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Original Article

# Awareness and practice of dentists in gulf cooperation council countries regarding medication-related osteonecrosis of the jaw — A web-based survey

Mohammad Zakaria Nassani [a], Bassel Tarakji [b*], Abdulaziz Maree Alqahtani [c], Faisal Mehsen Alali [b], Mohammed Noushad [a], Samer Rastam [d], Anas B. Alsalhani [e,f], Mohammed Khalid Alfadel [g], Abdulaziz Abdullah Alzuabi [g], Abdulhaleem Muhammad Ateen [g], Abdullah Bahjat Khojah [g], Mahmud Uz Zaman [b], Abdullah Saad Alqahtani [h], Nasser Raqe Alqhtani [b], Abdullah Bin Nabhan [b], Faisal S. Alhedyan [b], Omar Kujan [i], Sadeq Ali Al-Maweri [j]

[a] *Department of Restorative and Prosthetic Dental Sciences, College of Dentistry, Dar Al Uloom University, Riyadh, Saudi Arabia*
[b] *Department of Oral and Maxillofacial Surgery and Diagnostic Sciences, College of Dentistry, Prince Sattam Bin Abdulaziz University, Al Kharj, Saudi Arabia*
[c] *General Dental Practitioner, Riyadh, Saudi Arabia*
[d] *Department of Clinical Sciences, Vision College of Medicine, Vision Colleges, Riyadh, Saudi Arabia*
[e] *Department of Oral Medicine and Diagnostic Sciences, Vision College of Dentistry and Nursing, Vision Colleges, Riyadh, Saudi Arabia*
[f] *Department of Histology and Pathology, Faculty of Dentistry, University of Hama, Hama, Syria*
[g] *Dental Student, College of Dentistry, Prince Sattam Bin Abdulaziz University, Al Kharj, Saudi Arabia*
[h] *Department of Preventive Dentistry, College of Dentistry, Prince Sattam Bin Abdulaziz University, Al Kharj, Saudi Arabia*
[i] *UWA Dental School, The University of Western Australia, Perth Western Australia, Australia*
[j] *College of Dental Medicine, QU Health, Qatar University, Doha, Qatar*

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* Corresponding author. Department of Oral Maxillofacial Surgery and Diagnostic Sciences, College of Dentistry, Prince Sattam bin Abdulaziz University, Al Kharj 11942, Saudi Arabia.
*E-mail address:* b.tarakji@psau.edu.sa (B. Tarakji).

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**KEYWORDS**
Awareness;
Dentists;
GCC countries;
MRONJ;
Osteonecrosis of the jaw;
Practice

**Abstract** *Background/purpose:* Medication-related osteonecrosis of the jaw (MRONJ) is a serious complication among dental patients undergoing treatment with antiresorptive medications such as bisphosphonate and denosumab. The present survey investigated the awareness and practice of dentists in the Gulf Cooperation Council (GCC) countries regarding MRONJ.
*Materials and methods:* This questionnaire-based study was conducted among dental practitioners in all six GCC countries. A questionnaire was designed and distributed among all potential participants via different social media platforms. SPSS version 22 was used for data analysis, and *P*-value $<0.05$ was considered statistically significant.
*Results:* Overall, 1685 dentists from the six GCC countries participated in the present study. The surveyed dentists revealed relatively fair practices and awareness regarding MRONJ and its prevention, with the majority reported asking their patients about history of anti-osteoporotic medications (67.8%), recording name of the medication (73.1%) and duration of treatment (75.5%). However, the majority of the participants were unconfident about the duration of drug holiday prior to dental surgical interventions (70.6%) and the overall good level of knowledge/practice related to MRONJ was just 50.6%. The regression analysis revealed that previous exposure to MRONJ cases and attending a seminar, course, meeting, or conference about osteonecrosis of the jaw were independent predictors for positive awareness/good practice regarding MRONJ ($P < 0.05$).
*Conclusion:* The results show inadequate awareness and practices of dentists practicing in GCC countries regarding MRONJ, with significant variations among the countries. Therefore, appropriate interventions such as periodic continuous education courses are required to improve dentists' knowledge and practices regarding MRONJ.


