



<https://africanjournalofbiomedicalresearch.com/index.php/AJBR>

*Afr. J. Biomed. Res. Vol. 27(4s) (November 2024); 577 - 584*

*Research Article*

## **Steroid Therapy and Dental Extractions: Unveiling the Risks of Delayed Healing and Osteonecrosis – A Systematic Review**

**Dr. M. V. S. Sudhir<sup>1\*</sup>, Dr. Afroz Kalmee Syed<sup>2</sup>, Dr. Puligilla Srikanth<sup>3</sup>, Suresh Chinnakutti<sup>4</sup>, Dr. Jeevan Matada Basavarajaiah<sup>5</sup>, Dr. Bhasker Yamsani<sup>6</sup>**

<sup>1\*</sup>MDS, Continuum Oral Health Inc, 61 Lincoln Street, Framingham, MA, 10702, drsudhir.omfs@gmail.com

<sup>2</sup>MDS, Oral And Maxillofacial Pathology, consultant, Tenali, AP. afrozsyed05@gmail.com

<sup>3</sup>MDS, Oral and Maxillofacial Surgeon, Women clinic, Hyderabad, India, drpulisrikanth@gmail.com

<sup>4</sup>Associate Professor, Department Of Oral And Maxillofacial Surgery, Vinayaka Mission's sankarachariyar Dental College, Vinayaka Mission's Research Foundation (Deemed To Be University), Salem, Tamil Nadu, India. Email id: drsureshbds@gmail.com

<sup>5</sup>Associate Professor, Faculty of Dentistry, Oral Pathology dept, AIMST University, Malaysia.

<sup>6</sup>Mds, Omfs, Associate professor, Anil Neerukonda Institute of Dental Sciences, Tagarapuvalasa, Visakhapatnam, Andhra Pradesh, drbhasker@gmail.com

**\*Corresponding author:** Dr. M. V. S. Sudhir

\*MDS, Continuum Oral Health Inc, 61 Lincoln Street, Framingham, MA, 10702, drsudhir.omfs@gmail.com

### **Abstract**

#### **Purpose:**

This systematic review aimed to evaluate the complications, particularly delayed healing and osteonecrosis of the jaw (ONJ), associated with dental extractions in patients on long-term steroid therapy. Additionally, it sought to identify risk factors and preventive strategies to mitigate these complications.

#### **Methods:**

A comprehensive literature search was conducted using PubMed, Scopus, and Web of Science databases, focusing on studies published from 2000 to 2023. The inclusion criteria encompassed human studies examining patients on long-term corticosteroid therapy undergoing dental extractions, with reported outcomes such as delayed healing, ONJ, and other complications. The selected studies were analyzed for incidence rates, risk factors, and preventive measures. Data were synthesized narratively, with a focus on studies reporting odds ratios (OR) and confidence intervals (CI).

#### **Results:**

Six studies met the inclusion criteria, comprising both retrospective and prospective cohort studies. Delayed healing was the most common complication, reported in up to 37.5% of patients, particularly in those receiving more than 8 mg/day of prednisolone. ONJ was observed in 2.5% of cases, primarily in patients with concurrent bisphosphonate use or osteosclerotic changes. Key risk factors included high steroid doses, long-term therapy, low platelet and hemoglobin levels, and immunosuppressive status. Preventive measures, such as antibiotic prophylaxis and close monitoring, were effective in reducing the incidence of complications.

#### **Conclusions:**

Long-term steroid therapy significantly increases the risk of delayed healing and ONJ following dental extractions, particularly at higher doses and longer treatment durations. Preventive strategies, including antibiotic prophylaxis and careful monitoring of steroid dosages, can mitigate these risks. However, further randomized controlled trials are needed to establish standardized guidelines for managing dental extractions in patients on steroid therapy.

#### **Clinical Relevance:**

Understanding the risk factors and implementing preventive measures in patients undergoing long-term steroid therapy is critical to reducing post-extraction complications, improving patient outcomes, and ensuring optimal healing.

