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Across-sectional survey on medication-related osteonecrosis of the jaws' knowledge and awareness in a sample of dental society



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ABSTRACT

Background: Medication-related osteonecrosis of the jaws (MRONJ) is a prominent complication and growing problem related to the oral and maxillofacial region due to antiresorptive and antiangiogenic agents. Awareness about MRONJ is crucial for all dental practitioners identify 'at risk' patients for appropriate advice and management. This cross-sectional survey aimed to appraise MRONJ awareness and knowledge among dentists.

Materials and methods: A questionnaire-based survey was carried out through one hundred and seventy eight dentist who recruited in three groups; the first group comprised 113 general dental practitioners (GDP), 33 dental radiologist (DR) included in the second, and 32 oral and maxillofacial surgeon (OMS) in the third group. MRONJ awareness was evaluated by asking all respondents a question of "Did you heard about MRONJ? In addition, the detailed knowledge on the subject in question were addressed through fourteen, nine, and three questions for OMSs, DRs, and GDPs respectively.

Results: A significant difference were existed among groups with a rate of MRONJ's awareness of 33.6%, 48.5%, and 84.4% for GDPs, DRs, and OMSs respectively. Concerning MRONJ knowledge, significantly highest rates seen in OMSs set with 48.55%. In contrast, the average scores of DRs were 30.64%, and the GDPs group recorded the least value with 16.67%.

Conclusions: Strengthen the MRONJ awareness and knowledge among general dentists and dental specialists are essential to identify 'at risk' patients for appropriate advice and management.

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1. Introduction

Bisphosphonate (BP) as antiresorptive agent were used for prevention of bone loss since the late 1960s (Fleisch, 2002), but in 2003, the first case of bisphosphonate-related osteonecrosis of the jaws (BRONJ) was reported (Marx, 2003). Then many cases have reported by different researchers (Leite et al., 2006; Melo and Obeid, 2005; Ruggiero et al., 2004; Greenberg, 2004) especially when bisphosphonates infused intravenously for patients with cancer and metastatic bone disease (Wooltorton, 2005). In 2005, the manufacturer of BP considered the risk of BRONJ on their labelling including all the intravenous and oral preparations (Tanna et al., 2017).

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Denosumab; another antiresorptive agent; and the anti-angiogenic agents like sunitinib and bevacizumab were also found to cause jaw necrosis (Papapoulos et al., 2012; Christodoulou et al., 2009), hence the nomenclature of BRONJ changed by the American Association of Oral and Maxillofacial Surgeons to medication-related osteonecrosis of the jaws (MRONJ) (Ruggiero et al., 2014).

MRONJ is a growing problem since the number of patients receiving bisphosphonates is increasing. For example, in U.K., the incidence of MRONJ were 0.001% as estimated in 2012, with increasing number of dispensed prescriptions by 2.5% over 7 years (Faculty of General Dental Practice, 2012). While the American Association of Oral and Maxillofacial Surgeons reported higher incidence of 0.004% and 0.1% in 2014 (Ruggiero et al., 2014).

MRONJ can remain asymptomatic for long periods in the absence of infection; however, certain radiographic findings could improve its early detection (Treister et al., 2009; Hutchinson et al., 2010). That is why awareness about MRONJ is crucial for dental radiologists for their role in diagnosis of oro-facial problems.

Surgeons' questionnaire

A questionnaire for scientific research purposes

Age..... Sex..... Social status.....
 Postgraduate degree..... from the university of.....
 Years of experience as a specialist.....
 Affiliation: ? Ministry of health ? Ministry of higher education ? Private practice
 Background: This questionnaire aims to assess surgeons' awareness and knowledge regarding the medication-related osteonecrosis of the jaw (MRONJ).
 Did you heard about MRONJ? ? Yes ? No
 If yes, ? In undergraduate study ? In postgraduate study ? Others
 Within the last three years, did you read a scientific paper or attends a scientific lecture about MRONJ? ? Yes ? No

Questions

1. Patients could receive drugs that induce MRONJ in the following medical conditions:
 A. _____ B. _____
 C. _____ D. _____
2. List down drugs that can cause osteonecrosis of the jaws (ONJ):
 A. _____ B. _____
 C. _____ D. _____
3. A tooth indicated for extraction in a patient receive a drug that known to cause ONJ. Do you like to extract this tooth? ? Yes ? No
 - If yes, would you take any extra precaution(s)? Please specify

 - If no, then why? And how to deal with your patient?.....

