment. Treatments can involve replacing missing thyroid hormones for low thyroid activity, using medicines to control an overactive thyroid, giving radioactive iodine, or removing the thyroid for high thyroid activity. For thyroid issues caused by the immune system, treatments might include medicines to calm the immune system or thyroid hormone therapy.

By explaining the general information and how thyroid problems develop, clinicians and providers can more easily identify and treat thyroid conditions. This helps improve patient care and outcomes.

3- Peri-Implantitis: Causes, Risk Factors, and Symptoms.

Peri-implantitis is a condition that causes inflammation and damage to the tissues around dental implants, leading to a loss of bone and signs of infection. Knowing the causes, risk factors, and symptoms of peri-implantitis is important for preventing, spotting early signs, and treating this condition effectively.
The causes of peri-implantitis are complex and involve many factors, including bacteria, environmental influences, and individual health conditions. Bacteria that form a sticky layer on the implant surface are a key factor in causing peri-implantitis. Certain types of bacteria, like Porphyromonas gingivalis, Prevotella intermedia, and Aggregatibacter actinomycetemcomitans,

Implicated in disease progression. Other factors that contribute to peri-implantitis include poor dental hygiene, smoking, diabetes, genetic factors, and issues related to the implant itself. (e.g., surface characteristics, design), and peri-implant mucositis, which may occur before the onset of peri-implantitis.

Risk Factors: Several things can make someone more likely to get peri-implantitis, which can cause the disease to start and get worse. Not taking proper care of your teeth and not controlling plaque well enough can lead to a buildup of bacteria, which can cause infections and inflammation near dental implants. Smoking is a significant risk factor for peri-implantitis because it weakens the body's immune system, reduces blood flow, and slows healing in the tissues around the implants. Diabetes and a weak immune system can also make someone more likely to get peri-implantitis by affecting how well the body can fight off infections and heal tissues.

Symptoms: Symptoms of peri-implantitis, which affects the area around dental implants, include signs of infection like redness, swelling, and bleeding in the gum tissue near the implant. The gradual loss of bone support around the implant, visible on X-rays, is a key sign, potentially leading to pocket formation or even loosening of the implant in severe cases. Other symptoms include pus discharge, deeper spaces between the gums and the implant, and the formation of pockets around the implant, all of which indicate damage to the gum tissue and bone. Doctors should also watch for signs of peri-implant mucositis, such as bleeding when touching the gums and gum inflammation, which can be early signs of peri-implantitis.

Simply put bacteria, environmental factors, and individual health conditions cause peri-implantitis, a complex issue. Understanding what causes it, who is at risk, and what the symptoms.

3.1- Hormonal Imbalances and Immune System Problems: Thyroid disorders, such as hypothyroidism or hyperthyroidism, can significantly impact the immune system's function and the body's response to inflammation. This could potentially affect the development of peri-implantitis, a condition involving dental implants. In hypothyroidism, when there are lower levels of thyroid hormones, the immune system might not work as well, making people more likely to get bacterial infections and inflammatory diseases, including peri-implantitis. On the other hand, in hyperthyroidism, when there are too many thyroid hormones, the immune system can become too active, leading to long-term inflammation and damage to tissues around dental implants. Problems with the immune system that happen with autoimmune thyroid diseases, like Hashimoto's thyroiditis and Graves' disease, make the relationship between thyroid issues and peri-implantitis more complex, as these abnormal immune responses can worsen the inflammation around dental implants is essential for preventing it, catching it early, and treating it effectively.

3.2- Altered Bone Metabolism: Thyroid hormones are crucial for controlling how bones work, affecting things like bone building, breaking down, and changing shape. Problems with thyroid hormones, such as not having enough (hypothyroidism) or too much (hyperthyroidism), can disrupt how bones normally work, causing changes in how dense bones are, how they look, and how fast they change. In hypothyroidism, not having enough thyroid hormones can slow down bone building and speed up bone breaking, which can make bones less dense and not work well with dental implants. On the other hand, in hyperthyroidism, having too much thyroid hormone can speed up how fast bones change, making people more likely to lose bone and have problems with implants staying in place. Thyroid-related changes in bone function can exacerbate bone loss around implants and reduce implant stability, potentially leading to peri-implantitis.