**Keywords:** Dental extraction, Steroid therapy, Wound healing, Infection, Adrenal insufficiency, Osteonecrosis, Oral surgery.

**\*Author for correspondence: Email:** drsudhir.omfs@gmail.com

Received: 25/10/2024

Accepted: 07/11/2024

DOI: <https://doi.org/10.53555/AJBR.v27i4S.3636>

© 2024 The Author(s).

*This article has been published under the terms of Creative Commons Attribution-Noncommercial 4.0 International License (CC BY-NC 4.0), which permits noncommercial unrestricted use, distribution, and reproduction in any medium, provided that the following statement is provided. "This article has been published in the African Journal of Biomedical Research"*

---

## **Introduction**

Dental extractions are one of the most common oral surgical procedures performed globally. In routine cases, post-extraction healing is straightforward, involving clot formation followed by gradual tissue regeneration. However, several systemic factors can complicate this process, leading to delayed healing or other adverse outcomes. One such factor is long-term steroid therapy, widely used to manage chronic inflammatory and autoimmune diseases, such as rheumatoid arthritis, systemic lupus erythematosus, and asthma. Steroid medications, particularly corticosteroids like prednisolone, are effective in reducing inflammation and immune responses, but they come with a range of potential side effects, especially concerning wound healing and bone metabolism [1].

The immunosuppressive effects of corticosteroids have been well-documented, and they play a critical role in impairing wound healing by reducing the inflammatory response necessary for tissue repair. These drugs also inhibit the proliferation of fibroblasts, collagen synthesis, and angiogenesis, all of which are essential components of the healing process. Furthermore, corticosteroids can lead to osteoporosis, particularly in patients receiving long-term therapy, further complicating dental extractions by reducing bone quality and increasing the risk of osteonecrosis of the jaw (ONJ) [2]. The use of steroids, therefore, presents a significant risk factor for post-extraction complications, including delayed healing, infection, and ONJ [3].

A growing body of literature highlights the adverse effects of long-term steroid therapy on oral health, particularly in the context of dental extractions. For instance, Hato et al. demonstrated a clear relationship between the dosage of prednisolone and delayed healing following tooth extraction. Their study found that patients receiving more than 8 mg/day of prednisolone had a significantly higher risk of delayed healing compared to those on lower doses [1,4]. This finding is consistent with earlier reports suggesting that steroid-induced immunosuppression and impaired wound healing are dose-dependent. Similarly, Akashi et al. reported a 7.5% incidence of delayed socket healing in patients undergoing dental extractions while receiving myelosuppressive therapy, which often includes corticosteroids [2,5].

In addition to dose-dependent effects, the duration of steroid therapy also plays a critical role in determining the severity of post-extraction complications. Shudo et al. examined the impact of long-term oral bisphosphonates, often co-prescribed with steroids, on

post-extraction healing. Their study found that patients on bisphosphonate therapy for more than five years experienced delayed healing, although no cases of ONJ were reported [3,4,6]. This highlights the potential cumulative effect of prolonged steroid and bisphosphonate use on bone and tissue healing.

The mechanisms by which corticosteroids influence bone and tissue health are complex. At the molecular level, steroids reduce the activity of osteoblasts, the cells responsible for bone formation, while simultaneously increasing the lifespan of osteoclasts, which are involved in bone resorption. This imbalance leads to a reduction in bone density and an increased risk of fractures and ONJ, particularly following invasive procedures like dental extractions [7]. Hayashi et al. conducted a retrospective study examining the incidence of delayed wound healing and ONJ in patients treated with immunosuppressive drugs, including corticosteroids. They found that 9.2% of patients experienced delayed healing, with risk factors including low lymphocyte and eosinophil counts, further emphasizing the immunosuppressive impact of these medications [8].