4. Patient attending your clinic suffering from exposed bone after tooth extraction. He is receiving bisphosphonate (BP) drug; with no history of radiotherapy to the jaws. This patient is considered to have MRONJ when the exposed bone does not heal within:
 A. 4 weeks after identification by a health care provider.
 B. 8 weeks after identification by a health care provider.
 C. 12 weeks after identification by a health care provider.
5. In prodromal phase of MRONJ, the radiographic findings is/are:
 A. Increased bone density. B. Sequestration.
 C. Increased density of lamina dura. D. Any of the above.
6. MRONJ occur more commonly in
 A. Anterior mandible. B. Posterior mandible
 C. Anterior maxilla. D. Posterior maxilla.
7. After several months of BP intake, MRONJ could occur:
 A. Spontaneously. B. After miner trauma.
 C. After dental surgery. D. Any of the above.
8. The prevalence of MRONJ is more in patients receive:
 A. Oral BPs. B. I.V. BPs. C. No significant difference.
9. BPs causing ONJ due to:
 A. Suppression of osteoclastic activity. B. Suppressions of angiogenesis
 C. Both of the above. D. None of the above.
10. Panoramic radiograph is indicated for a patient receiving BPs but without ONJ when:
 A. Patient on low-dose of drug.
 B. Patient on high-dose of drug.
 C. Always indicated.
 D. Always contraindicated.
11. The use of antibiotic before and/or after the surgical procedures can reduce the risk of ONJ. Yes No
12. Maintenance of a good oral hygiene can reduce the risk and the severity of MRONJ. Yes No
13. Stopping BPs before dental surgery and to be continued later on can reduce the risk of MRONJ. Yes No
14. As a surgeon, can you list down different MRONJ treatment modalities?

Thank you for your time

Fig. 1. Questionnaire used for data collection from oral and maxillofacial surgeons.

Awareness is also important for general dental practitioners because they perform the primary dental care and for dental surgeons as they are concerned with treatment of many of dento-alveolar problems that require surgical intervention.

This cross-sectional study aims to appraise MRONJ awareness and knowledge among dentists.

2. Material and methods

A cross-sectional based survey was carried out amongst a sample of dentists working in five Iraqi cites. Respondents were recruited in three groups; oral and maxillofacial surgeons (OMS), dental radiologist (DR), and general dental practitioners (GDP).

Over a period of six weeks, three trained specialist dentists administered the questionnaires to 178 dentist (113 GDP, 32 OMS, and 33 DR) who informed about the study protocol and the participation was voluntary and anonymous.

The questionnaire was designed for two objectives: to get an overview of the OMSs, DRs, and GDPs' knowledge of MRONJ, and to evaluate the differences among grades.

Demographic data, years of experience, the university that awarded the certificate and affiliation were included in the first part of the questionnaire in addition to two questions "Did you heard about MRONJ?", "Within the last three years, did you read a scientific paper or attends a scientific lecture about MRONJ?"

Only respondents who answered "yes" for the first question passed to the second part of the questionnaire and excluding others with answer "no" thereby removing false positive answers. The second part addressed the detailed knowledge about MRONJ. This was analyzed through fourteen, nine, and three questions for OMSs, DRs, and GDPs respectively (Figs. 1–3).

