CORE
Metadata, citation and similar papers at core.ac.uk
Provided by Queen Mary Research Online

Archives of Orofacial Sciences
www.dental.usm.my/aos/ © Penerbit Universiti Sains Malaysia. 2019
print ISSN: 1823-8602
e-ISSN: 2231-7163

Arch Orofac Sci (2019), **14**(1): 1-10.

Original Article

The scope and pattern of practice in the delivery of endodontic treatment in Malaysia: A survey study

Wong Lishen[a], Amy Kia Cheen Liew[a]*, Dalia Abdullah[a], Bun San Chong[b]

[a] Faculty of Dentistry, Universiti Kebangsaan Malaysia, Jalan Raja Muda Abdul Aziz, 50300 Kuala Lumpur, Malaysia.
[b] Institute of Dentistry, Barts and the London School of Medicine and Dentistry, Queen Mary University of London, London, United Kingdom.

* Corresponding author: amyliew@ukm.edu.my

Submitted: 18/07/2018. Accepted: 15/01/2019. Published online: 15/01/2019.

Abstract The study aimed to compare the scope and pattern of practice between general dental practitioners (GDPs), restorative dentistry specialists and endodontists. Self-administered postal questionnaires were distributed to 22 restorative dentistry specialists, 16 endodontists and a random sample of 566 GDPs. The pre-tested questionnaire inquired about demographic data, endodontic practices and referrals. Fisher's exact test with Bonferroni adjustment was performed for pairwise comparisons. The overall response rate was 73.8%. The restorative dentistry specialists and the endodontists performed a wider array of endodontic procedures than the GDPs and were more consistent in the use of specific armamentarium (p<0.017). Endodontists were referred to mostly for cases requiring advanced endodontic skills, while restorative dentistry specialists were mainly consulted for second opinions, pain and restorative management. GDPs should be encouraged to further their education on endodontic practice. Overlapping scope of practice and referrals among the specialists, merits scrutiny to optimize resources and manpower.

Keywords: Endodontics; endodontists; general dental practitioners; questionnaire.

Introduction

Endodontology is the study of the structure and health of dental pulp and periradicular tissues. In essence, endodontic treatment aims to control pulpal and periradicular diseases (European Society of Endodontology, 2006). Although a large portion of endodontic cases could be treated in general practice, the demand for specialty care increases over time as the improvement of dental materials and medical care renders more complex cases salvageable. Nevertheless, the recognition of endodontics as an official dental specialty is not universal (European Society of Endodontology, 1998). In Malaysia, the recognition and roles of GDPs, restorative dentistry specialists and endodontists could be represented by Fig. 1.

GDPs are expected to be capable of effectively managing pulpal and periapical diseases or arranging appropriate referrals to a specialist when required (European Society of Endodontology, 2001). Quality guidelines for endodontic treatment have been formulated to guide dentists on the current best endodontic practice (European Society of Endodontology, 2001). However, not all dentists perform endodontic treatment according to the guidelines (Slaus and Bottenberg, 2002). For instance, some GDPs do not routinely use a dental dam (Jenkins *et al.*, 2001; Slaus and Bottenberg, 2002; Palmer *et al.*, 2009). Other studies have found that endodontic practice differs between GDPs and endodontists, particularly in the use of radiographs (Chandler and Koshy, 2002; Orafi and Rushton, 2013), dental dam (Whitten *et al.*, 1996; Anabtawi *et al.*, 2013), sodium hypochlorite (Clarkson *et al.*, 2003) and engine-driven files (Parashos and Messer, 2004).

The disparity in skills and training may give rise to the different treatment outcomes (Alley *et al.*, 2004; Burry *et al.*, 2016). Root canal treatment performed by endodontists or supervised students was reported of achieving success rates of around 90%, while GDPs achieved a success rate of around 70% (Eriksen, 1991). Simple cases may be treated more effectively in general practice, but specialists may provide treatment at a lower cost–benefit ratio for complicated cases (Eriksen, 2008).

Due to the overlapping nature of the work scope between GDPs, restorative dentistry specialists and endodontists in the field of endodontics, it is imperative to define, compare and contrast the practice of each profession. Ultimately, this will help in structuring the dental workforce and the planning of continuous professional development for dental health professionals. Therefore, the purpose of this study was to compare the endodontic practice performed by GDPs, restorative dentistry specialists and endodontists in Malaysia, as well as to examine the referral pattern of endodontic cases.

Materials and methods

A cross-sectional questionnaire survey was conducted. Ethics approvals were obtained from the research ethics committee of the university [UKM 1.5.3.5/244/DD/2014/054 (1)] and the Ministry of Health, Malaysia [NMRR-15-364-24705(IIR)]. The research was conducted in accordance with the Declaration of Helsinki.

The questionnaire consisted of five parts, structured as follows: (i) demographics; (ii) responsibilities; (iii) clinical procedures performed; (iv) endodontic equipment and materials used; and (v) referral of endodontic cases. The responses for part (v) were only obtained from the GDPs. The questionnaire was pre-tested on final-year undergraduate dental students. A cognitive interview was carried out while they were completing the questionnaire. These students were asked to comment on the content, structure and ease of completion. After necessary amendments, the questionnaires were administered among 20 final-year undergraduate students, and this was repeated after a week. Intra-rater agreement was excellent (κ=0.835). In this cross-sectional survey, the sample consisted of practising GDPs, restorative dentistry specialists and endodontists registered on the Malaysia Dental Register, identified through the Dental Practitioners' Information Management System (Malaysian Dental Council, 2014) and the National Specialist Register (National Specialist Register, 2014).