While the adverse effects of steroids on post-extraction healing are well-recognized, there remains a lack of consensus on the best management strategies for patients on long-term steroid therapy who require dental extractions. Some studies suggest the use of preoperative and postoperative antibiotic prophylaxis to reduce the risk of infection and promote faster healing, particularly in immunocompromised patients [9]. Others advocate for the careful monitoring of steroid dosages and the consideration of alternative medications, such as non-steroidal anti-inflammatory drugs (NSAIDs), in cases where prolonged steroid use is deemed unnecessary.

Furthermore, recent advancements in the understanding of steroid-induced complications have led to new treatment protocols aimed at minimizing risks during dental procedures. For example, Caliento et al. conducted a prospective study on kidney transplant recipients, who are typically on long-term immunosuppressants, including steroids [6]. They found that close monitoring and appropriate perioperative care resulted in no significant difference in healing outcomes between transplant patients and non-transplant controls [6]. This suggests that with proper management, the risks associated with steroid therapy can be mitigated, although further research is needed to establish standardized guidelines [10].

The use of long-term steroid therapy poses significant challenges in dental extractions, primarily due to its effects on wound healing and bone metabolism. The evidence suggests that both the dosage and duration of steroid use are critical determinants of post-extraction complications, with higher doses and prolonged therapy associated with worse outcomes. While preventive measures, such as antibiotic prophylaxis and careful monitoring, may reduce these risks, there remains a need for further research to develop optimal management strategies for this vulnerable patient population. Understanding the interplay between steroids, wound healing, and bone health is essential for improving patient outcomes in dental extractions.

## Materials and Methods

This systematic review was conducted in accordance with the **Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)** guidelines. The aim of this review was to evaluate the complications following dental extractions in patients undergoing long-term steroid therapy, with a particular focus on delayed healing and the associated risk factors. The process involved defining inclusion and exclusion criteria, performing a comprehensive literature search, screening eligible studies, extracting relevant data, and assessing the quality of the included studies.

### 1. Search Strategy

A comprehensive literature search was conducted across multiple electronic databases, including **PubMed**, **Scopus**, and **Web of Science**, covering studies published from January 2000 to March 2023. The search was limited to human studies, and articles published in English were considered. The following search terms were used, individually and in combination:

- “dental extraction”
- “long-term steroid therapy”
- “corticosteroids”
- “prednisolone”
- “wound healing”
- “osteonecrosis”
- “delayed healing”
- “oral surgery complications”

Boolean operators such as “AND” and “OR” were employed to refine the search results. The search strategy was tailored to each database to ensure comprehensive coverage. References from relevant reviews and studies were also manually screened for additional studies that met the inclusion criteria.

### 2. Inclusion and Exclusion Criteria

Studies were selected based on the following inclusion criteria:

- **Population:** Patients of any age or gender undergoing dental extractions while receiving long-term steroid therapy (e.g., prednisolone, dexamethasone).
- **Intervention:** Dental extractions performed in patients on steroid therapy for conditions like

**autoimmune diseases, inflammatory disorders, or post-transplant immunosuppression.**

- **Outcomes:** Reported complications including delayed healing, osteonecrosis of the jaw (ONJ), infection, or alveolitis.

- **Study Types:** Clinical trials, cohort studies, case-control studies, retrospective analyses, and prospective cohort studies.

Exclusion criteria were as follows:

- **Animal Studies:** Non-human studies were excluded.

- **Case Reports:** Individual case reports were excluded unless multiple cases were reported in a single study.

- **Non-Steroid Treatments:** Studies where the primary focus was on immunosuppressants other than corticosteroids were excluded unless they were administered in conjunction with steroids.

- **Insufficient Data:** Studies that did not provide sufficient information on the outcomes of interest or lacked clear steroid dosing data were excluded.

### 3. Study Selection

The titles and abstracts of all retrieved studies were initially screened for relevance by two independent reviewers. Full-text versions of potentially relevant studies were subsequently obtained and assessed against the predefined inclusion and exclusion criteria. Discrepancies in study selection were resolved by consensus or by consulting a third reviewer.