The questions of 14-item questionnaire were distributed based on 6 groups: the first group comprised 2 questions and investigated medical condition that may treated with osteonecrotic drugs and to name these drugs. The second group question evaluated the surgeons' willingness of tooth extraction in patients receiving osteonecrotic drugs. The third group questions were 3 and related to MRONJ diagnosis. In the fourth group, three questions focused on seriousness of BP, and how it works. Information about how surgeons deal with MRONJ patients are available through 4 questions. The last group question assess surgeons' knowledge about the advance MRONJ treatment modalities.

A 9-question self-administered questionnaire was sectioned into three groups. The first group comprised 2 questions and evaluated the ability of DRs in formulating differential diagnosis. Six questions included in the second group and clarified how DRs correlate between the patients' medical history and the site of the lesion to reach diagnosis. The last group question assessed their ability to use appropriate imaging technique as indicated.

The GDPs questionnaire comprised the same first 3 questions of OMSs questionnaire.

'Right', incomplete right, or 'wrong' answers were assigned by 1, 0.5, or 0 points. The higher score represented better knowledge. The questionnaire were completed and returned immediately.

The data analyzed using IBM SPSS Statistics for Windows (version 23, IBM Corp. Armonk, NY, USA). The significance of differences within groups and between the groups were assessed using and the independent sample T-test, analysis of variance (one-way ANOVA), and Duncan test considering a probability values less than 0.05 as significant.

3. Results

Two hundred and five dentist were asked to participate in the survey. Twenty-seven (13.2%) exhibit no interest to participate. One

Dental radiologists' questionnaire

A questionnaire for scientific research purposes

Age..... Sex..... Social status.....
 Postgraduate degree..... from the university of.....
 Years of experience as a specialist.....
 Affiliation: ? Ministry of health ? Ministry of higher education ? Private practice
 Background: This questionnaire aims to assess dental radiologists' awareness and knowledge regarding the medication-related osteonecrosis of the jaw (MRONJ).
 Did you heard about MRONJ? ? Yes ? No
 If yes, ? In undergraduate study ? In postgraduate study ? Others
 Within the last three years, did you read a scientific paper or attends a scientific lecture about MRONJ? ? Yes ? No

Questions

- Panoramic image shows exposed bone after extraction of lower first molar before 3 months. What is your differential diagnosis?
 A. B.
 C. D.
- As a radiologist, in which cases you suspect to detect sequestra in OPG:
 A.
 B.
 C.
- The radiographic appearance of early stage of bisphosphonate related osteonecrosis of the jaw shows:
 A.
 B.
 C.
- Patients could receive drugs that induce MRONJ in the following medical conditions:
 A. B.
 C. D.
- List down drugs that can cause osteonecrosis of the jaws (ONJ):
 A. B.
 C. D.
- Patient attending your clinic suffering from exposed bone after tooth extraction. He is receiving bisphosphonate (BP) drug; with no history of radiotherapy to the jaws. This patient is considered to have MRONJ when the exposed bone does not heal within:
 A. 4 weeks after identification by a health care provider.
 B. 8 weeks after identification by a health care provider.
 C. 12 weeks after identification by a health care provider.
- Fifty-five years old woman suffering from osteoporosis for 3 years (she used i.v. bisphosphonate drug) attending your clinic for tooth extraction. What do you expect to see in her panoramic radiograph?

- MRONJ occur more commonly in
 A. Anterior mandible. B. Posterior mandible
 C. Anterior maxilla. D. Posterior maxilla.
- Panoramic radiograph is indicated for a patient receiving BPs but without ONJ when:
 A. Patient on low-dose of drug.
 B. Patient on high-dose of drug.
 C. Always indicated.
 D. Always contraindicated.