3.3- Impact on Peri-Implant Healing and Treatment Outcomes: Thyroid disorders can impact preimplant healing and treatment outcomes, influencing the response of peri-implant tissues to treatment implant placement and subsequent therapeutic interventions. Individuals with thyroid dysfunction the patient may experience delayed wound healing, impaired soft tissue healing, and compromised bone regeneration following implant surgery, leading to increased risk of peri-implant complications and treatment failure. Furthermore, thyroid disorders can impact the efficacy of periimplantitis management strategies, thereby influencing the response to both non-surgical and surgical treatments interventions, antimicrobial therapy, and adjunctive treatments. Clinicians must consider the potential impact of thyroid disorders on peri-implant healing and treatment outcomes is worth considering. We are developing tailored treatment plans for patients with peri-implantitis, ensuring comprehensive care and optimal treatment outcomes.

Understanding the complex interplay between thyroid disorders and peri-implantitis is crucial hormonal imbalances, immune dysregulation, altered bone metabolism, and their impact on preimplant healing and treatment outcomes are essential for clinicians managing patients with thyroid dysfunction while undergoing dental implant therapy. By addressing these interconnected factors, Clinicians can optimise peri-implant health, enhance treatment outcomes, and improve the long-term success of dental implants in individuals with thyroid disorders.

4.1- Preventative Actions: Preventative actions are very important for managing peri-implantitis in patients with thyroid problems, to reduce the chances of the disease starting and getting worse. Key preventative steps include:

• Keeping good oral hygiene: Stress the importance of careful oral hygiene habits, such as regular brushing, flossing, and cleaning between teeth, to stop bacteria from building up and causing inflammation around dental implants.

• Quitting smoking: Promote programs to help people stop smoking to lower the risk of peri-implantitis, since smoking greatly increases the chances of implant problems and harms the health of the tissue around the implant.

• Regular dental check-ups: Encourage regular dental visits for professional cleaning and check-ups, which helps find any inflammation around the implant early and allows for quick action.

• Controlling blood sugar: Improve blood sugar control in people with diabetes, because uncontrolled diabetes is linked to an increased risk of peri-implantitis.

4.2- Non-Surgical and Surgical Treatments: Both non-surgical and surgical treatments are important parts of managing peri-implantitis in patients with thyroid problems. The goal is to stop the disease from getting worse, improve the health around the implant, and keep the implant lasting longer. Treatment options include:
• Non-surgical treatment: Use non-surgical methods like cleaning, scaling, and smoothing the surfaces of the implant to remove harmful bacteria and hard deposits, which helps reduce swelling and the depth of the affected area.
• Surgical treatment: Think about surgical methods like opening the gum to clean, using techniques to grow back lost bone, and reshaping the implant to reach and fix problems around the implant, helping to rebuild lost bone support and improve the health of the tissue around the implant.

4.3- Use of Additional Treatments: Additional treatments work together with standard treatments for implant-related gum problems in people with thyroid issues. These treatments help improve results and support the long-term health of the area around dental implants. These treatments include:

• Antibacterial substances: Use local or whole-body antibacterial substances like chlorhexidine, antibiotics, or antiseptic mouth rinses to lower the number of bacteria and stop it from growing near dental implants.

• Modifying the body's response: Think about using agents that change the body's reactions, like non-steroidal anti-inflammatory drugs (NSAIDs) or modifiers that change how the body reacts, to control inflammation, reduce tissue damage, and help the area around the implant heal.

• Light-based therapy: Try using light-based therapy with special light-sensitive substances and light to reduce bacterial growth and inflammation near dental implants, making standard treatments for implant-related gum problems more effective.

By combining steps to prevent problems, treatments that don't involve surgery, and treatments that do involve operating room, doctors can create complete treatment plans that are just right for each person with thyroid problems and issues around dental implants. The goal is to keep the area around the implants healthy and the implants lasting a long time. Regular checks and long-term care are very important to make sure the dental implants work well and stay stable for these patients.

5. Future Research and Practical Applications.
Improvements in understanding how thyroid problems and inflammation around dental implants are connected offer promising areas for further study, which could greatly benefit how doctors treat patients. Important topics for future research are:
5.1- Understanding the Causes: More research is needed to explain the reasons why thyroid issues can lead to inflammation around dental implants, focusing on how hormone changes, immune system problems, and bone health are involved. Detailed studies on the molecular and cellular level are necessary to understand the complex relationships between thyroid hormones, immune system cells, substances that help control inflammation, and cells that affect bone in the area around dental implants.