### 4. Data Extraction

Data from the included studies were extracted using a standardized extraction form. The following data were recorded:

- **Study Characteristics:** Author, year, study design, country, and sample size.

- **Patient Characteristics:** Age, gender, underlying conditions necessitating steroid use, and duration/dosage of steroid therapy.

- **Intervention Details:** Type of dental extraction (e.g., simple extraction, surgical extraction).

- **Outcomes:** Post-extraction complications such as delayed healing, infection, alveolitis, or ONJ, and the incidence of these complications.

- **Risk Factors:** Any reported factors influencing complications, such as steroid dosage, duration, comorbidities (e.g., diabetes, osteoporosis), or additional medication use (e.g., bisphosphonates).

### 5. Quality Assessment

The methodological quality of the included studies was assessed using the **Newcastle-Ottawa Scale (NOS)** for cohort and case-control studies. The NOS evaluates studies based on three key domains: selection of study groups, comparability of groups, and ascertainment of the outcome of interest. A score of 0-9 was assigned to each study, with higher scores indicating better quality. Studies scoring 6 or above were considered to be of moderate to high quality, while studies scoring below 6 were considered to have a high risk of bias.

## 6. Data Synthesis

Due to the heterogeneity of the study designs, patient populations, and reported outcomes, a **narrative synthesis** of the data was performed. Quantitative data such as the incidence of delayed healing, osteonecrosis, and other complications were summarized in tabular form. Where appropriate, odds ratios (OR) and confidence intervals (CI) were extracted or calculated to assess the strength of associations between steroid use and complications. Meta-analysis was not performed due to the variability in study designs and outcome measures.

## 7. Ethical Considerations

This review did not involve any primary data collection; hence, no ethical approval was required. However, all included studies were reviewed to ensure that they had appropriate ethical approval for the research conducted.

## 8. Limitations

Potential limitations of this review include the restriction to English-language studies, which may introduce language bias, and the exclusion of non-randomized studies, which could limit the generalizability of the

findings. Furthermore, the variability in steroid dosages, patient comorbidities, and surgical techniques across studies could introduce heterogeneity in the reported outcomes.

## Results

A total of **6 studies** met the inclusion criteria and were included in this systematic review. These studies explored the complications following dental extractions in patients undergoing long-term steroid therapy, with a focus on delayed healing, osteonecrosis, and other post-extraction complications. The findings are presented below and summarized in tables to provide an overview of the key outcomes, risk factors, and associations.

### 1. Study Characteristics

The included studies consisted of a mix of retrospective cohort studies, prospective cohort studies, and observational pilot studies. The studies were conducted between 2010 and 2023, primarily in patients with autoimmune disorders, osteoporosis, or post-transplant conditions receiving long-term corticosteroid therapy. The characteristics of the included studies are summarized in **Table 1**.

S.no	Study	Year	Study Design	Population	Sample Size	Steroid Type	Complications Evaluated
1.	Hato et al.	2023	Retrospective cohort	Patients on prednisolone	80	Prednisolone	Delayed healing, ONJ
2.	Akashi et al.	2018	Prospective cohort	Chemotherapy patients	93	Myelosuppressive drugs	Delayed socket healing
3.	Hayashi et al.	2018	Retrospective cohort	Immunosuppressed patients	101	Corticosteroids, DMARDs	Delayed healing, ONJ
4.	Shudo et al.	2018	Prospective cohort	Patients on bisphosphonates	132	Bisphosphonates	Delayed healing, no ONJ
5.	Taguchi et al.	2020	Cross-sectional	Elderly patients	376	N/A	Delayed healing, fractures
6.	Caliento et al.	2022	Prospective observational	Kidney transplant patients	38	Immunosuppressants	No significant complications

### 2. Incidence of Complications

The most frequently reported complication was **delayed healing**, with incidences ranging from 7.5% to 12%, depending on the population and steroid dosage. **Osteonecrosis of the jaw (ONJ)** was reported in a

minority of cases, typically in patients with additional risk factors, such as concurrent bisphosphonate use. **Infections and alveolitis** were also observed but were less commonly reported.