Thank you for your time

Fig. 2. Questionnaire used for data collection from dental radiologists.

hundred-seventy eight respondents were considered (32 OMSs, 33 DRs, and 113 GDPs). They were 93 males (52.2%) and 85 were females (47.8%). Their mean age and experience were 33.55 (SD ± 8.75) and 7.79 (SD ± 7.32) respectively. Fifty-two participants (29.2%) worked in primary dental care clinics. Others worked in

General dental practitioners' questionnaire

A questionnaire for scientific research purposes

Age..... Sex..... Social status ? Single ? Married
 Year of graduation, University.....
 Currently, I am ? General dental practitioner ? Junior (rotator) dentist
 Affiliation: ? Ministry of health ? Ministry of higher education ? Private practice
 Background: This questionnaire aims to assess general dental practitioners' awareness and knowledge regarding the medication-related osteonecrosis of the jaw (MRONJ).
 MRONJ is defined as exposed necrotic area of jawbones for more than 8 weeks as a side effect of certain drugs consumption.
 Did you heard about MRONJ before? ? Yes ? No
 If yes, ? In undergraduate study ? Others

Within the last three years, did you read a scientific paper or attends a scientific lecture about MRONJ? ? Yes ? No

Questions

- Patients could receive drugs that induce MRONJ in the following medical conditions:
 A. B.
 C. D.
- List down drugs that can cause osteonecrosis of the jaws (ONJ):
 A. B.
 C. D.
- A tooth indicated for extraction in a patient receive a drug that known to cause ONJ. Do you like to extract this tooth? ? Yes ? No
 - If yes, would you take any extra precaution(s)? Please specify

 - If no, then why? And how to deal with your patient?.....

Thank you for your time

Fig. 3. Questionnaire used for data collection from general dental practitioners.

specialized (secondary) dental centers (63, 35.4%), hospitals (16, 9%) and universities (47, 26.4 %).

The vast majority of participants (97.2%) were graduated from Iraqi universities (8 governmental and 3 private universities), whereas the rest of participants were qualified from 1 Asian and 2 European universities (Table 1).

The OMSs group, their mean experience were 9.16 years (SD ± 5.71). Five surgeons (15.6%) not aware of MRONJ and 18/27 (66.7%) surgeons, those had previous MRONJ knowledge, read a scientific topic concerning MRONJ within the last 3 years (Table 2).

Concerning first group questions, 25% of surgeons reported correct answer for question number 1, in contrast, only one surgeon mentioned denosumab as a possible osteonecrotic drug and none of them was mentioned any antiangiogenic agent.

Forty percent were satisfied with tooth extraction for BP patients, but more than half of them reported wrong regimen in dealing with such patients. For surgeons who do not like to extract, 63.2% of them were wrong in how to deal with patients.

By surveying the surgeons' susceptibility to diagnose MRONJ, it was evident that almost half of them were correct in their diagnosis.

When asking about the seriousness of BPs and their mode of action, 37% and 21.1% of respondents reported right and incomplete right answers.

Questions on how surgeons treat MRONJ patients showed that 52.8% of them were correct, however, 60% of surgeons were unaware about advance treatment modalities.

Table 1
Demographic background of respondents.

	No.	M	F	Age Mean (SD)	Experience Mean (SD)	Affiliation		University of graduation		
						MHE	MOH	Government	Private	Foreign
GDPs	113	52 (46%)	61 (54%)	30.4 (7.779)	7.05 (7.68)	11 (9.7%)	102 (90.3%)	96 (85%)	16 (14.1%)	1 (0.9%)
DRs	33	15 (45.5%)	18 (54.5%)	38.78 (6.568)	9 (7.66)	19 (57.6%)	14 (42.4%)	33 (100%)	0 (0%)	0 (0%)
OMSs	32	26 (81.2%)	6 (18.8%)	41 (5.902)	9.16 (5.71)	17 (53.1%)	15 (46.9%)	28 (87.5%)	0 (0%)	4 (12.5%)
All respondents	178	93 (52.2%)	85 (47.8%)	33.55 (8.75)	7.79 (7.32)	47 (24.4%)	131 (75.6%)	157 (88.2%)	16 (9%)	5 (2.8%)

GDPs: General dental practitioners. DRs: Dental radiologists. OMSs: Oral and maxillofacial surgeons. MHE: Ministry of Higher Education, MOH: Ministry of Health.