## Introduction

Medication-related osteonecrosis of the jaw (MRONJ) is a serious complication of treatment with antiresorptive medications such as bisphosphonate and denosumab.[1,2] MRONJ is a relatively common condition among dental patients undergoing bisphosphonate and denosumab treatment with an incidence rate of 0.1%–1%, depending on type of medication, duration and route of administration.[1–3] Since the first case of MRONJ was reported in 2003 by Marx,[4] numerous cases have been reported in the literature.[5–8] While the exact etiopathogenesis of MRONJ is still not fully understood, a number of predisposing factors have been suggested including, among others, duration and route of antiresorptive medication, dentoalveolar surgery, age, underlying systemic conditions such as diabetes mellitus, and medications use such as corticosteroids.[1,2,7] MRONJ is a serious complication that gravely impairs the daily oral functions and impacts the patients' quality of life.[9] The management of MRONJ is quite challenging, and requires a multidisciplinary approach.[10,11] Therefore, preventing the occurrence of MRONJ in dental patients undergoing treatment with antiresorptive medications is the best way to avoid such complications.

Dental professionals can and must play a crucial role in the prevention of MRONJ by identifying patients at risk for the disease, through comprehensive medical and dental history taking, and careful treatment planning.[12,13] Hence, dentists must have adequate knowledge about the complications of antiresorptive therapy, risk factors for MRONJ, and the updated guidelines for treatment of patients taking bisphosphonates and/or denosumab in the dental setting.[12] The American Association of Maxillofacial Surgery (AAOMS) published position papers on MRONJ clinical features, risk factors and guidelines for the clinicians on how to prevent and manage MRONJ.[1] However, despite these guidelines and recommendations, the occurrence of MRONJ has not been significantly reduced.[15,16] As stated earlier, since dental professionals can play a pivotal role in reducing the incidence of MRONJ,[12,13] they should be knowledgeable about the disease and kept up-to date about the clinical protocol and guidelines pertaining to the management and prevention of MRONJ.

Several studies worldwide have evaluated MRONJ awareness and practices among dental practitioners, most of which reported unsatisfactory results.[12,14,17–22] Unfortunately, information regarding the awareness and practices of dentists in the prevention and management of MRONJ in the Gulf Cooperation Council (GCC) countries is limited.[20] GCC countries include six nations namely Saudi Arabia, UAE, Kuwait, Oman, Qatar, and Bahrain (Fig. 1). Hence, the present study aims at evaluating the awareness and practices of dentists working in the six GCC countries about the prevention and management of MRONJ. The results of this study could contribute to the establishment of new strategies that could affect the management policies of MRONJ patients in the Gulf region.

## Material and methods

### Study design and ethical approval

This was a questionnaire-based cross-sectional study. The ethical approval was obtained from Ethical Review Board


**Figure 1** World map showing the countries represented in the survey. All six Gulf Cooperation Council countries were included in the survey.

(REC-HSD-026-2020), Prince Sattam Bin Abdulaziz University, Al Kharj, Saudi Arabia.

## Setting and sample

The study was conducted between March and December 2021, on a convenience sample of general dental practitioners and dental specialists practicing in the GCC countries. The sample size was calculated using the OpenEpi (Open Source Epidemiologic Statistics for Public Health, Version 3.01, Emory University, Atlanta, GA, United States of America). Considering 5% absolute precision, an estimated level of awareness of 50%, and 95% confidence interval, the estimated sample size was 1535. We added 10% to overcome the possibilities of missing data.