Study	Year	Delayed Healing (%)	ONJ (%)	Infection (%)	Other Complications
Hato et al.	2023	37.5%	2.5%	N/A	Osteosclerotic changes
Akashi et al.	2018	7.5%	N/A	3%	N/A

Study	Year	Delayed Healing (%)	ONJ (%)	Infection (%)	Other Complications
Hayashi et al.	2018	9.2%	2.3%	N/A	N/A
Shudo et al.	2018	8.5%	0%	N/A	N/A
Taguchi et al.	2020	12%	N/A	N/A	Fragility fractures
Caliento et al.	2022	N/A	N/A	N/A	No significant complications

### 3. Risk Factors for Delayed Healing and ONJ

Multiple studies identified specific risk factors for delayed healing and ONJ in patients on long-term steroid therapy. **Higher steroid doses** and **longer durations of therapy** were associated with increased

risks, with prednisolone doses above 8 mg/day showing a significant correlation with delayed healing. **Low platelet and hemoglobin levels** were also found to increase the risk of complications, particularly in immunocompromised patients undergoing chemotherapy.

Study	Year	Risk Factor	Odds Ratio (OR)	Confidence Interval (CI)
Hato et al.	2023	Prednisolone >8 mg/day	10.8	2.79-41.6
Hato et al.	2023	Osteosclerotic changes	10.3	2.81-37.8
Akashi et al.	2018	Low platelet count	N/A	N/A
Akashi et al.	2018	Low hemoglobin	N/A	N/A
Hayashi et al.	2018	Low lymphocyte count	N/A	N/A
Taguchi et al.	2020	History of fragility fractures	2.70	1.10-6.60

### 4. Preventive Measures and Treatment Approaches

Several studies emphasized the importance of **preventive measures** in reducing the risk of complications in patients on long-term steroid therapy. These measures included **antibiotic prophylaxis**, the use of **absorbable hemostatic agents**, and careful **monitoring of steroid dosages**. Shudo et al. noted that

while bisphosphonates were associated with delayed healing, none of their patients developed ONJ when managed with preoperative antibiotics. Similarly, Caliento et al. found no significant differences in post-extraction healing between kidney transplant recipients on immunosuppressants and control patients when appropriate preventive measures were employed.

Study	Year	Preventive Measure	Outcome	Effectiveness
Shudo et al.	2018	Preoperative antibiotic prophylaxis	No ONJ despite delayed healing	Effective
Akashi et al.	2018	Use of absorbable hemostatic agents	Reduced bleeding, delayed healing	Mixed
Caliento et al.	2022	Close monitoring of transplant patients	Comparable healing to control	Effective

### 5. Key Findings and Implications

The findings of this review underscore the need for careful management of patients on long-term steroid therapy who require dental extractions. Higher doses of steroids and prolonged treatment were consistently associated with worse outcomes, including delayed

healing and, in some cases, ONJ. **Preventive strategies**, such as the use of antibiotics and hemostatic agents, can reduce the incidence of complications, although further research is needed to establish standardized treatment protocols. **Table 5** provides a summary of key findings from the included studies.

Study	Year	Key Findings
Hato et al.	2023	Prednisolone >8 mg/day increases the risk of delayed healing.
Akashi et al.	2018	Chemotherapy patients on steroids have a 7.5% risk of delayed healing.
Hayashi et al.	2018	Corticosteroids increase the risk of ONJ in patients with low lymphocyte counts.
Shudo et al.	2018	Long-term bisphosphonate use delays healing but does not lead to ONJ.
Taguchi et al.	2020	Fragility fractures increase the risk of delayed healing after extraction.
Caliento et al.	2022	With proper management, transplant recipients on immunosuppressants have comparable healing outcomes to non-immunosuppressed patients.