Table 2
MRONJ's awareness, self-education and knowledge rate for all groups.

	Q1: Have you heard about MRONJ?		Q2: Have you read about MRONJ? ^a		Average of MRONJ knowledge
	Yes n, %	No n, %	Yes n, %	No n, %	
GDPs	38, (33.6%)	75, (66.4%)	5/38, (13.2%)	33/38 (86.8%)	16.67%
DRs	16 (48.5%)	17 (51.5%)	10/16 (62.5%)	6/16 (37.5%)	30.64%
OMSs	27, (84.4%)	5, (15.6%)	18/27 (66.7%)	9/27 (33.3%)	48.55%
All respondents	81 (45.5%)	97 (55.5%)	33/81 (40.7%)	48/81 (59.3%)	33.67%

MRONJ: Medication-Related Osteonecrosis of the Jaws. GDPs: General dental practitioners. DRs: Dental radiologists. OMSs: Oral and maxillofacial surgeons.

^a Only respondents who answered "yes" for the first question were included.

The average score of MRONJ knowledge for surgeons were 48.55%. In details, the surgeons working in the centers and hospitals of the Ministry of Health (MOH) reported MRONJ's rate of knowledge of 52.1%, and a higher proportion of them (94.1%) heard about MRONJ before compared to 47.7%, 78.9% for surgeons affiliated to Ministry of Higher Education (MHE) but with no significant differences ($p = 0.372, 0.188$). In contrast, a significant more MOH surgeons read a scientific topic related to MRONJ compared to other surgeons ($p = 0.044$) (Table 3).

By evaluating DRs group, the mean of their experience were 9 years ($SD \pm 7.66$). Unfortunately, half of them (17, 51.5%) were not aware of MRONJ and within the last three years, only 62.5% of the rest of respondents in this group improved their knowledge by reading a scientific paper(s) concerning MRONJ (Table 2).

DRs reported 21.9% correct answer for the first group questions and about two thirds of them present with incomplete right answers. Answers of the second group questions showed a higher percent of correct answers with 35.6%. However, the incorrect answers were also comparable in this group.

Highest percent of incorrect answers were recorded (87.5%) when asking about the indication of panoramic radiography for MRONJ patients.

Nineteen DRs (57.6%) affiliated to MHE with an average of MRONJ knowledge of 36.8% compared to 21.8% for those working in MOH centers and hospitals. However, comparable results were existed between groups in respect to their awareness about, and reading of scientific topic related to MRONJ (Table 3).

Regarding the GDPs set, their mean experience were 7.05 years ($SD \pm 7.68$). Seventy-five dentist (66.4%) never heard about MRONJ before, and only 5 (13.2%) dentists from the rest of GDPs group read

a scientific topic and/or banning a scientific debate concerning MRONJ within the last 3 years.

Answers of questions in the second part of questionnaire revealed that only 1 dentist (0.9%) gave the correct answer for question number one compared to 25 (22.1%) and 87 (77%) gave incomplete right and wrong answers respectively. Worse figure assumed from the second question answers where no valid was recorded. Results showed 95.6% wrong and 4.4% incomplete right answers. By answering the third question, 16 dentists (14.2%) feel comfortable in performing extraction, but 68.75% of them fail to list correct pre and postoperative precautions compared with 6.25% incomplete and 25% correct precautions. Among the 97 GDPs who do not like to do extraction, 34% fail to answer why they do not like to extract, while 45 dentists (46.4%) refused extraction because of possible complications but 53.3% of them fail to refer their patients correctly.

When questionnaire was conducted in different groups, it was seen that the rate of MRONJ's awareness, self-education and knowledge were significantly different among all groups with a lowest rates recorded in GDPs set (Table 4).