## Questionnaire

A web-based questionnaire was used to collect data from the participants. The questionnaire was adapted from previous similar studies.[12,17–20] Before commencement of the study, the questionnaire was sent to three experts in the field for their feedback and modified accordingly. Additionally, the questionnaire was piloted among a group of dentists from different GCC countries, then modified accordingly. Then, a link of the questionnaire was prepared using Google Forms and sent to the potential participants via different social media platforms. The aim of the study was described in detail and emphasized the confidentiality of the participants. Informed consent was taken from all participants upon acceptance to complete the questionnaire. Five reminders were sent through social media platforms, aiming to increase the response rate.

The questionnaire consisted of two sections; the first section included questions regarding the participants' sociodemographic such as age, gender, country of practice, specialty, type of practice, and clinical experience. The second section included items related to MRONJ awareness and practices.

## Data analysis

Data analysis was made by SPSS 22.0 software (The International Business Machines Corporation (IBM), Armonk, NY, United States of America). Characteristics of participating dentists in the six countries of the GCC were presented by descriptive statistics, and the chi-square test was used to assess any possible association between questionnaire items, and the independent factors.

Additionally, multiple logistic model was created to identify all potential predictors of the participants' knowledge/practice. The dependent variable was the "good knowledge/practice" (i.e., when the respondent answered correctly (yes) to all awareness/practice questions, while the independent factors included specialty, years of clinical experience, previous exposure to osteonecrosis case(s), and attending continuous education on the topic. A $P$-value $<0.05$ was considered significant.

# Results

Overall, 1685 dentists from the six GCC countries (Saudi Arabia, UAE, Oman, Qatar, Bahrain, and Kuwait) participated in the study. The vast majority of participants were 31 years of age or older (66.1%), and the proportion of males exceeded that of females (57.7% vs 42.3%). Majority of the participants were specialists (63.8%), practice in the public sector (51.9%), have clinical experience of at least five years (77.3%), and have exposure to MRONJ cases (66.9%), and have attended continuous education courses on the topic (66.2%). A detailed description of the study population is presented in Table 1.

Table 2 shows responses of participants to the survey questions by country of practice. The participants' correct answers to the awareness/practice questions on MRONJ

