Root Canal Irrigation Practice Among General Dental Practitioners in Misurata-Libya: A cross Sectional Study

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Abstract

Objective: The aim of this survey was to evaluate the current trends in the practice of general dental practitioners regarding the root canal irrigation during endodontic treatment in private and governmental dental clinics in Misurata- Libya.

Materials and Methods: A descriptive questionnaire survey was circulated among 220 general dental practitioners in private and governmental dental clinics in Misurata-Libya. The analysis of data was performed using SPSS. The descriptive statistics were used for determination of the frequency and percentage of the participant's responses. Chi-Square test was used to assess the impact of work sector and professional experience on the responses ($P < 0.05$).

Results: A total of 186 completed the survey questionnaire, giving a response rate of 84.5%. Around 99% of respondents used sodium hypochlorite in irrigation protocol while EDTA was included by 42%. 60% of respondents used full strength sodium hypochlorite (5.25%). 83.3% of respondents used smaller needle gauge (25 and 27). 68% of respondents used syringe capacity >5.0 ml. Only 45% of respondents used irrigation adjuncts and 89% agitate the irrigation solution manually. Around 38% of respondents insert the irrigation needle 2-3 mm from the apex. The majority of respondents irrigate the root canals < 10 minutes and do not change their primary irrigation solution according to the pulpal or periapical status. No significant impact observed for either the working sector or professional experience on the responses.

Conclusion: General dental practitioners in Misurata should be encouraged to introduce various techniques and adjuncts to improve the efficacy of endodontic irrigants.

I. Introduction

Proper chemomechanical preparation considered as the most critical issue in endodontic treatment. The main challenge however, is the great anatomical complexity of root canal system [1]. Efficient debridement and disinfection of root canal system adversely affected by the presence of accessory or extra canals, isthmus and apical ramifications [1,2]. This may interfere with mechanical instrumentation and the complete disinfection of the root canals [3]. Approximately 35–53% of canal surfaces will remain untouched during the routine chemo-mechanical preparation of root canals [4,5]. This results in the survival and recolonization of microorganisms in untreated spaces, which consequently predispose to the failure of endodontic treatment [6]. In addition, the mechanical instrumentation of root canals leads to the formation of a smear layer, which is an unstructured mass accumulated on the internal walls of root canals [7]. The smear layer decreases the permeability of dentinal tubules and prevents the penetration of irrigation agents and root canal sealant, therefore interfering with proper root canal disinfection and sealing [8,9]. To eliminate the debris, smear layer, and residual bacteria from untreated and uninstrumented canals, copious canal irrigation is crucial [10]. An ideal irrigation agent should exhibit several ideal properties, mainly the dissolving action on organic and inorganic debris and antibacterial activity [11–13]. Several irrigation agents have different properties, therefore to achieve adequate debridement and disinfection of root canals, a combination of irrigation agents should be used. Sodium hypochlorite [0.5–6%] is the most commonly used irrigation agent during endodontic treatments, for its antibacterial action and the ability to dissolve either the pulpal or organic components of dentin [14, 15]. The main drawbacks of sodium hypochlorite, however, include its lack of effect on inorganic component of the smear layer and its cytotoxicity [16, 17]. A chelating agent, such as EDTA, also is used as an endodontic irrigant and capable of eradication of the smear layer [18]. The lack of antibacterial activity and the minimum tissue dissolution ability are considered the main limitations for the use of EDTA as an irrigation agent [19, 20]. Therefore, a combination of sodium hypochlorite and EDTA is routinely used as an effective irrigation protocol [16]. Chlorhexidine (2.0%), a broad-spectrum antibacterial agent that can be used as an adjunctive canal irrigant with sodium hypochlorite [21]. The antibacterial property of chlorhexidine is prolonged due to the material's substantivity to dentin [22]. Despite the minimum tissue toxicity of chlorhexidine [23], it lacks the ability to dissolve necrotic and pulpal tissues [24], therefore, cannot be used as an alternative to sodium hypochlorite [25]. Another irrigation solution is sterile water or normal saline, both of which exhibit no antibacterial activity or tissue dissolving ability. They should be used as an intermediate irrigator between various irrigation solutions; to prevent the interactions between various irrigation solutions, which may lead to the formation of harmful byproducts [25]. In addition to mechanical instrumentation and irrigation with disinfected solutions, activation or agitation of irrigation solution is considered as the third strategy to ensure adequate disinfection of root canals [26]. Different adjuncts have been suggested to enhance the efficacy of chemomechanical preparation of root canals, this include manual activation [27], sonic and ultrasonic agitation [28,29], and negative pressure alternating devices [EndoVac] [30].

