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Short Communication

# A scientometric study on research trends and characteristics of medication-related osteonecrosis of the jaw

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the jaw;  
Stomatologists;  
Research  
characteristics

**Abstract** *Background/purpose:* Medication-related osteonecrosis of the jaw (MRONJ) is a debilitating condition characterized by a progressive necrosis of jaw bone in patients who have received anti-resorptive or anti-angiogenic medications. The purpose of this study was to analyze the scientometric characteristics and research trends of MRONJ.

*Materials and methods:* All the papers on MRONJ were comprehensively retrieved from the Scopus database.

*Results:* Among all the 2857 papers on MRONJ, 2251 (78.8 %) were published by stomatologists. The most common medications that cause MRONJ were diphosphonates, zoledronic acid, and denosumab. The MRONJ-related diseases were multiple myeloma, breast cancer, prostate cancer, bone metastasis, diabetes mellitus, and rheumatoid arthritis. Treatment strategies including debridement, antibiotic therapy, conservative treatment, hyperbaric oxygen therapy, low level laser therapy, and platelet-rich fibrin application. A good medical history with emphasis on the use of medication that cause MRONJ, detailed clinical and radiographic evaluations excluding jaw metastasis cancer and osteoradionecrosis, and attention to the patient's signs and symptoms are critical for the correct diagnosis and appropriate treatment. Herein,

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we also highlight the awareness of early recognition and timely diagnosis and improve the access to care for MRONJ.

**Conclusion:** This scientometric study elucidated the current scenario and research trends of MRONJ, and proposed that multidisciplinary comprehensive management should be conducted to achieve optimal outcomes.

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## Introduction

Medication-related osteonecrosis of the jaw (MRONJ) is a serious, debilitating condition characterized by a progressive necrosis of jaw bone in patients who have received anti-resorptive or anti-angiogenic medications.<sup>1</sup> In 2003, this condition was first reported to be necrosis and bone exposure of the jaw caused by bisphosphonates. In 2006, it was initially defined by the American Association of Oral and Maxillofacial Surgeons (AAOMS) as bisphosphonate-related osteonecrosis of the jaws (BRONJ). With the increasing number of cases associated not only with bisphosphonates but also with other anti-resorptive and anti-angiogenic drugs, the condition was then defined as MRONJ by the AAOMS in 2014.<sup>2,3</sup> The current management guidelines for MRONJ include local and systemic antibiotic treatments and surgical removal of necrotic bone.<sup>1</sup> Unfortunately, there are no validated preventive or pharmaceutical interventions to reduce surgical burden or improve the prognosis,<sup>4–7</sup> primarily due to our limited understanding of MRONJ pathogenesis.<sup>8</sup> Thus, the management of MRONJ are still challenging and not completely satisfactory.

Despite considerable research efforts in understanding the clinical characteristics and management approaches of MRONJ, gaps remain in its pathogenesis and treatment challenge clinical practice. Given the complex nature of MRONJ and its impact on patients' quality of life, finding multidisciplinary comprehensive treatment strategies is a crucial task.<sup>9,10</sup> Scientometrics/bibliometrics is a useful tool that utilizes citation and literature data to assess scientific output and research trend within a specific research field.<sup>11</sup> The previous bibliometric studies analyzed the 100 most-cited studies on MRONJ and the literature retrieved from Web of Science database up to 2023.<sup>2,3</sup> However, little has been conducted to analyze research characteristics focusing on the keywords in different decades and disciplines. Therefore, the purpose of this study was to analyze the scientometric characteristics and research trends of MRONJ, highlighting the discipline and chronological comparison of the keywords. We believe that our work will help to identify gaps in the literature and future research directions, contributing to a better understanding of MRONJ management.

## Materials and methods

As per the methodology described previously,<sup>11</sup> all the papers on MRONJ in the Scopus database were retrieved on 30