A comprehensive name list was compiled for each of the groups, including their clinic address and phone number. Because there were only 22 registered restorative dentistry specialists and 16 endodontists in the country at the time of the study, all of them were included. For GDPs, sample size was determined using PS Power and Sample Size Calculation (Dupont and Plummer, 1990), with the distributions of GDPs for a particular response estimated at 83.9% (Orafi and Rushton, 2013). Type I error rate was set at 0.05. With 80% desired power, a minimal sample size of 510 GDPs is required. Sample size was inflated by 10% to 561 GDPs, to account for non-respondents. Random sampling of GDPs was performed using SPSS 22 (IBM SPSS Inc., Chicago, IL, USA).

The self-administered questionnaire was sent to each selected individual, along with the cover letter and postage-paid return envelope. Dentists eligible and selected for participation received a written letter in which the rationale and conduct of the survey was described, along with the questionnaire. Written consent from the participants was waived, as informed consent was implied through the return of completed questionnaires. Participants were given one-month duration to complete and return the questionnaire. Non-respondents received another copy of the questionnaire after one month, followed by telephone reminders.

All the useable responses were dichotomised and analysed using SPSS 22 (IBM SPSS Inc., Chicago, IL, USA). The frequencies of the responses for each question were calculated. The unanswered questions and multiple selections per question were treated as missing data. Fisher's exact test was employed to test for differences between groups as small expected cell count occurred and the sample size between GDPs and the specialists was unequal. This method of analysis does not require the assumption of equal sample size (Dunn and Clark, 2009). When conducting multiple analyses on the same dependent variable, the chance of committing a Type I error increases, thus increasing the likelihood of coming about a significant result by pure chance. Bonferroni adjustment was conducted for the pairwise comparison, by dividing the statistical significance level to the number of groups, so the level of significance was established at α=0.05/3=0.017. By altering the level of significance to a more stringent value, it would then be less likely to commit Type I error.

Results

Of the 604 questionnaires posted out, 446 were returned, reflecting an overall response rate of 73.8%. The response rates are as follows: GDPs: 418/566=73.9%; restorative dentistry specialists: 14/22=63.6%; and endodontists: 14/16=87.5%. The socio-demographic distributions of the respondents are summarized in Table 1. The duties of the specialists were significantly more diverse, whereas the GDPs focused on clinical practice (Table 2). The restorative dentistry specialists and the endodontists also performed a wider array of endodontic procedures than the GDPs (Table 2).

Furthermore, as shown in Table 3, the restorative dentistry specialists and the endodontists were more consistent than the GDPs in the use of magnification, electric pulp tester (EPT), electronic apex locator (EAL), dental dam isolation, molar band, engine-driven files, sodium hypochlorite (NaOCl) irrigant, ethylene-diaminetetraacetic acid (EDTA), endodontic ultrasonic and mineral trioxide aggregate (MTA) (p<0.017). In contrast, a large number of GDPs consistently used normal saline as an irrigant (p<0.017). Remarkably, the endodontic microscope is mostly used by the endodontists, compared to GDPs (p<0.001) and restorative dentistry specialists (p=0.011).

In general, referrals to the endodontists were difficult cases requiring intricate operative and/or surgical skills (Table 4), which include endodontic non-surgical retreatment, endodontic surgery, treatment for calcified/blocked canals, retrieving fractured instruments, management of perforation and root resorption. In contrast, restorative dentistry specialists were consulted mainly for second opinions, management of pain and endodontic cases with restorative implications, including cracks and unusual anatomy or curvature. Most of the combined endodontic-periodontal lesions were referred to periodontists, while cases emphasizing holistic management were referred to oral surgeons.