To the best of our knowledge, no cross sectional survey study regarding the current trends in root canal irrigation performed by general dental practitioners in Libya. Therefore, the aim of this study was to ascertain the current trends in the practice of general dental practitioners regarding the root canal irrigation during endodontic treatment in private and governmental dental clinics in Misurata-Libya.

II.MATERIALS AND METHODS

This descriptive, cross-sectional study was performed using self-administered, closed ended survey questionnaire modified from previous study [31]. The questionnaire consisted of 16 questions, 4 demographical and 12 related to the practice of root canal irrigation. The survey questionnaire was hand delivered to the respondents between January to April 2023. The study included general dentists practicing endodontic treatment in either governmental or private dental clinics in Misurata- Libya. The exclusion criteria involved specialists in any dental disciplines and dentists that are working outside Misurata or are not registered in the local dental syndicate. All the survey participants voluntarily entered the study. Either the privacy or participant's outcomes in this study were guaranteed and remained confidential.

Statistical analysis: The data entered into Excel spreadsheet and then analysis performed using SPSS 26 (IBM, Armonk, NY, USA). The frequency and distribution of the participant's responses were determined by using descriptive statistics. Chi-square test ($p < 0.05$) was used to assess the impact of work sector and professional experience upon the responses.

II. RESULTS

The questionnaire has been circulated among 220 dentists, and 186 have responded, giving a response rate of 84.5%. The demographical data of the survey participants are shown in Table 1. Among the survey respondents, 53% were female and 47% male with the majority (81%) having an age range between 26 and 35 years. 19% of respondents were practicing endodontic treatment in the governmental sector, 33% in the private sector and 48% in both sectors. Among the survey participants, 22% had < 2 years of experience, 28% had 2–5 years of experience, 31% had 6-10 years of experience and only 19% had > 10 years of experience.

Table 2 shows the frequency distribution and percentage of respondents on questions regarding some aspects related to the practice of canal irrigation. Sodium hypochlorite was included in irrigation protocol by the vast majority respondents (99%), either alone (2.7%) or combined with other irrigants (96.3%). The survey participants used sodium hypochlorite with, saline (24.7%), saline/chlorhexidine (30.1%), saline/EDTA (28%) and with EDTA (13.5%). An extremely very lower percentage of respondents indicated that EDTA is used either alone (0.5%) or combined with sodium hypochlorite (41.5%). The majority of survey participants (83.3%) included normal saline within their protocol of root canal irrigation. The association between either the working sector (Pearson's Chi-square *p* value=0.27, *p>0.05*) or the professional experience (Pearson's Chi-square *p* value=0.52, *p>0.05*) with the question regarding the sequence of root canal irrigation protocol, was statistically insignificant. Around 60% of respondents preferred the use of 5.25% sodium hypochlorite while 29% and 8.0% preferred 2.5% and 0.5 %, respectively. Only 3.0% of respondents do not know the concentration of sodium hypochlorite used.

Table1: Frequency distribution (No.) and percentage (%) of survey respondents on the demographic questions.

Gender	Females Males	99 (53%) 87 (47%)
Age	26-35 36-40 > 40	151 (81%) 31 (17%) 4.0 (2.0%)
Years of experience in practicing endodontic treatment	< 2 2-5 6-10 >10	41(22%) 53 (28%) 57 (31%) 35 (19%)
Work sector	Governmental Private Both	41 (19%) 59 (33%) 86 (48%)

The association between either the working sector (Pearson's Chi-square *p* value=0.35, *p>0.05*) or the professional experience (Pearson's Chi-square *p* value=0.26, *p>0.05*) with the question regarding the concentration of sodium hypochlorite, was statistically insignificant. Vast majority of survey respondents (96%) used sodium hypochlorite without heating. The association between either the working sector (Pearson's Chi-square *p* value=0.70, *p>0.05*) or the professional experience (Pearson's Chi-square *p* value=0.36, *p>0.05*) with the question regarding the heating of sodium hypochlorite, was statistically insignificant. 44% and 35% of respondents indicated the use of hypodermic beveled and closed ended single side vented needles, respectively. Only 16% of survey participants however used closed ended double vented needles.