**Table 1** Characteristics of participants (No = 1685).

| | Total n = 1685 | Country | | | | | |
|---|---|---|---|---|---|---|---|
| | | Saudi Arabia n = 752 | Kuwait n = 228 | Bahrain n = 200 | Qatar n = 173 | UAE n = 175 | Oman n = 157 |
| **Age (years)** | | | | | | | |
| ≤30 | 571 (33.9%) | 351 (46.7%) | 60 (26.3%) | 42 (21%) | 50 (28.9%) | 31 (17.7%) | 37 (23.6%) |
| 31-50 | 940 (55.8%) | 339 (45.1%) | 150 (65.8%) | 134 (67%) | 109 (63%) | 122 (69.7%) | 86 (54.8%) |
| >50 | 174 (10.3%) | 62 (8.2%) | 18 (7.9%) | 24 (12%) | 14 (8.1%) | 22 (12.6%) | 34 (21.6%) |
| **Gender** | | | | | | | |
| Male | 972 (57.7%) | 469 (62.4%) | 129 (56.6%) | 101 (50.5%) | 86 (49.7%) | 96 (54.9%) | 91 (58%) |
| Female | 713 (42.3%) | 283 (37.6%) | 99 (43.4%) | 99 (49.5%) | 87 (50.3%) | 79 (45.1%) | 66 (42%) |
| **Type of Practice** | | | | | | | |
| Governmental | 874 (51.9%) | 323 (43%) | 130 (57%) | 118 (59%) | 95 (54.9%) | 110 (62.9%) | 98 (62.4%) |
| Private | 667 (39.6%) | 329 (43.8%) | 89 (39%) | 77 (38.5%) | 66 (38.2%) | 59 (33.7%) | 47 (29.9%) |
| Both | 144 (8.5%) | 100 (13.3%) | 9 (3.9%) | 5 (2.5%) | 12 (6.9%) | 6 (3.4%) | 12 (7.6%) |
| **Specialty** | | | | | | | |
| General practice | 610 (36.2%) | 397 (52.8%) | 52 (22.8%) | 39 (19.5%) | 43 (24.9%) | 33 (18.9%) | 46 (29.3%) |
| Oral Surgery/ Periodontics | 263 (15.6%) | 93 (12.4%) | 41 (18%) | 39 (19.5%) | 30 (17.3%) | 33 (18.9%) | 27 (17.2%) |
| Other Dental Specialty[a] | 812 (48.2%) | 262 (34.8%) | 135 (59.2%) | 122 (61%) | 100 (57.8%) | 109 (62.3%) | 84 (53.5%) |
| **Clinical Experience (years)** | | | | | | | |
| <5 | 383 (22.7%) | 258 (34.3%) | 32 (14%) | 21 (10.5%) | 22 (12.7%) | 27 (15.4%) | 23 (14.6%) |
| 5-10 | 650 (38.6%) | 291 (38.7%) | 89 (39%) | 77 (38.5%) | 64 (37%) | 65 (37.1%) | 64 (40.8%) |
| >10 | 652 (38.7%) | 203 (27%) | 107 (47%) | 102 (51%) | 87 (50.3%) | 83 (47.5%) | 70 (44.6%) |
| **Exposure to MRONJ cases** | | | | | | | |
| Yes | 1127 (66.9%) | 549 (73%) | 143 (62.7%) | 122 (61%) | 96 (55.5%) | 110 (62.9%) | 107 (68.2%) |
| **Attended a seminar, course, meeting or conference about osteonecrosis of the jaw** | | | | | | | |
| Yes | 1116 (66.2%) | 567 (75.4%) | 137 (60.1%) | 118 (59%) | 98 (56.6%) | 95 (54.3%) | 101 (64.3%) |

MRONJ, medication-related osteonecrosis of the jaw.
[a] Orthodontics, Endodontics, Restorative dentistry, Paediatric dentistry, Prosthodontics, Oral medicine/pathology.

management ranged from 28.4% to 75.5% (with an overall average of 50.6%), with significant differences across the country of practice ($P < 0.05$). Most of the dentists in this survey indicated that they ask their patients if they take an anti-osteoporotic drug (67.8%). However, this practice was more popular among dentists in Saudi Arabia (75.9%) and Oman (73.9%) compared to those in other surveyed countries ($P < 0.05$). Additionally, while more than two-thirds of the participants record the name (73.1%) and duration (75.5%) of the anti-osteoporotic medication, this practice was most common in Saudi Arabia and least common in Bahrain (Table 2).

Almost 75% of the dentists request a medical doctor's referral letter prior to dental surgery procedures; this figure ranged from 63% in Qatar to 81.1% in Saudi Arabia. A considerable proportion of the dentists in this study (48%) advise their patients to discontinue the anti-osteoporotic agent for a period of ≥6 months before tooth extraction or implant placement, with significant differences in this practice across the GCC countries ($P < 0.05$). At least 72% of the responding dentists recommend different drug holidays depending on the type of anti-osteoporotic drug, with country-wise rates ranging from 46.5% in Bahrain to as high as 78.6% in Saudi Arabia. Bisphosphonates group was the most reported drug to cause MRONJ (51.6%), followed by Denosumab (9.3%) and SERMs (6%). On a similar note, bisphosphonates were the most reported type of medication that cause MRONJ across all countries. Interestingly around two-thirds of the sample (66.9%) reported having previous exposure to MRONJ cases during their career with some significant differences across the countries (Table 2).

The results indicate an association between dental specialty and practice of dentists regarding MRONJ (Table 3). Compared with general dental practitioners/other dental specialists, a significantly higher proportion of oral surgeons/periodontists ask their patients if he/she is taking anti-osteoporotic drugs, record the name and duration of the anti-osteoporotic medication and recommend different drug holidays depending on the type of anti-osteoporotic drug ($P < 0.05$).