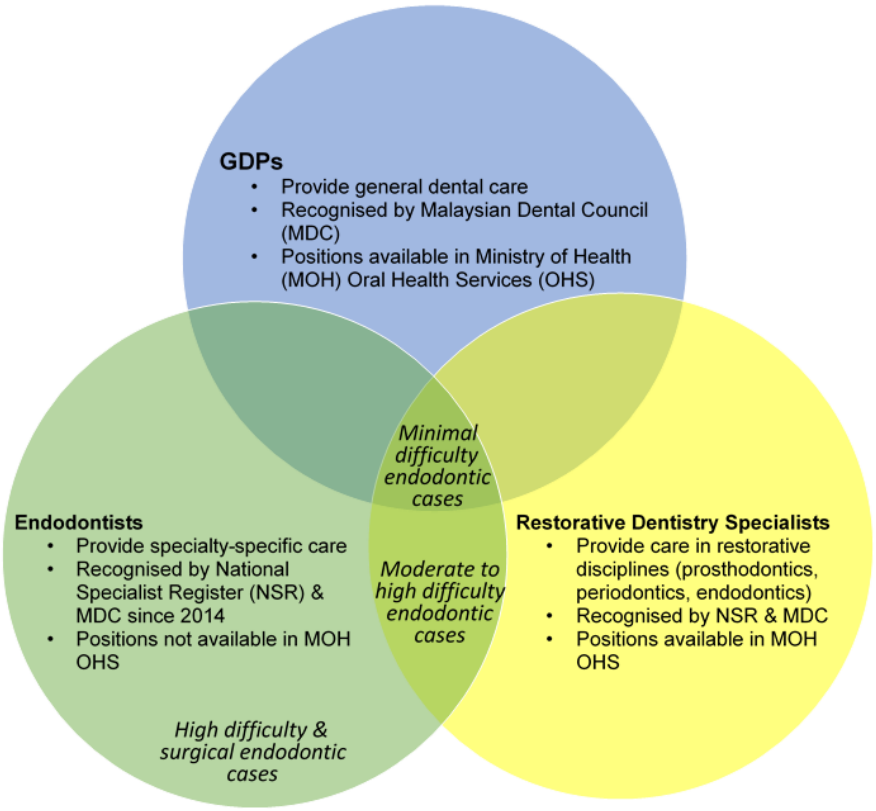

Fig. 1 Recognition and roles of GDPs, restorative specialists and endodontists in endodontics based on Malaysian Dental Council (2014) and National Specialist Register (2014).

Table 1 Socio-demographic characteristics of respondents

	GDPs (*n*=418)	Restorative Dentistry Specialists (*n*=14)	Endodontists (*n*=14)
	Count (%)	Count (%)	Count (%)
Gender			
Female	301 (72.0)	12 (86.0)	9 (64.0)
Male	117 (28.0)	2 (14.0)	5 (36.0)
Practice location			
Urban	316 (75.6)	14 (100.0)	13 (93.0)
Rural	102 (24.4)	0 (0.0)	1 (7.0)
Practice sector			
Academic institution	10 (2.4)	5 (36.0)	9 (64.3)
Public clinic/hospital	274 (65.6)	7 (50.0)	0 (0.0)
Private clinic/hospital	131 (31.3)	1 (7.0)	5 (35.7)
Armed force	1 (0.2)	1 (7.0)	0 (0.0)
Others	2 (0.5)	0 (0.0)	0 (0.0)
Post qualification experience (years)			
1-10	334 (79.9)	8 (57.2)	6 (42.9)
11-20	30 (7.2)	5 (35.7)	5 (35.7)
>20	54 (12.9)	1 (7.1)	3 (21.4)

Table 2 Frequency distributions of respondents, their duties and endodontic procedures performed within past three months

	GDPs (*n*=418)	Restorative Dentistry Specialists (*n*=14)	Endodontists (*n*=14)	GDPs vs. Restorative Specialists	GDPs vs. Endodontists	Restorative Specialists vs. Endodontists
	Count (%)	Count (%)	Count (%)	*p* value	*p* value	*p* value
Consistent involvement in certain roles or duties						
Clinical practice	384 (92.1)	11 (78.6)	11 (78.6)	0.103	0.103	1.000
Administrative duties	158 (37.8)	11 (78.6)	5 (35.7)	**0.004**	1.000	0.054
Teaching	27 (6.5)	10 (71.4)	10 (71.4)	**<0.001**	**<0.001**	1.000
Research	16 (3.8)	2 (14.3)	3 (21.4)	0.111	0.019	1.000
Performance of more than five cases of certain endodontic procedure within past three months						
Non-surgical root canal treatment of anterior tooth	81 (19.4)	4 (28.6)	7 (50.0)	0.297	**0.012**	0.440
Non-surgical root canal treatment of premolar tooth	66 (15.8)	5 (35.7)	8 (57.1)	0.046	**0.001**	0.449
Non-surgical root canal treatment of molar tooth	67 (16.0)	10 (71.4)	11 (78.6)	**<0.001**	**<0.001**	1.000
Non-surgical root canal retreatment	24 (5.8)	8 (57.1)	9 (64.3)	**<0.001**	**<0.001**	1.000
Non-surgical root canal treatment of fractured tooth	19 (4.5)	4 (28.6)	6 (42.9)	0.004	**<0.001**	0.695
Apicectomy/root-end surgery	1 (0.2)	0 (0.0)	1 (7.1)	0.968	0.064	1.000
Non-surgical perforation repair	4 (1.0)	3 (21.4)	2 (14.3)	**0.001**	**0.014**	1.000
Surgical perforation repair	1 (0.2)	0 (0.0)	0 (0.0)	1.000	1.000	-
Removal of fractured instrument within the canal	2 (0.5)	3 (21.4)	3 (21.4)	**<0.001**	**<0.001**	1.000
Non-surgical root canal treatment of calcified/ blocked canal	7 (1.7)	7 (50.0)	10 (71.4)	**<0.001**	**<0.001**	0.440

Bold *p* values indicate statistically significant differences ($p<0.017$) between groups.