Table 2: Frequency distribution (No.) and percentage (%) of survey respondents on some questions regarding the practice of canal irrigation.

	Answer options	**No. / (%)**
Indicate the root canal system irrigation protocol do you use?	Sodium hypochlorite only	5 (2.7%)
	Sodium hypochlorite+ saline	46 (24.7%)
	Sodium hypochlorite+ saline+ Chlorhexidine+ saline	56 (30.1%)
	EDTA only	1.0 (0.5%)
	EDTA + saline	1.0 (0.5%)
	Sodium hypochlorite + EDTA	20 (10.8%)
	EDTA+ Sodium hypochlorite	5.0 (2.7%)
	Sodium hypochlorite+ saline+ EDTA+ saline	52 (28.0%)
What is the concentration of sodium hypochlorite that you use most commonly?	0.5%	15 (8.0%)
	2.5%	54 (29%)
	5.25%	111 (60%)
	Do not Know	6.0 (3.0%)
Do you heat sodium hypochlorite before use?	Yes	8.0 (4.0%)
	No	178 (96%)
What is the type of needle you routinely use for the delivery of irrigation solution?	Closed ended double side vented	29 (16%)
	Closed ended single side vented	65 (35%)
	Hypodermic beveled	82 (44%)
	Do not know	10 (5.0%)
What is the gauge of the needle do you use for the delivery of the irrigation solution?	25 gauge	67 (36%)
	27 gauge	88 (47.3 %)
	30 gauge	24 (13%)
	Do not know	7.0 (3.7%)
Which syringe capacity do you use?	More the 5.0 ml	127 (68%)
	Less than 5.0 ml	56 (30%)
	Do not know	3.0 (2.0%)

An extremely less percentage of survey participants (5.0%) do not know about the type of needle used in root canal irrigation. The association between either the working sector (Pearson's Chi-square *p* value=0.23, *p>0.05*) or the professional experience (Pearson's Chi-square *p* value=0.09, *p>0.05*) with the question regarding the type of needle, was statistically insignificant. Regarding the needle gauge, 36% and 47.3% of respondents used 25 and 27 gauge, respectively while **only** 13% of respondents used 30 gauge. Extremely lower percentage of respondents (3.7%) do not know about the needle gauge. Insignificant association was found between either the working sector (Pearson's Chi-square *p* value=0.63, *p>0.05*) or the professional experience (Pearson's Chi-square *p*

value=0.44, *p>0.05*) with the question regarding the gauge of irrigation needle. The majority of the survey participants (68%) used syringe capacity > 5.0 ml while 30% preferred to use < 5.0 ml syringes. Extremely lower percentage of respondent (2.0%) do not know about the syringe capacity used in canal irrigation. The association between either the working sector (Pearson's Chi-square *p* value=0.47, *p>0.05*) or the professional experience (Pearson's Chi-square *p* value= 0.62, *p>0.05*) with the question regarding the capacity of irrigation needle, was statistically insignificant.

Among the survey respondents, 45% used an irrigation adjunct, of whom 89% activate the irrigation solution manually while only 9.0% agitate the irrigant by ultrasonic technique. Extremely lower percentage of respondents (2.0%) used negative pressure as an irrigation adjunct (Figure 1a and b). Insignificant association was found between either the working sector (Pearson's Chi-square *p* value=0.14 and 0.27, *p>0.05*) or the professional experience (Pearson's Chi-square *p* value= 0.75 and 0.08, *p>0.05*) with the questions regarding if the participant used irrigation adjuncts and what type of activation technique commonly used.