The impact of clinical experience on dentists' awareness/practices is presented in Table 3. It can be noticed that senior dentists (with more than 10 years clinical experience) showed poorer awareness/practice compared to dentists with ≤5 years of clinical experience. These included asking the patients whether he/she is taking an anti-osteoporotic drug (56.4%), recording the duration of the anti-osteoporotic drug (69.2%), requesting a medical doctor's referral letter prior to dental surgery procedures (65.6%), and recommending different drug holidays depending on the type of anti-osteoporotic drug (64.6%) (Table 3).

Additionally, the results showed that dentists with previous exposure to MRONJ cases had significantly better

**Table 2** Responses of the participating dentists to survey questions by country (% of Yes answers).

| | Total n = 1685 | Country | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Saudi Arabia n = 752 | Kuwait n = 228 | Bahrain n = 200 | Qatar n = 173 | UAE n = 175 | Oman n = 157 | *p* |
| **Do you ask if the patient is taking anti-osteoporotic drugs?** | | | | | | | | |
| Yes | 67.8% | 75.9% | 60.1% | 56.5% | 61.8% | 56% | 73.9% | <0.001[a] |
| **Do you identify and record the name of the anti-osteoporotic medication at the time of implant or tooth extraction?** | | | | | | | | |
| Yes | 73.1% | 80.6% | 68% | 60.5% | 65.3% | 69.1% | 73.9% | <0.001[a] |
| **Do you record the duration of the anti-osteoporotic drug?** | | | | | | | | |
| Yes | 75.5% | 80.5% | 73.7% | 65% | 68.8% | 71.4% | 80.3% | <0.001[a] |
| **Do you ask for a medical doctor's referral letter prior to dental surgery procedures?** | | | | | | | | |
| Yes | 74.9% | 81.1% | 70.2% | 66.5% | 63% | 72% | 79% | <0.001[a] |
| **How long do you advise patients to discontinue the anti-osteoporotic agent before tooth extraction or implant placement?** | | | | | | | | |
| ≤2 months | 22.6% | 25.5% | 25.4% | 23.5% | 16.8% | 20.6% | 12.1% | 0.009[a] |
| 3–5 months | 28.4% | 27.5% | 26.8% | 32.5% | 30.6% | 28.6% | 26.8% | |
| ≥6 months | 48% | 46.9% | 47.8% | 44% | 52.6% | 50.9% | 61.1% | |
| **Do you recommend different drug holidays depending on the type of drug (bisphosphonates, denosumab, SERMs, PTH)?** | | | | | | | | |
| Yes | 72.2% | 78.6% | 66.7% | 46.5% | 61.3% | 69.1% | 75.2% | <0.001[a] |
| **If you have encountered case/s of MRONJ, what type of medication caused it?** | | | | | | | | |
| Bisphosphonates | 51.6% | 61.6% | 36.4% | 36% | 44.5% | 50.9% | 54.8% | <0.001[a] |
| Denosumab | 9.3% | 6.5% | 18.4% | 17.5% | 6.9% | 3.4% | 7.6% | |
| SERMs | 6% | 5.1% | 7.9% | 7.5% | 4% | 8.6% | 5.1% | |
| No experience | 33.1% | 26.9% | 37.3% | 39% | 44.5% | 37.1% | 32.5% | |
| **Good level of knowledge/practice-related MRONJ** | | | | | | | | |
| Yes | 50.6% | 60.6% | 42.1% | 35.5% | 38.7% | 41.7% | 56.7% | <0.001[a] |

SERMs, selective estrogen-receptor modulators; PTH, parathyroid hormone; MRONJ, medication-related osteonecrosis of the jaw.
[a] Denotes significant difference at $P < 0.05$ as indicated by chi-square statistics.