Table 3 Frequency distributions of respondents who consistently used certain equipment or material in endodontic procedures

	GDPs (*n*=418) Count (%)	Restorative Specialists (*n*=14) Count (%)	Endodontists (*n*=14) Count (%)	GDPs vs. Restorative Specialists *p* value	GDPs vs. Endodontists *p* value	Restorative Specialists vs. Endodontists *p* value
Diagnostic						
Operating microscope	5 (1.2)	4 (28.6)	11 (78.6)	**<0.001**	**<0.001**	**0.011**
Loupes	31 (7.4)	4 (28.6)	3 (21.4)	0.020	0.089	1.000
Periapical radiograph						
Pre-operative radiograph	339 (81.1)	14 (100.0)	14 (100.0)	0.083	0.083	-
Intra-operative radiograph	324 (77.5)	13 (92.9)	11 (78.6)	0.321	1.000	0.596
Post-operative radiograph	286 (68.4)	13 (92.9)	13 (92.9)	0.074	0.074	1.000
Cone beam computed tomography	6 (1.4)	1 (7.1)	1 (7.1)	0.207	0.207	1.000
Electric pulp tester	133 (31.8)	10 (71.4)	7 (50.0)	**0.003**	0.159	0.440
Electronic apex locator	228 (54.5)	14 (100.0)	14 (100.0)	**<0.001**	**<0.001**	-
Tooth isolation						
Dental dam	84 (20.1)	14 (100.0)	14 (100.0)	**<0.001**	**<0.001**	-
Molar band	38 (9.1)	9 (64.3)	6 (42.9)	**<0.001**	**<0.001**	0.449
Root canal instrumentation						
K-type hand files	372 (89.0)	12 (85.7)	13 (92.9)	0.661	1.000	1.000
NiTi hand files	197 (47.1)	9 (64.3)	5 (35.7)	0.278	0.430	0.257
Engine-driven NiTi files	98 (23.4)	13 (92.9)	13 (92.9)	**<0.001**	**<0.001**	1.000
Laser	7 (1.7)	0 (0.0)	0 (0.0)	1.000	1.000	-
Root canal irrigant						
Sodium hypochlorite	243 (58.1)	14 (100.0)	14 (100.0)	**0.001**	**0.001**	-
Normal saline	312 (74.6)	5 (35.7)	3 (17.6)	**0.003**	**<0.001**	0.678
Chlorhexidine	151 (36.1)	5 (35.7)	6 (42.9)	1.000	0.586	1.000
Ethylenediamminetetraacetic acid	164 (39.2)	10 (71.4)	13 (92.9)	0.024	**<0.001**	0.326
Endodontic ultrasonic	26 (6.2)	6 (42.9)	9 (64.3)	**<0.001**	**<0.001**	0.449
Other						
Mineral trioxide aggregate	19 (4.5)	5 (35.7)	2 (14.3)	**<0.001**	0.144	0.385

Bold *p* values indicate statistically significant differences ($p<0.017$) between groups.

Table 4 Frequency distributions of GDPs who had referred at least one endodontic case in the past three months and recipient of referrals

	Specialists				GDPs limited to Endodontics	Total Count
	Oral Surgeon Count (%)	Restorative Dentistry Specialists Count (%)	Endodontics Count (%)	Periodontics Count (%)	Count (%)	
Non-surgical root canal retreatment	6 (6.5)	28 (30.4)	**46 (50.0)**	1 (1.1)	11 (12.0)	92
Endodontic surgery	13 (29.5)	3 (6.8)	**23 (52.3)**	2 (4.5)	3 (6.8)	44
Calcified/blocked canal/s	5 (4.3)	47 (40.5)	**55 (47.4)**	0 (0.0)	9 (7.8)	116
Fractured instruments	5 (11.1)	15 (33.3)	**21 (46.7)**	0 (0.0)	4 (8.9)	45
Perforation	5 (12.2)	14 (34.1)	**20 (48.8)**	0 (0.0)	2 (4.9)	41
Root resorption	6 (11.3)	19 (35.8)	**21 (39.6)**	1 (1.9)	6 (11.3)	53
Cracked tooth	9 (10.1)	**36 (40.4)**	32 (36.0)	4 (4.5)	8 (9.0)	89
Tooth with unusual root anatomy or curvature/s	7 (6.1)	**52 (45.6)**	41 (36)	2 (1.8)	12 (10.5)	114
Presence of crown or bridge	3 (2.8)	**67 (61.5)**	25 (22.9)	1 (0.9)	13 (11.9)	109
Endodontic-periodontal lesions	3 (3.2)	21 (22.1)	21 (22.1)	**43 (45.3)**	7 (7.4)	95
Dental trauma	**30 (50.0)**	15 (25.0)	9 (15.0)	3 (5.0)	3 (5.0)	60
Patients with medical complications	**58 (63.7)**	13 (14.3)	11 (12.1)	1 (1.1)	8 (8.0)	91
Management of pain	29 (30.2)	**30 (31.3)**	20 (20.8)	0 (0.0)	17 (17.7)	96
Difficult with anaesthesia	**14 (46.7)**	4 (13.3)	4 (13.3)	1 (3.3)	6 (20.0)	29
Nervous patient	**15 (35.7)**	10 (23.8)	6 (14.3)	0 (0.0)	11 (26.3)	42
Patient with sensitive gag reflex	**6 (40.0)**	3 (20.0)	2 (13.3)	0 (0.0)	4 (26.7)	15
Second opinion	26 (14.2)	**74 (40.4)**	40 (26.8)	4 (2.2)	40 (16.4)	184

Figures in bold indicate highest values within categories.

Discussion

The questionnaire survey is a valid method for collecting data from a large and geographically dispersed population. The simplified layout, inclusion of a stamped return envelope and reminder phone calls (Edwards *et al.*, 2002) used in this study resulted in an acceptable response rate.