The ideal penetration depth of the irrigation needle was indicated as 2.0-3.0 and >3.0 mm, from the apex, by 38% and 23% of survey participants, respectively. The option of needle insertion as long as the needle goes was indicated by 32% of respondents. An extremely low percentage of respondents (7.0%) indicated that the needle depth is 1.0 mm from the apex (Figure 2). The association between either the working sector (Pearson's Chi-square *p* value=0.65, *p>0.05*) or the professional experience (Pearson's Chi-square *p* value= 0.24, *p>0.05*) with the question regarding the depth of needle penetration inside the canal, was statistically insignificant.

The time of sodium hypochlorite irrigation for each canal was indicated as <1.0 and 1.0–5.0 minutes by 36% and 40% of respondents, respectively. A similar percentage of respondents (12%) considered that the ideal time of canal irrigation to be 6–10 minutes, or > 10 minutes (Figure 3). Insignificant association was found between either the working sector (Pearson's Chi-square *p* value=0.09, *p>0.05*) or the professional experience (Pearson's Chi-square *p* value= 0.10, *p>0.05*) with the question regarding the time of canal irrigation with sodium hypochlorite.

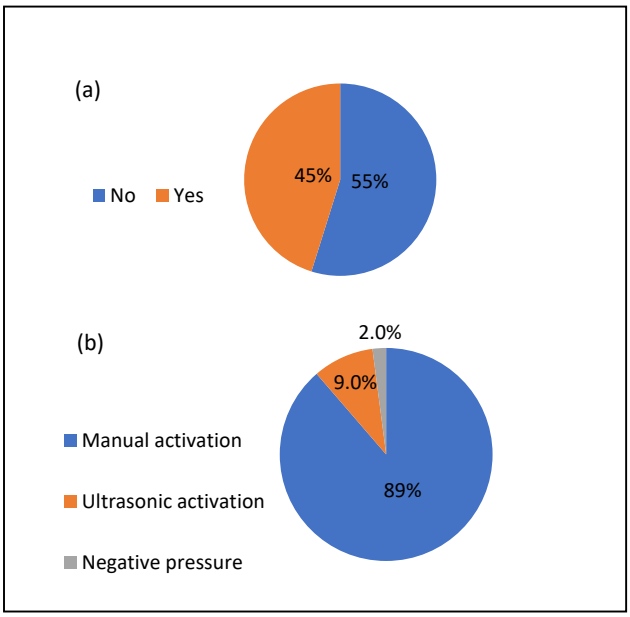

Figure 1 (a) and (b): Use of irrigation adjuncts among the survey participants.

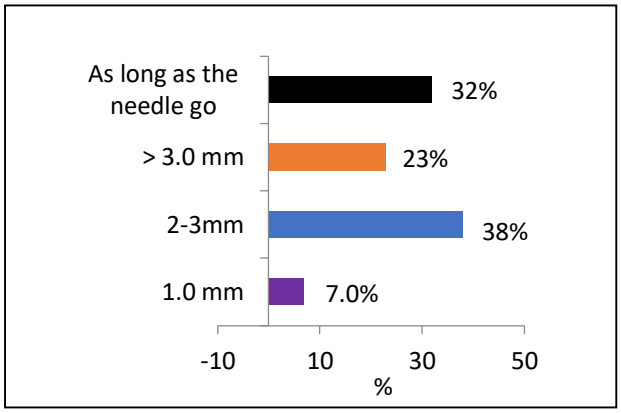

Figure 2: The percentage of respondents (%) on question regarding the depth of needle insertion during irrigation.

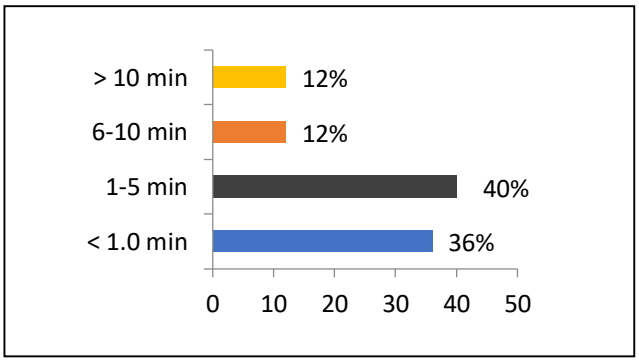

Figure 3: The percentage of respondents (%) on question regarding the time of canal irrigation with sodium hypochlorite.