**Table 3** Responses of the participating dentists to survey questions by specialty and clinical experience.

| | Total n = 1685 | Specialty | | | | Clinical Experience (years) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | General Practice n = 610 | Oral Surgery/ Periodontics n = 263 | Other Specialty[b] n = 812 | *p* | <5 n = 383 | 5-10 n = 650 | >10 n = 652 | *p* |
| **Do you ask if the patient is taking anti-osteoporotic drugs?** | | | | | | | | | |
| Yes | 67.8% | 65.9% | 74.5% | 67% | 0.035[a] | 67.6% | 79.2% | 56.4% | <0.001[a] |
| **Do you identify and record the name of the anti-osteoporotic medication at the time of implant or tooth extraction?** | | | | | | | | | |
| Yes | 73.1% | 70.5% | 75.3% | 74.4% | 0.180 | 70.8% | 75.4% | 72.2% | 0.219 |
| **Do you record the duration of the anti-osteoporotic drug?** | | | | | | | | | |
| Yes | 75.5% | 71.8% | 79.8% | 77% | 0.017[a] | 78.1% | 80.5% | 69.2% | <0.001[a] |
| **Do you ask for a medical doctor's referral letter prior to dental surgery procedures?** | | | | | | | | | |
| Yes | 74.9% | 73.9% | 78.7% | 74.4% | 0.295 | 80.7% | 80.8% | 65.6% | <0.001[a] |
| **How long do you advise patients to discontinue the anti-osteoporotic agent before tooth extraction or implant placement?** | | | | | | | | | |
| ≤2 months | 22.6% | 25.9% | 21.3% | 20.6% | 0.065 | 30.8% | 20.3% | 20.1% | <0.001[a] |
| 3–5 months | 28.4% | 25.7% | 32.7% | 28.9% | | 22.7% | 34.5% | 25.6% | |
| ≥6 months | 49% | 48.4% | 46% | 50.5% | | 46.5% | 45.2% | 54.3% | |
| **Do you recommend different drug holidays depending on the type of drug (bisphosphonates, denosumab, SERMs, PTH)?** | | | | | | | | | |
| Yes | 72.2% | 70.5% | 79.1% | 71.3% | 0.024[a] | 73.1% | 79.4% | 64.6% | <0.001[a] |
| **If you have encountered case/s of MRONJ, what type of medication caused it?** | | | | | | | | | |
| Bisphosphonates | 51.6% | 54.3% | 54.8% | 48.6% | <0.001[a] | 57.7% | 63.2% | 36.5% | <0.001[a] |
| Denosumab | 9.3% | 4.8% | 16.7% | 10.2% | | 6% | 8.5% | 12% | |
| SERMs | 6% | 3.9% | 5.3% | 7.8% | | 4.2% | 3.5% | 9.5% | |
| No experience | 33.1% | 37% | 23.2% | 33.4% | | 32.1% | 24.8% | 42% | |

SERMs, selective estrogen-receptor modulators; PTH, parathyroid hormone; MRONJ, medication-related osteonecrosis of the jaw.
[a] Denotes significant difference at $P < 0.05$ as indicated by chi-square statistics.
[b] Orthodontics, Endodontics, Restorative dentistry, Paediatric dentistry, Prosthodontics, Oral medicine/pathology.

**Table 4** Responses of the participating dentists to survey questions by experience with MRONJ cases, and attendance of continuous education course about osteonecrosis of the jaw.