In this study, the specialists were more involved in administration, teaching and research when compared to the GDPs, as half of the specialists (50%, *n*=14) worked in academic institutions. Drugan *et al.* (2004) highlighted the important roles played by specialists in academia, but juggling between these tasks could be challenging, especially to maintain the clinical practice. When workload becomes excessive, it is recommended that additional faculty or part-time educators be employed, but the positions should only be filled by qualified endodontists, not GDPs (Glickman *et al.*, 2005). This is because the competencies are markedly different between the two. Compared to endodontists who worked mostly in the academic institutions (64%), more than half of the restorative specialists worked in public clinic/hospital/armed forces (57%). Hypothetically, they would be exposed to a greater number of patients compared to those in academia. However, it was observed that some of the respondents reported treating a limited number of endodontics cases. This could be due to the differences in the patient profiles which require the restorative specialists to manage the multiple oral conditions and not just endodontic cases. On top of that, as specialists, they were usually appointed as the head of the clinic and therefore, had to perform administrative duties as well.

As observed in this study, the specialists were more consistent in providing endodontic care and they performed a wider array of highly complex endodontic procedures. This finding is consistent with earlier reports (Abbott, 1994a). The endodontic practice of GDPs is mostly confined to non-surgical treatment of anterior teeth (Saunders *et al.*, 1999a; Lazarski *et al.*, 2001). It was suggested that specialist training in endodontics allowed clinicians to provide timely intervention, without which the clinicians would delay and observe (McCaul *et al.*, 2001). Also, the additional training and clinical experience render a higher success rate for cases treated by endodontists (Alley *et al.*, 2004).

In particular, the main challenge reported by GDPs was finding and preparing root canals (Saunders *et al.*, 1999a). The use of magnification would be of tremendous help (Buhrley *et al.*, 2002), but use of the endodontic microscope remained the forte of the endodontists in this study. Only 1.2% of GDPs reported using a microscope and they were more at ease in using a loupe, which is similar to earlier findings (Savani *et al.*, 2014). The main barrier to adopting the use of an operating microscope is the high cost (Savani *et al.*, 2014) and the requirement to become accustomed to operating it (Kersten *et al.*, 2008).

The proportion of respondents who referred their patients for CBCT in endodontic cases is lower than that of other studies (Reddy *et al.*, 2013). This reflects that the use of CBCT for endodontic treatment is still relatively uncommon. Studies showed that the main reason for CBCT prescription was for implant treatment planning (Sudhakara Reddy *et al.*, 2013; Hol *et al.*, 2015). The high cost for CBCT arises from the need to employ a radiologist and maintenance of the CBCT machine (Christell *et al.*, 2012), hence limiting its use. Other potential reasons for the rare application of CBCT include ambiguity of the referral criteria and justification (Hol *et al.*, 2015).

In the present study, only 31.8% of GDPs routinely used EPT as a diagnostic tool in their practices. To the best of the authors' knowledge, no survey had looked into the use of EPT by endodontists and GDPs. Despite shortcomings such as technique sensitivity and false responses, it could be used to determine whether or not there is viable pulp tissue in the tooth, but it should not be used to assess vitality (vascularity) of the pulp (Jafarzadeh and Abbott, 2010).

Nonetheless, all the specialists and half of the GDPs reported using EAL to derive definitive root canal length. The percentages of EAL users were higher than

previously reported rates of 45.5% among endodontists and 23.2% among GDPs in the United Kingdom (UK) (Orafi and Rushton, 2013). Use of EAL is mostly accurate in determination of working length but should be confirmed radiographically (European Society of Endodontology, 2006), which most clinicians did in this study.

All the restorative dentistry specialists and the endodontists surveyed used the dental dam, but many GDPs claimed that they did not. In addition, a large number of GDPs consistently used normal saline as an irrigant. This clearly departed from the guidelines for root canal treatment (European Society of Endodontology, 2006). Compliance in using a dental dam among GDPs is lower in the present study when compared to previous reports (Whitworth *et al.*, 2000; Chandler and Koshy, 2002; Palmer *et al.*, 2009; Anabtawi *et al.*, 2013). Some reasons given for not using a dental dam include lack of training, difficulty in use and increased cost of treatment (Saunders *et al.*, 1999b; Mala *et al.*, 2009). It is possible that dental dam use had a bearing on irrigant selection. Higher numbers of dental dam users irrigated with sodium hypochlorite compared to non-users (Whitworth *et al.*, 2000).

K-files remained the most widely used instruments among the GDPs. In contrast, the majority of the restorative dentistry specialists and the endodontists reported using a combination of hand files and engine-driven files. Apparently, training and instrument availability are decisive factors in this divergence (Parashos and Messer 2004). Also, the use of engine-drive files was prevalent among the specialists because the use of hand files can be physically taxing and time-consuming (Jenkins *et al.*, 2001). Owing to the unknown clinical outcomes of lasers at the moment (American Association of Endodontists, 2013), most respondents did not use them.

The GDPs and the specialists also differ in the use of an adjunctive irrigant. Specifically, the endodontists were most consistent in removing smear layers using EDTA. The majority of endodontists also use an ultrasonic system to agitate the irrigant. Despite the controversies surrounding smear layer removal, such practice is in line with the findings by Dutner *et al.* (2012). In addition, a small number of clinicians used MTA, conforming to evidence-based recommendations, especially for perforation repairs and root-end fillings (Lee *et al.*, 2009).