Majority of survey respondents (83%) used hypochlorite as the primary irrigant of choice for teeth with acute irreversible pulpitis while extremely lower percentage of respondents used chlorhexidine (5.0%) or normal saline (10%). Around 77% of the survey participants also used sodium hypochlorite as primary irrigant for teeth with periapical pathology while chlorhexidine and normal saline was indicted by only 19.8% and 1.2% of respondents, respectively.

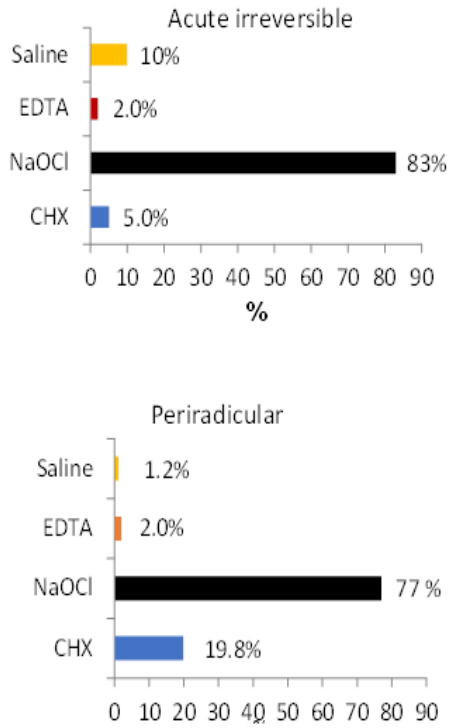

Figure 4: The percentage of respondents (%) on questions regarding the primary irrigation solution used with acute irreversible pulpitis and perirradicular pathology

An extremely lower percentage of respondents used EDTA as primary irrigant for either acute irreversible pulpitis (2.0%) or periapical pathology cases (2.0%) (Figure 4). Insignificant association was found between either the working sector (Pearson's Chi-square p value=0.50 and 0.16, p>0.05) or the professional experience (Pearson's Chi-square p value= 0.70 and 0.38, p>0.05) with the questions regarding the primary irrigant used in cases of acute irreversible pulpitis and perirradicular pathology.

Discussion:

This study is oriented mainly to collect data from general dental practitioners in Misurata. Endodontic treatment mostly undertaken by general dental practitioners, therefore, collection of data regarding their contemporary trend in canal irrigation is a fundamental issue. The survey studies is a simple strategy for data collection within reasonable timeframe, however demands the participant's cooperation and may affected by poor rate of return of survey questionnaire [32]. In our study the response rate was high (84.5%). A similar survey study held among indian dental practitioners showed high response rates of 71.3% [33].

In this study, vast majority of survey participants use sodium hypochlorite, as a part of their irrigation protocol (99%) and as primary irrigant solution [96.3]. The results are comparable with earlier survey study conducted among australian endodontists where sodium hypochlorite used by 94% of participants [34]. In addition, several studies indicate sodium hypochlorite as the most commonly used root canal irrigation agent [31,35,36]. Sodium hypochlorite is considered as the gold standards for root canal irrigation and exhibited most of the desirable properties of an ideal irrigation agents [37]. Approximately 17% of survey participants in our study do not include normal saline in their irrigation protocol. Normal saline acts as an intermediate irrigation solution to prevent interactions between various irrigation agents [25]. The interaction between sodium hypochlorite and chlorhexidine leads to formation of cytotoxic, brownish-orange precipitate "Parachloranaline" which induce tooth discoloration, obliteration of dentinal tubules and compromise the proper sealing of root canals [38]. In addition, tissues dissolving capability of sodium hypochlorite is decreased when combined with EDTA [38]. In this study, only 13.5% of survey respondents used irrigation protocol that combine sodium hypochlorite with EDTA without saline.