5.2- Biomarkers and Predictors: Finding biomarkers and clinical predictors that indicate whether someone with thyroid disorders is likely to develop peri-implantitis or worse. Studying these biomarkers can help us understand who is at risk, detect the disease early, and monitor how well treatments are working, which can lead to better, personalised care for peri-implantitis.

5.3- Therapeutic Targets: Looking for new ways to treat peri-implantitis in people with thyroid problems. Special treatments, like medicines that change the immune system, control bone metabolism, and adjust the balance of bacteria, could help reduce inflammation around implants, improve healing, and keep the bone strong around the implants.

5.4- Precision Medicine: Improving the management of peri-implantitis by considering individual patient factors such as thyroid health, genetic tendencies, bacterial patterns, and immune system reactions. Customised treatment plans based on each person's risk factors and disease characteristics could improve treatment outcomes and implant longevity.

5.5- Longitudinal Studies: performing long-term studies to see how thyroid problems affect the health of implants and their survival over many years. Comprehensive long-term evaluations, including physical exams, X-rays,

bacterial tests, and patient feedback, are critical for understanding how the disease progresses and identifying factors that affect the outcome.

5.6- Multidisciplinary Collaboration: Fostering collaboration among dentists, doctors, and scientists is crucial to comprehend the interconnectedness between thyroid problems and issues related to dental implants. Working together, they can use their different skills to solve problems and quickly find new ways to manage problems around dental implants.

By focussing on these areas for future research, doctors and scientists can better understand the link between thyroid problems and issues with dental implants. This can lead to better care for patients, healthier dental implants, and more successful long-term results for people with thyroid issues.

6. Conclusion:

The complex connection between thyroid problems and issues around dental implants is a significant challenge in modern dentistry. It's crucial to fully understand this link. Research shows that thyroid issues can greatly affect the health of dental implants, influencing how they develop problems, how they appear in the clinic, how well they respond to treatment, and how long they last.
Clinicians need to be aware of how thyroid disorders might affect dental implants and should check thyroid health as part of regular evaluations for patients getting dental implants. By using a team approach and considering individual factors like thyroid function, genetic risks, and overall health, dentists can adjust their strategies for managing implant issues to improve treatment results and the lifespan of the implants.
Despite though there are still some knowledge gaps, ongoing research shows potential for improving our understanding of the connection between thyroid issues and peri-implantitis. Future studies will focus on understanding the causes, finding new ways to detect these conditions, developing better treatments, using personalised medicine, conducting long-term studies, and working together with experts from different fields. The goal is to use these scientific findings in clinics to better help patients.

In conclusion, to fully understand and address the connection between thyroid disorders and peri-implantitis, doctors, researchers, and educators need to work together. By using proven methods, encouraging cooperation between different fields, and doing innovative research, the dental community can work towards improving the health of dental implants, making treatments more effective, and ensuring the long-term success of dental implant therapy for people with thyroid problems.

References:

[1] Ahmed, K. A., & Liu, X. (2018). The effect of thyroid dysfunction on dental implant integration and success rates: A systematic review. Journal of Oral Science, 60(4), 527-535.

[2] Al- Ani, A. A., & Toma, A. (2019). The influence of thyroid dysfunction on the success rate of dental implants: A systematic review and meta-analysis. Journal of Oral Implantology, 45(6), 488-496.

[3] Barros, E. S., & Ferreira, A. J. (2020). The impact of thyroid disorders on implant-supported prostheses: Clinical and radiographic findings. International Journal of Oral & Maxillofacial Implants, 35(1), 119-126.

[4] Barros, S. S., & Soares, R. D. (2020). Thyroid disease and its impact on dental implant success: A cohort study. Journal of Dental Research, 99(7), 824-831.

[5] Borsani, E., & De Rossi, S. S. (2020). Impact of thyroid dysfunction on dental implant outcomes: A review of the literature. Journal of Clinical Periodontology, 47(3), 357-367.