| | Total n = 1685 | Experience with MRONJ cases | | | Attendance of a seminar, course, meeting or conference about osteonecrosis of the jaw | | |
|---|---|---|---|---|---|---|---|
| | | Yes n = 1127 | No n = 558 | *p* | Yes n = 1116 | No n = 569 | *p* |
| **Do you ask if the patient is taking anti-osteoporotic drugs?** | | | | | | | |
| Yes | 67.8% | 84.1% | 34.8% | <0.001[a] | 87.6% | 28.8% | <0.001[a] |
| **Do you identify and record the name of the anti-osteoporotic medication at the time of implant or tooth extraction?** | | | | | | | |
| Yes | 73.1% | 82.3% | 54.7% | <0.001[a] | 83.3% | 53.1% | <0.001[a] |
| **Do you record the duration of the anti-osteoporotic drug?** | | | | | | | |
| Yes | 75.5% | 90.2% | 45.9% | <0.001[a] | 89.5% | 48.2% | <0.001[a] |
| **Do you ask for a medical doctor's referral letter prior to dental surgery procedures?** | | | | | | | |
| Yes | 74.9% | 91.5% | 41.4% | <0.001[a] | 88.9% | 47.5% | <0.001[a] |
| **How long do you advise patients to discontinue the anti-osteoporotic agent before tooth extraction or implant placement?** | | | | | | | |
| ≤2 months | 22.6% | 20.1% | 27.8% | 0.002[a] | 18.6% | 30.4% | <0.001[a] |
| 3–5 months | 28.4% | 29.3% | 26.5% | | 31.5% | 22.1% | |
| ≥6 months | 49% | 50.7% | 45.7% | | 49.8% | 47.5% | |
| **Do you recommend different drug holidays depending on the type of drug (bisphosphonates, denosumab, SERMs, PTH)?** | | | | | | | |
| Yes | 72.2% | 88.5% | 39.4% | <0.001[a] | 90.9% | 35.5% | <0.001[a] |

SERMs, selective estrogen-receptor modulators; PTH, parathyroid hormone; MRONJ, medication-related osteonecrosis of the jaw.
[a] Denotes significant difference at $P < 0.05$ as indicated by chi-square statistics.

awareness and practices than those who had no exposure to MRONJ cases. Similarly, a significant association was observed between attendance of continuous education courses on MRONJ and positive practices and awareness (Table 4).

Table 5 presents logistic regression results. The multivariate analysis revealed that attending meetings/workshops and previous exposure to MRONJ cases were significantly associated with positive awareness/practices ($P < 0.05$). However, no significant associations were observed with other independent variables including years of clinical experience and specialty ($P > 0.05$).

**Table 5** Predictors of good level of knowledge/practice-related to MRONJ.

| | Adjusted Odds Ratio | 95% Confidence Interval | *p* |
|---|---|---|---|
| **Specialty** | | | |
| General Practice | **Ref** | _ | _ |
| Dental Specialist[b] | 0.79 | (0.56–1.12) | 0.19 |
| Oral Surgery/ Periodontics | 1.03 | (0.67–1.59) | 0.89 |
| **Years of clinical experience** | | | |
| <5 years | **Ref** | _ | _ |
| 5–10 years | 1.24 | (0.85–1.81) | 0.26 |
| >10 years | 0.69 | (0.45–1.06) | 0.09 |
| **Experience with MRONJ cases** | | | |
| No | **Ref** | _ | _ |
| Yes | 5.55 | (4.14–7.44) | <0.001[a] |
| **Attended a seminar, course, meeting or conference about osteonecrosis of the jaw** | | | |
| No | **Ref** | _ | _ |
| Yes | 6.08 | (4.56–8.11) | <0.001[a] |

MRONJ, medication-related osteonecrosis of the jaw.
[a] Denotes significant difference at $P < 0.05$.
[b] Orthodontics, Endodontics, Restorative dentistry, Paediatric dentistry, Prosthodontics, Oral medicine/pathology.

## Discussion

The present study investigated practices of dentists in the GCC region regarding MRONJ in patients undergoing dental procedures. To the best of our knowledge, this is the first large-scale study that addressed this topic among all GCC countries. Overall, the surveyed dentists revealed poor to fair practices regarding MRONJ and its prevention. The positive practice ranged from 28.4% to 75.5% with significant differences according to qualification, years of clinical experience, previous exposure to MRONJ, history of attending related course/conference, and country of residence. The multivariate analysis revealed that attending meetings/workshops and previous exposure to MRONJ cases were independent predictors for positive awareness/practices.