Overall, endodontic practice is markedly different between the specialists and the GDPs, largely because the GDPs do not always conform to quality guidelines. Costs, lack of a comprehensive public dental health service and public perception of endodontic care may have impacted on the results. Thus, education and training emphasizing the fundamental principles of root canal treatment should be carried out periodically, along with review of clinical performance.

On a different note, the recognition of endodontics as an independent dental specialty or as part of restorative dentistry specialty deserves discussion. To date, the General Dental Council (GDC) in the UK recognizes the mono-specialties of endodontics, periodontics and prosthodontics, as well as the more integrated restorative dentistry specialty which has endodontics as part of its practice (General Dental Council, 2009). In contrast, the American Dental Association only recognizes the mono-specialties (American Dental Association, 2016). In the context of this study, the Malaysian Dental Council and National Specialist Register recognizes restorative dentistry specialty and the recently added endodontics mono-specialty, but the Ministry of Health only includes restorative dentistry specialists as part of the Oral Health Services. Hence, this explains lack of endodontists in government clinics/hospitals (Table 1).

Although there are numerous reports of the endodontic practice of GDPs and endodontists, the data for restorative dentistry specialists is scarce, despite their vital contribution to the field in some countries. The two groups differed by the use of dental operating microscope. Besides, there is a distinct pattern in the referrals (Table 4).

Most cases requiring the application of advanced endodontic skills and contemporary armamentarium were referred to the endodontists. Specifically, calcified or blocked canals were among the most important reasons for referrals (Ree *et al.*, 2003; Neukermans *et al.*, 2015). In fact,

these occurrences were much more prevalent than the number reported by the referring dentists (Abbott, 1994a). Also, retreatment is often required because of the inadequacies of the initial treatment, but it is an arduous task to remove a previous tooth filling (Abbott, 1994b). Similarly, iatrogenic damage such as file separation and perforation could be managed effectively using cutting-edge technologies and materials, which are mostly available in endodontic practices. Since microscopes were predominantly used by endodontists, they could perform microsurgeries, which were shown to have better outcomes than traditional methods (Setzer *et al.*, 2010). Overall, GDPs tend to refer difficult cases to endodontists because GDPs acknowledge that endodontists have the special skills and/or equipment required to overcome these problems (Caplan *et al.*, 1999).

In contrast, restorative dentistry specialists' expertise was mostly sought for integrated management, as it is relevant to their training. According to the GDC, a restorative dentistry specialist is trained "to provide and where necessary coordinate the care of individuals with complex multidisciplinary needs within the specialist arena and both secondary and tertiary care settings as well as undertaking an interdisciplinary treatment planning service for colleagues in the primary care sector" (Restorative Dentistry Specialist Advisory Committee, 2017). Although the restorative dentistry specialists should have developed competence across a range of clinical disciplines including Operative Dentistry, Fixed and Removable Prosthodontics, Endodontics and Periodontics, trainees undertaking the current restorative dentistry curriculum "will no longer be entitled to be entered onto the specialist lists of endodontics, prosthodontics and periodontics unless they can also show that they meet the requirements for entry onto those lists" (General Dental Council, 2016). Hence, it can be concluded that the training in these two specialties might not result in the same level of knowledge and competency in endodontic procedures. It is timely that the Ministry of Health and the Ministry of Higher Education are looking into defining the scope of training and practice of dental specialties in Malaysia.

Some referrals might also be explained by the shortage of endodontists in the public health system and the disproportionate geographic distribution of endodontic practices, because close proximity of an endodontic practice was a critical factor for the GDPs when selecting a specialist (Barnes *et al.*, 2011). If given a choice, GDPs in the UK preferred to refer a private patient to an appropriate mono-specialist as opposed to a restorative dentistry specialist, but the preferences were more balanced if the patient was seen in a public-funded healthcare system (Nixon and Benson, 2005).

This current study also reported that cases of combined endodontic-periodontal lesions were predominantly referred to periodontists. Interestingly, Abbott (1994b) observed that the referrals of patients with combined endodontic-periodontal lesions to endodontists in Western Australia were all made by periodontists, suggesting that an interdisciplinary management of these cases was more feasible. Lastly, oral surgeons were consulted more for cases of dental trauma and challenging patient management, especially patients with medical complications. This finding is in agreement with Coulthard *et al.* (2000). These cases may be better seen in a hospital-based setting with comprehensive medical support.

The notable limitations of this study are the reliance of self-reported measures, the lack of measurements on the quality of care and treatment outcome. Therefore, we recommend future studies to compare these aspects through clinical audit.

Conclusion

The present study found that most of the endodontists in Malaysia worked in the academic institutions whilst majority of the restorative specialists were in public clinics/hospitals. Being specialists, they were more involved in administration, teaching and research compared to the GDPs and despite of the multiple tasks, they performed more endodontic cases than the GDPs. The specialists were more inclined to use the equipment and materials that adhered to current best practices and guidelines, probably due to the advanced

formal training in endodontics. The GDPs however, did not always conform to these standards. Therefore, GDPs should be encouraged to further their education on endodontic practice. Overlapping scope of practice and referrals among the specialists, merits scrutiny to optimize resources and manpower.