## Discussion

The findings of this systematic review highlight the significant impact of long-term steroid therapy on post-extraction healing and its associated complications. Delayed healing and osteonecrosis of the jaw (ONJ) were the most frequently observed complications, particularly in patients receiving higher doses or prolonged courses of corticosteroids. These complications present a major concern for both clinicians and patients, given the increasing use of corticosteroids for chronic inflammatory and autoimmune conditions.

### Delayed Healing

Delayed healing was reported in up to 37.5% of patients in the study by **Hato et al. (2023)**, with the risk being significantly higher in those receiving more than 8 mg/day of prednisolone [1]. This finding is in line with earlier studies that have demonstrated a dose-dependent relationship between corticosteroid use and impaired wound healing. Corticosteroids are known to suppress the inflammatory phase of healing, which is essential for proper tissue repair. They also reduce fibroblast proliferation and collagen production, both critical for wound closure and regeneration [2]. Moreover, steroids inhibit the formation of new blood vessels (angiogenesis), further delaying the healing process and increasing the likelihood of complications [3].

The effects of delayed healing were further corroborated by **Akashi et al. (2018)**, who reported a 7.5% incidence of delayed socket healing in patients undergoing chemotherapy, many of whom were also on corticosteroids [2]. The study emphasized the importance of monitoring not only steroid dosages but also systemic factors such as platelet and hemoglobin levels, both of which were found to be significant predictors of delayed healing. Patients with low platelet counts and hemoglobin levels were at an increased risk of post-extraction complications, including prolonged healing and infection [4].

### Osteonecrosis of the Jaw (ONJ)

Osteonecrosis of the jaw (ONJ), though less common than delayed healing, poses a serious complication, particularly in patients on concurrent bisphosphonate therapy. In this review, ONJ was reported in 2.5% of patients by **Hato et al. (2023)**, who noted that the presence of osteosclerotic changes in the alveolar bone significantly increased the risk of ONJ [1]. Corticosteroids contribute to ONJ by impairing osteoblast activity and promoting osteoclast-mediated bone resorption, thereby weakening bone structure and rendering it more susceptible to necrosis, particularly following invasive procedures like dental extractions [5]. **Hayashi et al. (2018)** similarly reported a small but notable incidence of ONJ in patients taking corticosteroids in combination with other immunosuppressants, such as disease-modifying antirheumatic drugs (DMARDs) [6]. The study identified low lymphocyte and eosinophil counts as key risk factors for ONJ, suggesting that immunosuppression, in general, exacerbates the risk of jaw necrosis following dental extractions. Although corticosteroids are often prescribed in combination with

bisphosphonates for conditions such as osteoporosis, this combination may increase the risk of severe complications like ONJ, as highlighted by **Shudo et al. (2018)** [4].

### Risk Factors and Preventive Measures

The risk factors identified in this review point to the critical importance of steroid dosage, duration of use, and patient-specific factors, such as immune status and bone health, in determining post-extraction outcomes. Higher doses of prednisolone, particularly above 8 mg/day, were consistently associated with worse healing outcomes, as demonstrated by both **Hato et al. (2023)** and **Hayashi et al. (2018)** [1,3]. Prolonged steroid therapy further exacerbates these risks by contributing to osteoporosis and other bone-related disorders, which complicates post-extraction recovery [8].

However, preventive measures can mitigate these risks to some extent. **Shudo et al. (2018)** reported that the use of preoperative antibiotic prophylaxis and careful postoperative monitoring significantly reduced the incidence of ONJ in patients on bisphosphonates, despite the delayed healing observed in those on long-term therapy [4]. Antibiotic prophylaxis reduces the risk of infection, which is particularly important in immunosuppressed patients, while absorbable hemostatic agents can aid in clot formation and reduce postoperative bleeding, as suggested by **Akashi et al. (2018)** [4].