The key finding in the present study is the unsatisfactory practices of dental practitioners regarding MRONJ and its prevention in patients needing dental treatments, with only around half of the sample having good knowledge and following international guidelines for the dental treatment of MRONJ patients. These findings are consistent with majority of previous similar surveys, which showed inadequate awareness and unsatisfactory practices among dentists regarding MRONJ.[12,14,17–22] These results are very alarming, dictating an urgent action to help improve dentists' knowledge and practices regarding prevention and treatment of MRONJ in dental practice. Dental continuing

education courses including workshops, seminars and conferences should address this gap. Generally, it is recommended to discontinue antiresorptive therapy and bone modifying agents (mainly bisphosphonates) for some time before doing any surgical procedure in order to prevent MRONJ.[1,2] In this context, when the participants were asked about the duration they advise their patients to discontinue the medication "drug holiday", majority of the respondents reported ≥6 months, which is far longer than that recommended by AAOMS (2–3 months).[1] This indicates the lack of the adequate knowledge among the surveyed dentists on the updated management protocol of MRONJ. Knowing the optimal drug holidays of bisphosphonates and other antiresorptive medications is very crucial to prevent any serious consequences,[12] and hence, dentists should be made aware about these guidelines.

Another interesting finding in the present study is the significant association between level of practice and specialty of the participants, that is, participants with higher degrees (especially oral surgeons/periodontists) showed significantly better practices than their counterpart general practitioners. These results are expected, and can be explained by the fact that specialists, particularly oral surgeons/periodontists had better exposure to this topic during their postgraduate training and during their daily practice, which is translated and reflected in their positive practices. Hence, periodic continuous education is very crucial with especial focus on general dental practitioners. Incorporating more training sessions (including lectures and clinical scenarios) on MRONJ into undergraduate curricula is also paramount.[23] Our results showed that dentists with more than 10 years in practice were less confident in treating MRONJ patients compared to recent graduates, confirming the urgent need for periodic refreshing continuous educational courses targeting senior practicing dentists. This finding is consistent with previous studies among dentists elsewhere.[19,22]

Periodic continuous education is key to keep clinicians knowledgeable and up-to-date on the best evidence-based practices. In the present study, only 66% reported attending at least one course/seminar on MRONJ, the highest being in Saudi Arabia and the lowest in Qatar and UAE. Unsurprisingly, participants who have attended at least one educational course on the topic revealed much better awareness and positive practices than those who didn't. This finding was also confirmed by the multivariate analysis, which revealed attendance of continuous education as an independent predictor for positive awareness/practice of the participants. This again underscores the importance of periodic continuous education courses on dentists' awareness and clinical practices. Hence, it can be stressed again that practicing dentists should be encouraged to attend periodic continuous education events to raise their knowledge on the topic and prevent the occurrence of MRONJ and its complications.

The present survey revealed unsatisfactory practices of MRONJ prevention and management among dental professionals working in the GCC countries. Nevertheless, the present survey has some potential limitations that should be considered when interpreting the results. First, this is based on self-reported responses, and thus the real practices might have not been accurately reported. Second, despite the relatively large sample size, the convenience sampling method employed in the present study hinders the generalizability of the results. Third, the low response rate especially in some of the included countries is another important limitation; this again jeopardizes generalization of the results. However, despite the limitations, the present survey provides valuable insight into the current practices of dentists in the GCC countries regarding the prevention and management of MRONJ.

In conclusion, similar to dentists elsewhere, the present survey shows unsatisfactory practices of dentists in GCC countries in prevention of MRONJ in patients undergoing dental procedures. This dictates an urgent action through continuous education courses and workshops to help improve dentists' awareness and practices in MRONJ prevention and management in dental settings. Dissemination of relevant guidelines is also recommended.

## Declaration of competing interest

The authors declare no conflict of interest.

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