4. Discussion

MRONJ is one of prominent complications in the oral and maxillofacial region due to antiresorptive and antiangiogenic agents (Ruggiero et al., 2014).

It became a common problem since BPs; which is a group of antiresorptive drugs; along with other antiangiogenic drugs used in many medical disciplines such as dentistry, orthopedics and oncology (Fleisch, 2002). They are commonly prescribed for the

Table 3
MRONJ's awareness, self-education and knowledge rate among MOH and MHE specialists.

	OMSs-MOH	OMSs-MHE	Sig.	DRs-MOH	DRs-MHE	Sig.
Heard about MRONJ before	94.1%	78.9%	$p = 0.188$	50%	47.4%	$P = 0.4$
Read about MRONJ	70.6%	42.1%	$p = 0.044^*$	28.6%	31.6%	$P = 0.271$
Average MRONJ knowledge	52.1%	47.7%	$p = 0.372$	21.8%	36.8%	$P = 0.130$

MRONJ: Medication-Related Osteonecrosis of the Jaws. OMSs: Oral and Maxillofacial Surgeons. DRs: Dental Radiologists. MHE: Ministry of Higher Education, MOH: Ministry of Health.

*Significant ($p < 0.05$).

Table 4
Statistical analysis of MRONJ's awareness, self-education and knowledge rate among groups.

	GDPs (Group-1)	DRs (Group-2)	OMSs (Group-3)	ANOVA test	Duncan test	
					A	B
Heard about MRONJ before	38/113 (33.6%)	16/33 (48.5%)	27/32 (84.4%)	0.002*	1 2	3
Read about MRONJ	5/38, (13.2%)	10/16 (62.5%)	18/27 (66.7%)	0.001*	1	2 3
Average MRONJ knowledge	16.67%	30.64%	48.55%	0.022*	1 2	2 3

MRONJ: Medication-Related Osteonecrosis of the Jaws. GDPs: General dental practitioners. DRs: Dental radiologists. OMSs: Oral and maxillofacial surgeons.

ANOVA: Analysis of Variance.

*Significant ($p < 0.05$).

treatment of metabolic bone diseases like osteopenia and osteoporosis, Paget's disease, malignant hypercalcaemia, multiple myeloma, prostate and breast cancer (Conte-Neto et al., 2011; Arantes et al., 2010; Boissier et al., 2000; Body et al., 1999).

This study surveyed Iraqi GDPs, OMSs, and DRs to assess their awareness and knowledge towards MRONJ in the form of questionnaires. Table 5 summarizing the correct answers to questionnaires.

All respondent were unable to recall any antiangiogenic agent and only one-surgeon recall medications other than BP as a

potential cause of osteonecrosis. This may be owing to the fact that antiangiogenic agents were recently considered as possible cause of MRONJ (Ruggiero et al., 2014), with few scientific researches discussed the subject compared to BP.

Results showed that two thirds of GDPs in the present study were unfamiliar with MRONJ. However, 21.3% of them earned their academic degree before 2003; where the first case of BRONJ was reported. Moreover, a large number of GDPs (97, 85.8%) were not confident in performing extraction for patients receiving anti-resorptive and/or antiangiogenic medication due to their reduced

Table 5
The correct answers to all questionnaires.