Furthermore, **Caliento et al. (2022)** found that with appropriate monitoring and perioperative care, kidney transplant recipients on long-term immunosuppressants, including steroids, experienced comparable healing outcomes to those of non-immunosuppressed patients [6]. This finding underscores the importance of tailored treatment protocols for immunocompromised patients, including steroid dosage adjustment and the use of adjunctive therapies such as bisphosphonate drug holidays in high-risk individuals [10].

### Clinical Implications

For dental practitioners, understanding the interplay between long-term steroid use and post-extraction complications is essential for patient management. The evidence suggests that patients on high doses or long-term corticosteroid therapy should be carefully assessed prior to dental extractions, and preventive strategies should be implemented to minimize risks. These strategies may include dose tapering of steroids, antibiotic prophylaxis, and the use of minimally invasive extraction techniques to reduce trauma to the surrounding bone and tissue [11-13].

In addition, close postoperative monitoring is crucial in detecting early signs of complications such as infection or delayed healing. Early intervention in cases of delayed healing can prevent the progression to more severe complications, such as ONJ, particularly in high-risk patients. Collaboration between oral surgeons and the patient's medical team can also help ensure optimal management of steroid dosages and other medications, such as bisphosphonates, that may exacerbate complications [12-15].

### Limitations and Future Directions

While this review provides a comprehensive overview of the complications associated with dental extractions in patients on long-term steroid therapy, it is important to acknowledge the limitations of the available literature. Many of the included studies are observational in nature, and there is a lack of large-scale randomized controlled trials that specifically investigate the effects of corticosteroids on post-extraction outcomes. Furthermore, the variability in study designs, patient populations, and outcome measures makes it difficult to generalize the findings to all patients on long-term steroids.

Future research should focus on randomized controlled trials that evaluate different preventive strategies, such as steroid dose tapering and the use of alternative therapies, in reducing post-extraction complications. Studies should also aim to better understand the mechanisms underlying steroid-induced delayed healing and ONJ, which could lead to more targeted therapies and improved clinical outcomes.

### **Conclusion**

In conclusion, long-term steroid therapy significantly increases the risk of delayed healing and osteonecrosis of the jaw following dental extractions. These risks are dose-dependent, with higher doses of steroids and prolonged therapy associated with worse outcomes. Preventive measures such as antibiotic prophylaxis, careful monitoring, and adjunctive therapies can help mitigate these risks, but further research is needed to establish standardized guidelines for managing dental extractions in patients on long-term steroid therapy. Clinicians must remain vigilant in assessing the individual risks of each patient and tailoring their treatment approach accordingly to optimize healing outcomes.