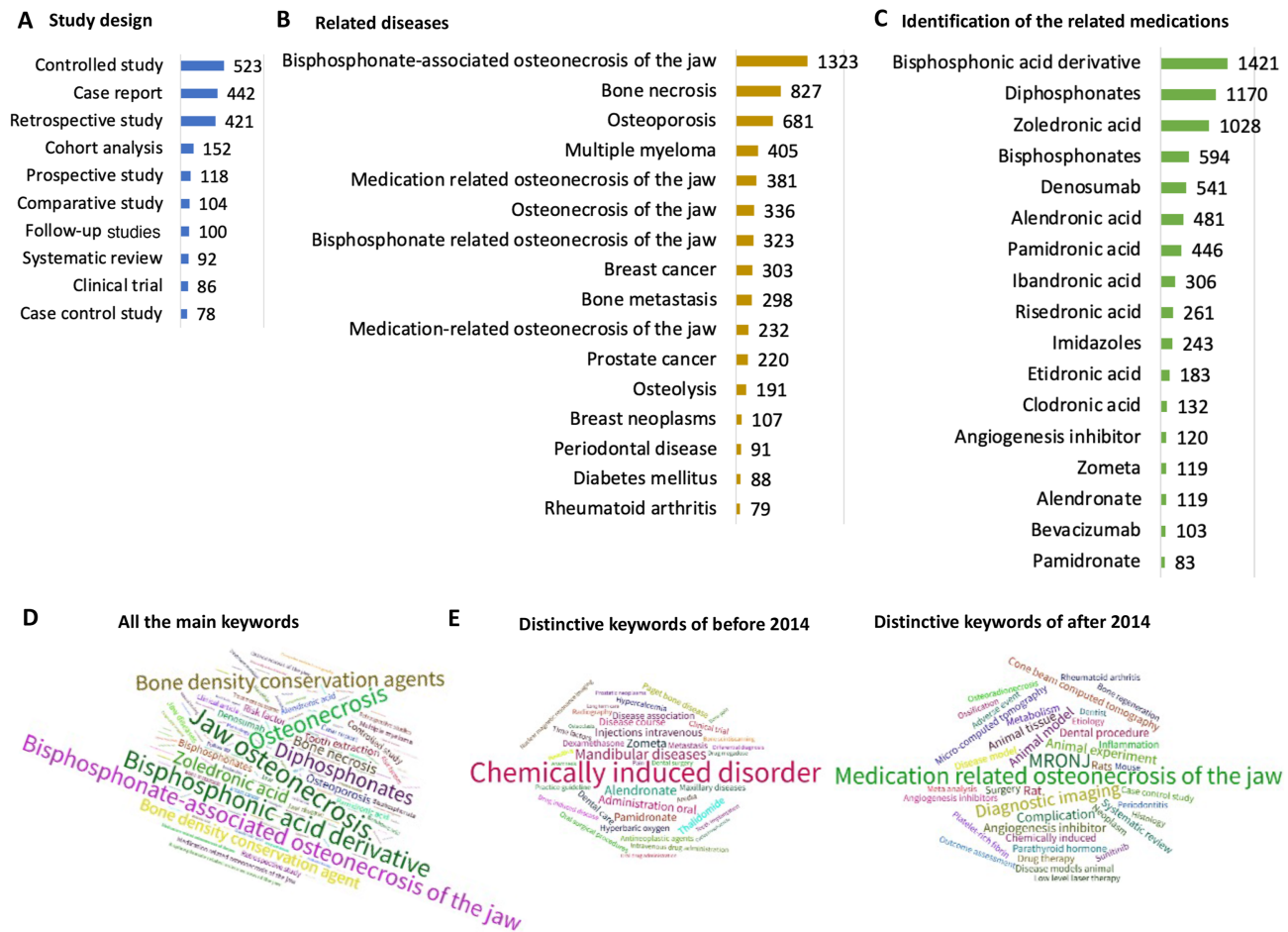
Sep 2025. We used medical subject terms “medication OR bisphosphonate” in the title/abstract/keywords and “Jaw OR maxilla\* OR mandib\*” and “osteonecrosis” in the title in literature search, without restriction to paper type and year of publication. Only English language literature was included because it is an international language of knowledge exchange. The papers with the word “dent\* OR oral OR maxillofac\* OR stomatolog\*” in the affiliations generally represent scientific output of stomatologists, and the remaining papers generally represent scientific output of other scholars. The years of publication were divided into before 2014 and Jan 2015–Sep 2025, since the definition of BRONJ was revised to MRONJ according to the AAOMS in 2014. The bibliometric characteristics of all the eligible papers were reviewed and recorded for the following information: title, keyword, citation count, publication year, journal of publication, authorship, affiliation, and country/region of origin. Data search and extraction were performed independently by two investigators, and any discrepancy of results was resolved in a consensus symposium. Microsoft Office Excel 365 was used for index model building, and the Bibliometrix Biblioshiny R-package software was used for bibliometric statistics. In this descriptive study, variables are presented as numbers and percentages. No comparisons were made, and thus no *P*-values were set.

## Results

### Bibliometric characteristics of MRONJ publications

With the search strategy algorithm, a total of 2857 papers on MRONJ were retrieved in the Scopus database. There were 2251 (78.8 %) and 606 (21.2 %) papers were published by stomatologists and other scholars, respectively. Fig. 1A illustrates the number and distribution of their paper types. The detailed information on publication year, title, journal, citation count, authors, keywords, document types, affiliations and countries/regions of the top-100 most-cited papers on MRONJ are presented in Supplementary Table S1. To further concretize the trends of scientific output, we assessed the annual number and annual accumulated citations of the papers on MRONJ during 2005–2024 (Fig. 1B). The annual number of the publications by stomatologists changed from 12 to 186, and the accumulated citations of these papers changed from 104 to 6285 during 2005–2024. The annual number of the publications by other scholars changed from 14 to 41, and the accumulated citations of these papers changed from 15 to 1293 during this period. Fig. 1C displays cloud graphs of journals of publications,





**Figure 2** Research characteristics of the papers on medication-related osteonecrosis of the jaw (MRONJ). (A) Study design. (B) The related diseases. (C) Identification of the related medications. (D) Cloud graph of all the main keywords. (E) Distinctive keywords of papers published before 2014 and after 2014. The font size indicates the number of papers; a larger size means more papers in the cloud graphs.