During mechanical preparation of root canals, inorganic deposit (smear layer) accumulated on the internal walls of root canals [39]. The smear layer could not be effectively removed with other irrigation agents [17]. Inadequate

removal of smear layer compromises the proper disinfection and sealing of root canals [40,41]. Efficient elimination of smear layer is considered as one of the basic prerequisites for successful endodontic treatment [42]. Therefore, chelating agents, such as EDTA, are recommended as an irrigant during endodontic treatment [9]. In the present study, the majority of survey participants (57.5%) does not include EDTA in their irrigation protocol. In addition, only 3.7% of respondents used EDTA as a primary irrigation agent. Previous studies reported that EDTA is used by 25% [31] and 14.3% [43] of general dental practitioners.

Chlorhexidine has been recommended as an adjunctive irrigation agent particularly in retreatment cases [44], primarily for its effective antibacterial activity and substantivity [22]. The majority of participants of current survey (69.9%) were found to not include chlorhexidine in the irrigation protocol. Previous studies had also reported lower use of chlorhexidine as an irrigation agents among general dental practitioners [31,32].

In our study, it was found that the majority of the respondents (59.7%) prefer to use full strength sodium hypochlorite (5.25%) while 29% and 8.0% used 2.5% and 0.5%, respectively. Our results are in agreement with several studies which revealed that the majority of dentists prefer to use full strength sodium hypochlorite [45-47]. Although the concentration of sodium hypochlorite is crucial factor for its antibacterial activity [48], use of full strength sodium hypochlorite however not recommended [49]. Higher concentrations of sodium hypochlorite enhance the risk of periapical tissue irritation and increase susceptibility to root fracture in endodontically treated teeth. [49,50]. Sodium hypochlorite demonstrated effectiveness even at lower concentrations [51]. This effect however, rapidly become deteriorated [52]. The effectiveness of lower sodium hypochlorite concentration could be enhanced by increasing the exposure time, volume of irrigation solution and use of varies irrigation adjuncts or activation methods [53,54,29]. Despite the fact that sodium hypochlorite is usually prepared by the auxiliary staff in dental clinic, only 3.0% of survey respondents in this study do not know the concentration.

The potency of the antibacterial and dissolving activities of sodium hypochlorite could be enhanced by heating [55]. The heating of sodium hypochlorite increases its rate of penetration into dentinal tubules, resulting in a substantial increase in either disinfecting or dissolving efficiency [56]. Sodium hypochlorite heating could be performed either by preheating the irrigant extraorally or heating inside the root canal [57], with the latter technique being more effective [58]. The warming of sodium hypochlorite enables the clinician to avoid the use of higher irrigant concentrations with reduced risks of periapical irritation and root fracture [56]. In the present study, the vast majority of survey respondents (96%) does not heat sodium hypochlorite. This is in agreement with a survey study which reported that 69.2% of dental professionals does no heat sodium hypochlorite [36]. In our study, the majority of survey participants does not heat sodium hypochlorite, probably because they mainly used full-strength sodium hypochlorite.

The efficacy of endodontic irrigation depends upon several factors, including the diameter of the irrigation needle, the design of the needle, the volume of irrigation solution, the depth of needle engagement within the root canal and the final size of the prepared canal [59].

Decreasing the diameter of the irrigation needle substantially enhances both the rate of flow and the efficiency of endodontic irrigant [59, 60]. Irrespective of the design of irrigation needles, 30 gauge type was the most effective in canal cleaning [61]. According to the ISO 9626 1991/2001 standard, needles with gauges 25, 27, and 30 indicate an external diameter of 0.5, 0.4, and 0.3 mm, respectively [62]. The majority of this survey respondents (83.3%) prefer to use smaller needle gauges [25 and 27], while only 13% used a greater [30] gauge. This may be attributed to the unawareness of the general practitioners regarding the factors affecting the rate of irrigant flow

within the root canal system. A recent survey study published that 54% of dental professionals used larger diameter irrigation needles [31].

Side-vented needles exhibited higher tissues debridement efficiency than the single-beveled needles [63]. The flushing action of single beveled needles is weak, therefore the effective removal of debris from root canal could be impaired, particularly in the middle and apical one third. Furthermore, canal irrigation with beveled needles associated with high risk of sodium hypochlorite extrusion into periradicular tissues which may results in pain and hypochlorite accident [64]. In the present study, 51% of respondents used side-vented needles, however still 44% preferred the use of beveled needles. Our results are comparable with another survey study [65], which indicated that 45.3% of dental professionals used open-ended needles for endodontic irrigation.