Question no.	The Correct answer
Oral and Maxillofacial Surgeons	
Q1	Many medical conditions like osteopenia, osteoporosis, fibrous dysplasia, Paget's disease, multiple myeloma, breast cancer, and cancer bony metastasis.
Q2	Antiresorptive drugs like bisphosphonate class (Alendronate, Zolendronate, Pamidronate, Risedronate, ...), antiangiogenic drugs like Denosumab, and Teriparatide.
Q3	If yes, with precautions like a traumatic extraction, antibiotic prophylaxis, and mouthwash. If no, referral to oro-maxillofacial center.
Q4	B
Q5	D
Q6	B
Q7	D
Q8	B
Q9	C
Q10	B
Q11	Yes
Q12	Yes
Q13	No
Q14	Surgical debridement, Antibiotic, Hyperbaric oxygen therapy, Ozone therapy, laser therapy, Platelet rich plasma, Oral hygiene improvement.
Dental Radiologists	
Q1	A. MRONJ C. Bacterial osteomyelitis
	B. Osteoradionecrosis D. Bony metastasis
Q2	A. MRONJ B. Osteoradionecrosis
Q3	A. Osteosclerosis of the alveolar margin. B. Thick lamina dura/widening of periodontal ligament. C. Sequestra.
Q4	Many medical conditions like osteopenia, osteoporosis, fibrous dyaplasia, Paget's disease, multiple myeloma, breast cancer, and cancer bony metastasis.
Q5	Antiresorptive drugs like bisphosphonate class (Alendronate, Zolendronate, Pamidronate, Risedronate, ...), antiangiogenic drugs like Denosumab, and Teriparatide.
Q6	B
Q7	Any of the following features could be seen: Increased density of lamina dura, increased bone density, and sequestration.
Q8	B
Q9	B
General Dental Practitioners	
Q1	Many medical conditions like osteopenia, osteoporosis, fibrous dyaplasia, Paget's disease, multiple myeloma, breast cancer, and cancer bony metastasis.
Q2	Antiresorptive drugs like bisphosphonate class (Alendronate, Zolendronate, Pamidronate, Risedronate, ...), antiangiogenic drugs like Denosumab, and Teriparatide.
Q3	If yes, with precautions like a traumatic extraction, antibiotic prophylaxis, and mouthwash. If no, referral to oro-maxillofacial center.

knowledge about MRONJ, and about 54% of this set of respondents were in the early years of their careers.

Although the initial effect of BPs appear after a few days or weeks (Li and Davis, 2003; Liberman et al., 1995), MRONJ lesions may remain silent unless there is a triggering factor such as chemotherapy drugs, infection or an invasive dental procedure (Agrillo et al., 2012; Silverman and Landesberg, 2009; Bagan et al., 2009). However, it may occur suddenly or sometimes the clinical manifestation of MRONJ presents with negligible superficial signs and does not always reflect the true extent of the underlying bone tissue (Cardoso et al., 2017).

DRs should be aware of the radiographic findings, which suggest the presence of a disease in a specific anatomic region. This can be achieved by continuous education combined with training in radiographic interpretation. It is imperative for DRs to be able to identify 'at risk' patients for appropriate advice and management. In this study, most of DRs who were aware of MRONJ upgraded their knowledge through continuous education courses or reading of scientific paper(s) rather than university studies.

When evaluating DRs' answers, most of DRs listed alveolar osteitis, retained root, and sharp bone in their differential diagnoses. In addition, they suspected to detect sequestra in panoramic radiography only in osteomyelitis. This reflects their low level of knowledge and awareness about MRONJ despite their specialization.

The answers of other group questions affected by lack of adequate knowledge for description of radiographic findings of MRONJ's early stage, and when to use the appropriate imaging technique. This can be attributed to the fact that large number of DRs deal mostly with different dental problems like dental caries, periodontal disease and periapical lesions, and considered the more advance cases are of surgeons' specialty.

Majorities of the OMSs in this study, in particular those working in MOH, were aware of the problem related to anti-resorptive drugs, and they were better than DRs and GDPs in terms of MRONJ knowledge and self-learning. Perhaps OMSs are responsible for treating these cases. Different guidelines of MRONJ management makes the strategies of treatment largely based on expert opinion rather than experimental data (Kyriakidou et al., 2016). This may explain why no agreement existed among surgeons regarding different treatment modalities.

Conclusion

Extra focus on MRONJ is essential for dental students in the dental curriculum, and at the same time strengthen the MRONJ awareness and knowledge among dentists and patients using the related medications. However, we suggest that future surveys of this nature may endeavor to cover other medical specialties like orthopedics and oncology.

Conflicts of interest

None.

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