Acknowledgements

This research was supported by Fundamental Research Grant Scheme, Ministry of Higher Education Malaysia (FRGS/1/2015/SKK14/ UKM/02/1).

Conflict of interest

The authors deny any conflict of interest related to this study.

References

Abbott PV (1994a). Analysis of a referral-based endodontic practice: Part 1. Demographic data and reasons for referral. *J Endod*, **20**(2): 93-96.

Abbott PV (1994b). Analysis of a referral-based endodontic practice: Part 2. Treatment provided. *J Endod*, **20**(5): 253-257.

Alley BS, Kitchens GG, Alley LW, Eleazer PD (2004). A comparison of survival of teeth following endodontic treatment performed by general dentists or by specialists. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*, **98**(1): 115-118.

American Association of Endodontists (2013). *Use of Lasers in Dentistry: AAE Position Statement.* Retrieved 12 May 2015, from https://www.aae.org/uploadedfiles/publications_and_research/guidelines_and_position_statements/lasersnew.pdf

American Dental Association (2016). *Specialty Definitions*. Retrieved 13 July 2016, from http://www.ada.org/en/education-careers/careers-in-dentistry/dental-specialties/specialty-definitions

Anabtawi MF, Gilbert GH, Bauer MR, Reams G, Makhija SK, Benjamin PL *et al.* (2013). Rubber dam use during root canal treatment: Findings from The Dental Practice-Based Research Network. *J Am Dent Assoc*, **144**(2): 179-186.

Barnes JJ, Patel S, Mannocci F (2011). Why do general dental practitioners refer to a specific specialist endodontist in practice? *Int Endod J*, **44**(1): 21-32.

Buhrley LJ, Barrows MJ, BeGole EA, Wenckus CS (2002). Effect of magnification on locating the MB2 canal in maxillary molars. *J Endod*, **28**(4): 324-327.

Burry JC, Stover S, Eichmiller F, Bhagavatula P (2016). Outcomes of primary endodontic therapy provided by endodontic specialists compared with other providers. *J Endod*, **42**(5): 702-705.

Caplan DJ, Reams G, Weintraub JA (1999). Recommendations for endodontic referral among practitioners in a dental HMO. *J Endod*, **25**(5): 369-375.

Chandler NP, Koshy S (2002). Radiographic practices of dentists undertaking endodontics in New Zealand. *Dentomaxillofac Radiol*, **31**(5): 317-321.

Christell H, Birch S, Hedesiu M, Horner K, Ivanauskaité D, Nackaerts O *et al.* (2012). Variation in costs of cone beam CT examinations among healthcare systems. *Dentomaxillofac Radiol*, **41**(7): 571-577.

Clarkson RM, Podlich HM, Savage NW, Moule AJ (2003). A survey of sodium hypochlorite use by general dental practitioners and endodontists in Australia. *Aust Dent J*, **48**(1): 20-26.

Coulthard P, Kazakou I, Koron R, Worthington HV (2000). Referral patterns and the referral system for oral surgery care. Part 1: General dental practitioner referral patterns. *Br Dent J*, **188**(3): 142-145.

Drugan CS, Chestnutt IG, Boyles JR (2004). The current working patterns and future career aspirations of specialist trainees in dentistry. *Br Dent J*, **196**(12): 761-765.

Dunn OJ, Clark VA (2009). Categorical data analysis of two-way frequency tables. In: Dunn OJ, Clark VA (eds.), *Basic Statistics: A Primer for the Biomedical Sciences*. New Jersey: John Wiley & Sons, Inc., pp 141-164.

Dupont WD, Plummer WD Jr (1990). Power and sample size calculations. A review and computer program. *Control Clin Trials*, **11**(2): 116-128.

Dutner J, Mines P, Anderson A (2012). Irrigation trends among American Association of Endodontists members: a web-based survey. *J Endod*, **38**(1): 37-40.

Edwards P, Roberts I, Clarke M, DiGuiseppi C, Pratap S, Wentz R *et al.* (2002). Increasing response rates to postal questionnaires: Systematic review. *BMJ*, **324**(7347): 1183.

Eriksen HM (1991). Endodontology--epidemiologic considerations. *Endod Dent Traumatol*, **7**(5): 189-195.

Eriksen HM (2008). Epidemiology of apical periodontitis. In: Ørstavik D, Pitt Ford T (eds.), *Essential Endodontology: Prevention and Treatment of Apical Periodontitis*. London: Blackwell Munksgaard, pp 262-274.

European Society of Endodontology (1998). Guidelines for specialty training in endodontology. *Int Endod J*, **31**(1): 67-72.

European Society of Endodontology (2001). Undergraduate curriculum guidelines for endodontology. *Int Endod J*, **34**(8): 574-580.

European Society of Endodontology (2006). Quality guidelines for endodontic treatment: Consensus report of the European Society of Endodontology. *Int Endod J*, **39**(12):921-930.

General Dental Council (2009). *GDC Policy Statement on Restorative Dentistry and the Specialties of Endodontics, Prosthodontics And Periodontics*. Retrieved 22 November 2017, from https://www.gdc-uk.org/api/files/Policystatementonrestorativeandtherelatedspecialties.pdf

General Dental Council (2016). *Look for A Specialist*. Retrieved 13 July 2016, from http://www.gdc-uk.org/Membersofpublic/Lookforaspecialist/Pages/default.aspx

Glickman GN, Gluskin AH, Johnson WT, Lin J (2005). The crisis in endodontic education: Current perspectives and strategies for change. *J Endod*, **31**(4): 255-261.