A majority (68%) of survey participants used syringes with a capacity of >5.0 ml, while 30% preferred using <5.0 ml syringes. A similar survey study reported that dental professionals most commonly use 5.0 ml syringe capacity [66]. The authors also reported that the use of greater syringe capacity with thinner gauge needle results in increase of intrabarrel pressure during irrigant delivery with subsequent early fatigue of the operator and reduction in the irrigation time. Although our study not mentioning anything regarding the fatigue of the operator, the finding of the latter study cloud be applied to explain our results regarding the time of canal irrigation.

The majority of survey respondents in our study mainly used thinner gauge irrigation needles (see above) and syringe capacity >5.0 ml. In our finding, the majority of survey participants (88%) does not irrigate the root canals more than10 minutes which is far below the suggested optimum time (40 min) for effective irrigation of root canals [67]. Despite the controversies regarding the ideal time for canal irrigation [2], longer exposure of root canals for irrigation agent may enhance its efficacy [68].

The penetrability of endodontic irrigant is limited only to 1.0 mm deeper to the tip of irrigation needle [69]. Therefore, to enhance the efficacy of an irrigant, the irrigation needle should be placed deeply into apical one third of the root canal without increasing the risk of extrusion of irrigation solution into periradicular tissues [70]. The optimum position of irrigation needle that allow proper irrigant flow through the canal is 2.0-3.0 mm short of the root apex [71]. Insertion of irrigation needle 3.0 mm shorter than the working length associated with less extrusion of debris [72]. Our results revealed that the majority (68%) of survey respondents consider the working length when inserting the irrigation needles. Effectiveness of endodontic irrigant is enhanced upon increasing of root canal diameter [59], therefore the assessment of working length is crucial for efficacy of irrigation solution. In the present study, 38%, 23% and 7.0% of respondents insert irrigation needle 2-3mm, >3.0 and 1.0 mm from root apex, respectively. Increasing distance between needle tip and root apex decrease the apical pressure however it reduce the efficiency of irrigant exchange [73].

The present study revealed that almost half of survey respondents (45%) used irrigation adjuncts, of which the vast majority (89%) agitated the irrigation solution manually. This is in agreement with previous studies which reported that 45% [45] and 47% [31] of dental professionals used an adjuncts with endodontic irrigant. In accordance with our findings, several survey studies conducted among dental professionals indicated that most of them activate the irrigation solution by manual techniques [31,65,74]. Despite the simplicity and cost effectiveness of manual irrigant activation, its efficacy is inferior to sonic or ultrasonic techniques [75,76]. In addition, the standardization of the technique is difficult as its depends on the operator and exhibited high risk of irrigant extrusion with subsequent postoperative pain [77]. In our study, it was found that extremely lower percentage of respondents used either ultrasonic activation (9.0%) or negative

pressure (2.0%) as an irrigation adjunct which may attributed to the higher costs of such systems.

In our study, the majority of survey respondents do not change their primary irrigation solution according to the pulpal or periapical status. Sodium hypochlorite was indicated as primary irrigant by 83% and 77% of survey participants in cases of acute irreversible pulpitis and periapical pathology, respectively. In agreement with our study, earlier survey study also reported that general dental practitioners do not change their primary irrigant according to pulpal and periapical status [32].

Conclusion:

The vast majority of survey respondents used full strength sodium hypochlorite in their irrigation protocol, however the majority also not included EDTA. The survey respondents also tend to irrigate root canals mainly by using full strength sodium hypochlorite, thicker diameter side vented needles and lager capacity syringes. The majority of the respondents consider the working length before canal irrigation. The majority of survey respondents irrigate root canals for a period of time less than 10 minutes. The survey participants do not change the primary irrigant according to pulpal and periapical diagnosis. Most of the survey participants do not either heat sodium hypochlorite or agitate the irrigation solution. The current trends in irrigation practice not dependent on either the working sector or the professional experience. The general dental practitioners in Misurata should be encouraged to introduce various techniques and adjuncts into their irrigation protocol to improve the efficacy of endodontic irrigants.

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Conflicts of interest:

There are no conflicts of interest

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