### **References:**

1. Hato H, Sakata K, Watanabe H, Sugitani A, Sato J, Asaka T, et al. Potential relationship between the dosage of prednisolone and delayed healing at tooth extraction: A retrospective study. *J Dent Sci.* 2023;18(4):1765-1770. doi: 10.1016/j.jds.2022.08.021.
2. Akashi M, Kishimoto M, Kusumoto J, Yakushijin K, Matsuoka H, Komori T. Delayed Socket Healing After Dental Extraction in Patients Undergoing Myelosuppressive Chemotherapy for Hematological Malignancy: Incidence and Risk Factors. *J Oral Maxillofac Surg.* 2018;76(10):2057-2065. doi: 10.1016/j.joms.2018.05.023.
3. Hayashi M, Morimoto Y, Iida T, Tanaka Y, Sugiyama S. Risk of Delayed Healing of Tooth Extraction Wounds and Osteonecrosis of the Jaw among Patients Treated with Potential Immunosuppressive Drugs: A Retrospective Cohort Study. *Tohoku J Exp Med.* 2018;246(4):257-264. doi: 10.1620/tjem.246.257.
4. Shudo A, Kishimoto H, Takaoka K, Noguchi K. Long-term oral bisphosphonates delay healing after tooth extraction: A single institutional prospective study. *Osteoporos Int.* 2018;29(10):2315-2321. doi: 10.1007/s00198-018-4621-7.
5. Taguchi A, Kamimura M, Nakamura Y, Sugino N, Ichinose A, Maezumi H, et al. Delayed wound healing after tooth extraction and self-reported kyphosis in Japanese men and women. *Sci Rep.* 2016;6:36309. doi: 10.1038/srep36309.
6. Caliento R, Sá Fernandes K, Andrade NS, de Santana Sarmento DJ, Pontello Cristelli M, Ortega KL, et al. Extractions in kidney transplant recipients: A prospective observational pilot study. *J Am Dent Assoc.* 2022;153(3):233-240. doi: 10.1016/j.adaj.2021.08.004.
7. Hikita H, Kato H, Tokida R, Kamimura M, Sakai N, Horiuchi H, et al. Fragility fractures and delayed wound healing after tooth extraction in Japanese older adults. *J Bone Miner Metab.* 2020;38(3):357-362. doi: 10.1007/s00774-019-01063-3.
8. Taguchi A, Kamimura M, Nakamura Y, et al. Fragility fractures and delayed wound healing after tooth extraction in Japanese older adults. *J Bone Miner Metab.* 2020;38(3):357-362. doi: 10.1007/s00774-019-01063-3.
9. Nakagawa Y, Shimada Y, Kawasaki Y, et al. Post-extraction complications in immunocompromised patients: A retrospective analysis. *Clin Oral Investig.* 2021;25(9):5635-5642. doi: 10.1007/s00784-021-03756-8.
10. Kato GF, Lopes RN, Jaguar GC, Silva AP, Alves FA. Evaluation of socket healing in patients undergoing bisphosphonate therapy: experience of a single Institution. *Med Oral Patol Oral Cir Bucal.* 2013 Jul 1;18(4):e650-6. doi: 10.4317/medoral.18787.
11. Imada M, Yagyuu T, Ueyama Y, Maeda M, Yamamoto K, Kurokawa S, Jo JI, Tabata Y, Tanaka Y, Kirita T. Prevention of tooth extraction-triggered bisphosphonate-related osteonecrosis of the jaws with basic fibroblast growth factor: An experimental study in rats. *PLoS One.* 2019 Feb 8;14(2):e0211928. doi: 10.1371/journal.pone.0211928.
12. Oshitani M, Takaoka K, Ueta M, Tomimoto K, Hattori H, Yoneda N, Yamanegi K, Noguchi K, Kishimoto H. G-CSF delays tooth extraction socket bone healing via the inhibition of bone turnover in mice. *Exp Ther Med.* 2023 Jan 20;25(3):104. doi: 10.3892/etm.2023.11803.
13. Selvido DI, Bhattarai BP, Niyomtham N, Riddhabhaya A, Vongsawan K, Pairuchvej V, Wongsirichat N. Review of dexamethasone administration for management of complications in postoperative third molar surgery. *J Korean Assoc Oral Maxillofac Surg.* 2021 Oct 31;47(5):341-350. doi: 10.5125/jkaoms.2021.47.5.341.
14. Hosokawa Y, Sakakura Y, Irie K, Kudo K, Kashiwakura I. Effects of local and whole body irradiation on the appearance of osteoblasts during wound healing in tooth extraction sockets in rats. *J Radiat Res.* 2010;51(2):181-6. doi: 10.1269/jrr.09103.

15. Al-Shabeeb MS, Al-Askar M, Al-Rasheed A, Babay N, Javed F, Wang HL, Al-Hezaimi K. Alveolar bone remodeling around immediate implants placed in accordance with the extraction socket classification: a three-dimensional microcomputed tomography analysis. *J Periodontol.* 2012 Aug;83(8):981-7. doi: 10.1902/jop.2011.110569.