Hol C, Hellén-Halme K, Torgersen G, Nilsson M, Møystad A (2015). How do dentists use CBCT in dental clinics? A Norwegian nationwide survey. *Acta Odontol Scand*, **73**(3): 195-201.

Jafarzadeh H, Abbott PV (2010). Review of pulp sensibility tests. Part II: Electric pulp tests and test cavities. *Int Endod J*, **43**(11): 945-958.

Jenkins SM, Hayes SJ, Dummer PM (2001). A study of endodontic treatment carried out in dental practice within the UK. *Int Endod J*, **34**(1): 16-22.

Kersten DD, Mines P, Sweet M (2008). Use of the microscope in endodontics: Results of a questionnaire. *J Endod*, **34**(7): 804-807.

Lazarski MP, Walker WA 3rd, Flores CM, Schindler WG, Hargreaves KM (2001). Epidemiological evaluation of the outcomes of nonsurgical root canal treatment in a large cohort of insured dental patients. *J Endod*, **27**(12): 791-796.

Lee M, Winkler J, Hartwell G, Stewart J, Caine R (2009). Current trends in endodontic practice: Emergency treatments and technological armamentarium. *J Endod*, **35**(1): 35-39.

Mala S, Lynch CD, Burke FM, Dummer PM (2009). Attitudes of final year dental students to the use of rubber dam. *Int Endod J*, **42**(7): 632-638.

Malaysian Dental Council (2014). *Ministry of Health Malaysia: Dental Practitioners' Information Management System (DPIMS)*. Retrieved 5 September 2014, from http://dpims.moh.gov.my/

McCaul LK, McHugh S, Saunders WP (2001). The influence of specialty training and experience on decision making in endodontic diagnosis and treatment planning. *Int Endod J*, **34**(8): 594-606.

National Specialist Register (2014). *Dental Specialties*. Retrieved 10 October 2014, from http://nsr.org.my/dental/specialties2.html

Neukermans M, Vanobbergen J, De Bruyne M, Meire M, De Moor RJ (2015). Endodontic performance by Flemish dentists: Have they evolved? *Int Endod J*, **48**(12): 1112-1121.

Nixon PJ, Benson RE (2005). A survey of demand for specialist restorative dental services. *Br Dent J*, **199**(3): 161-163.

Orafi I, Rushton VE (2013). The use of radiography and the apex locator in endodontic treatment within the UK: A comparison between endodontic specialists and general dental practitioners. *Int Endod J*, **46**(4): 355-364.

Palmer NOA, Ahmed M, Grieveson B (2009). An investigation of current endodontic practice and training needs in primary care in the north west of England. *Br Dent J*, **206**(11): E22.

Parashos P, Messer HH (2004). Questionnaire survey on the use of rotary nickel-titanium endodontic instruments by Australian dentists. *Int Endod J*, **37**(4): 249-259.

Ree MH, Timmerman MF, Wesselink PR (2003). Factors influencing referral for specialist endodontic treatment amongst a group of Dutch general practitioners. *Int Endod J*, **36**(2): 129-134.

Restorative Dentistry Specialist Advisory Committee (2009). Curriculum for specialty training in restorative dentistry. Retrieved 22 November 2017, from https://www.gdc-uk.org/api/files/RestorativeDentistryCurriculum.pdf

Saunders WP, Chestnutt IG, Saunders EM (1999a). Factors influencing the diagnosis and management of teeth with pulpal and periradicular disease by general dental practitioners. Part 1. *Br Dent J*, **187**(9): 492-497.

Saunders WP, Chestnutt IG, Saunders EM (1999b). Factors influencing the diagnosis and management of teeth with pulpal and periradicular disease by general dental practitioners. Part 2. *Br Dent J*, **187**(10): 548-554.

Savani GM, Sabbah W, Sedgley CM, Whitten B (2014). Current trends in endodontic treatment by general dental practitioners: Report of a United States national survey. *J Endod*, **40**(5): 618-624.

Setzer FC, Shah SB, Kohli MR, Karabucak B, Kim S (2010). Outcome of endodontic surgery: A meta-analysis of the literature--Part 1: Comparison of traditional root-end surgery and endodontic microsurgery. *J Endod*, **36**(11): 1757-1765.

Slaus G, Bottenberg P (2002). A survey of endodontic practice amongst Flemish dentists. *Int Endod J*, **35**(9): 759-767.

Sudhakara Reddy R, Sai Kiran C, Ramesh T, Naveen Kumar B, Mahadev Naik R, Ramya K (2013). Knowledge and attitude of dental fraternity towards cone beam computed tomography in south India – A questionnaire study. *Indian J Dent*, **4**(2): 88-94.

Whitten BH, Gardiner DL, Jeansonne BG, Lemon RR (1996). Current trends in endodontic treatment: Report of a national survey. *J Am Dent Assoc*, **127**(9): 1333-1341.

Whitworth JM, Seccombe GV, Shoker K, Steele JG (2000). Use of rubber dam and irrigant selection in UK general dental practice. *Int Endod J*, **33**(5): 435-441.