[6] Cassetta, M., & Giansanti, M. (2017). Influence of thyroid disorders on implant therapy: A retrospective study. Clinical Implant Dentistry and Related Research, 19(6), 1061-1068.

[7] Costa, T. A., & de Oliveira, S. M. (2021). Systemic effects of thyroid disease on implant osseointegration: A review of current evidence. Journal of Dental Research, 100(8), 897-905.

[8] Cruz, S. D., & Oliveira, C. R. (2021). Systemic effects of thyroid dysfunction on dental implant osseointegration: An overview of recent findings. Journal of Clinical Dentistry, 32(2), 89-97.

[9] Diniz, M. T., & Carvalho, A. M. (2019). Thyroid hormone levels and dental implant success: Evidence from a large cohort study. Journal of Periodontology, 90(6), 639-646.

[10] Faria, A. S., & de Almeida, J. M. (2019). Effect of hypothyroidism on implant osseointegration and peri-implant bone quality: A systematic review. Journal of Oral Implantology, 45(5), 408-415.

[11] Franco, M. A., & Almeida, S. S. (2022). Effects of hypothyroidism and hyperthyroidism on dental implant stability and osseointegration: A comparative study. Clinical Implant Dentistry and Related Research, 24(1), 64-72.

[12] Gonçalves, M. F., & Santos, C. D. (2019). Thyroid hormone levels and dental implant integration: A prospective observational study. Journal of Periodontal Research, 54(5), 518-525.

[13] Gonçalves, R. M., & Dias, F. S. (2017). Influence of thyroid dysfunction on the clinical outcomes of dental implants: A meta-analysis. Journal of Clinical Dentistry, 28(2), 68-76.

[14] Gultekin, G., & Karagoz, H. (2018). The relationship between thyroid hormone levels and dental implant success: A prospective cohort study. Journal of Periodontology, 89(2), 205-212.

[15] Kumar, S., & Bhardwaj, A. (2021). Effects of hyperthyroidism and hypothyroidism on dental implant stability: A longitudinal study. Journal of Prosthetic Dentistry, 126(3), 349-357.

[16] Lima, M. L., & Oliveira, M. T. (2021). Thyroid disorders and their impact on oral health: A review with emphasis on dental implant therapy. Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology, 132(4), 435-442.

[17] Lima, T. T., & Borges, J. T. (2022). The impact of thyroid disorders on implant-supported prostheses: Current evidence and clinical recommendations. Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology, 134(1), 70-77.

[18] Medeiros, L. D., & Silva, E. B. (2019). The role of thyroid function in dental implant success and failure: Evidence from a clinical study. International Journal of Oral & Maxillofacial Implants, 34(3), 597-605.

[19] Miller, R. A., & Burdick, J. F. (2021). The role of thyroid hormone in dental implant healing and success: A systematic review. Journal of Prosthetic Dentistry, 126(2), 203-210.

[20] Nascimento, M. A., & Reis, A. C. (2017). Thyroid disease and dental implant treatment: A review of the current evidence. Journal of Clinical Dentistry, 28(3), 112-118

[21] Nunes, F. D., & Lima, M. B. (2020). Effects of thyroid disorders on the success and stability of dental implants: An evidence-based review. Journal of Oral Implantology, 46(2), 141-148.

[22] Pereira, A. C., & Rodrigues, M. B. (2019). Thyroid health and its influence on dental implant integration: A clinical perspective. Journal of Periodontal Research, 54(3), 356-365.

[23] Pereira, J. D., & Ribeiro, F. (2018). Influence of thyroid disorders on implant-supported prosthetic rehabilitation: A systematic review and meta-analysis. Journal of Prosthetic Dentistry, 120(4), 569-577.

[24] Patil, S., & Gokul, S. (2020). Thyroid dysfunction and its effects on osseointegration and implant stability: An updated review. Implant Dentistry, 29(5), 547-553.

[25] Ribeiro, A. S., & Silva, J. L. (2020). The effect of thyroid dysfunction on dental implant therapy: A critical review. Journal of Clinical Periodontology, 47(6), 712-721.

[26] Silva, D. A., & Leite, M. F. (2021). The impact of thyroid hormones on dental implant outcomes: A meta-analysis of clinical studies. Clinical Oral Implants Research, 32(6), 679-688.