2025. There have always been the same common keywords such as tooth extraction, risk factor, pathology, follow up, treatment outcome, animal, wound healing, bone metastasis, bone remodeling, bone turnover, computer assisted tomography, panoramic radiography, quality of life, debridement, antibiotic therapy, conservative treatment, and drug withdrawal. The more frequent keywords in different years can basically reflect research trends (Fig. 2E). Before 2014, clinical trial, practice guideline, hypercalcemia, pain, time factors, differential diagnosis, bone scintiscanning, radiography, and nuclear magnetic resonance imaging were distinctive keywords of clinical management. Mandibular diseases, maxillary diseases, Paget bone disease, drug induced disease, disease course, disease association, prostatic neoplasms, and metastasis were disease-related keywords. Tooth implantation, intravenous injections, dental care, long term care, hyperbaric oxygen, drug megadose, alendronate, aredia, pamidronate, dexamethasone, penicillin G, cyclophosphamide, thalidomide, and zometa were therapeutic and drug keywords before 2014. After 2014, medication related osteonecrosis of the jaw, MRONJ, osteoradionecrosis, diagnostic imaging,

CBCT, micro-CT, ossification, etiology, angiogenesis inhibitor, sunitinib, complication, metabolism, parathyroid hormone, periodontitis, rheumatoid arthritis, inflammation, bone regeneration, outcome assessment, drug therapy, low level laser therapy, and platelet-rich fibrin (PRF) were distinctive keywords. Meanwhile, disease model, animal model including rat and mouse, and animal experiment were mainly conducted after 2014.

## Discussion

Along with the increasing prevalence of cancer and osteo-metabolic diseases, MRONJ has emerged as a distinct and growing clinical challenge.<sup>12–14</sup> The main etiological factors for MRONJ are antiresorptive and antiangiogenic medications for treating these diseases. Given the complexities of MRONJ, a multidisciplinary approach is crucial for managing MRONJ effectively and improving patient symptoms and quality of life.<sup>1,9</sup> This scientometric study attempted to analyze the bibliometric and research characteristics of all English publications on MRONJ from its

initial footprints. Bibliometric items in sequence would aid clinicians and researchers in choosing target journals, finding potential collaborators or partner institutions, as well as promoting mutual understanding and more reciprocal cooperation. The increasing number and citations of those publications by stomatologists each year, suggests that the field of MRONJ has garnered increasing attention and investigation by stomatologists. The journal of publication with largest number of papers was *Journal of Oral and Maxillofacial Surgery*, further suggesting that MRONJ was investigated mainly by oral and maxillofacial surgeons. The patients with MRONJ are frequently seen in stomatological clinics and the diagnosis and treatment are mainly conducted by stomatologists and oral and maxillofacial surgeons.<sup>15–19</sup> Herein, we highlight the awareness of early prevention and timely diagnosis and improve the access to care for MRONJ.<sup>20–22</sup>

The strength of this scientometric study was to analyze the common and distinctive keywords in different disciplines (stomatology versus others) and different decades (before 2014 versus 2014–2025). These keywords contained the aspects of clinical feature, risk factor, diagnostic imaging, and treatment strategies. For instance, the frequency (302) of the mandible was more than that (180) of the maxilla, in agreement with MRONJ more frequently occurring in the mandible than the maxilla in clinical practice. Treatment strategies including bone resection, debridement, antibiotic therapy, conservative treatment, hyperbaric oxygen therapy, low level laser therapy, drug withdrawal discontinuing medication that cause MRONJ, and PRF application during tooth extraction to enhance wound healing and tissue regeneration.<sup>23–25</sup> The related diseases (Fig. 2B) such as multiple myeloma, breast cancer, prostate cancer, bone metastasis, diabetes mellitus, rheumatoid arthritis confirmed that the diagnosis and treatment of MRONJ in many cases need be multidisciplinary cooperation involving stomatologists, oncologists, specialist physicians and nurses.<sup>26</sup> This highlights the importance of personalized treatment strategies in managing MRONJ, considering the specific medication and its impact on den-toalveolar and jaw health. A good medical history with emphasis on the use of medication that causes MRONJ, detailed clinical and radiographic evaluations excluding jaw metastasis cancer and osteoradionecrosis, and attention to the patient's signs and symptoms is critical for the correct diagnosis and appropriate treatment, which in turn can lead to better patient prognosis.

In summary, this scientometric study elucidated the current scenario and research trends of MRONJ. Finding the scientometrics would elucidate the comprehensive identification and recognition of the important and relevant research topics concerned, but also help in improving in reciprocal collaboration and communication for investigations on this disease. Multidisciplinary comprehensive management should be proposed to achieve optimal outcomes.

## Declaration of competing interest

The authors have no conflicts of interest relevant to this article.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jds.2025.11.002>.

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