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Opinions and attitudes of endodontists and general dental practitioners in the UK towards the intracanal fracture of endodontic instruments: part 1

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Abstract

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Aim To investigate the attitudes and opinions of general dental practitioners (GDPs) and endodontists in the UK towards fracture of endodontic instruments. It was hypothesized that there would be no significant difference between GDPs and endodontists regarding their experience of fracture of endodontic instruments.
Methodology A pilot questionnaire was carried out on 20 postgraduate dental students to ensure that the questions were easily understood. This was followed by a further pilot survey on a group of GDPs and endodontists (50) to facilitate sample size calculation. The sample size comprised 330 systematically selected GDPs, and all endodontic specialists working in the UK (170). The questionnaire comprised both close-ended and partially close-ended questions in four categories: demographics; pattern of practice and experience of instrument fracture; management of fractured instruments; and unsuccessful management of fractured instruments. Nonrespondents were sent another two mailings (first and second reminders). After collecting the responses, data were analysed using chi-square and Linear-by-Linear Association tests at the 0.05 level of significance.
Results The overall response rate was 75% (82.82% for endodontists and 70.92% for GDPs). Overall, 88.8% of respondents had experienced fractured instruments with a significantly higher proportion of endodontists (94.8%) compared with that of GDPs (85.1%).
Conclusion Both endodontists and GDPs were aware of most factors contributing to endodontic instrument fracture. With experience and knowledge, fracture of endodontic instruments was associated with the number of root canal treatments performed.

Keywords: endodontic files separation, instruments fracture, questionnaire, survey.

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Introduction

Fracture of endodontic instruments is a problematic incident that may occur during root canal preparation. Even with the advent of nickel–titanium (NiTi) instruments, which are reported to be stronger and more flexible (Walia *et al.* 1988); fracture still may occur especially in canals that are narrow and curved (Hülsmann & Schinkel 1999). Many studies have investigated the occurrence and removal of fractured instruments and other associated factors (Hulsmann & Schinkel 1999, Shen *et al.* 2004, Suter *et al.* 2005). However, little information is available regarding the opinions and attitudes of dental practitioners in this regard. Survey studies can provide information about the knowledge, attitudes, preferences, opinions,

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experiences, practices and demographics of participants (Fink 1995). Nevertheless, such studies should be well planned and conducted to enable a high response rate so that results will be representative (Lydeard 1991).

In a study related to the integration of the LightSpeed rotary system (Lightspeed Technology Inc., San Antonio, TX, USA) into dental practice in Switzerland, 76% of participants reported that they had experienced fracture of rotary instruments (Barbakow & Lutz 1997). Respondents reported various reasons for instrument fracture such as excessive pressure, incorrect insertion angle and complex anatomy. Another study evaluated the introduction of NiTi rotary systems in dental practice in Australia and reported 74% of participants had experienced fracture of rotary instruments (Parashos & Messer 2004).

The aim of this study was to investigate the attitudes and opinions of general dental practitioners (GDPs) and endodontic specialists in the UK towards endodontic instrument fracture. This article will cover the first two parts of the study which are related to endodontic practice and experience of instrument fracture. It was hypothesized that there would be no significant difference between GDPs and endodontists regarding their experience of fracture of endodontic instruments.

Material and methods

This study was granted Ethics Committee approval by the Multi-Centre for Research Ethics Committee for Wales. A pilot self-administrated questionnaire was first carried out on 20 postgraduate students at the School of Dentistry, University of Manchester to ensure that the questions were easily understood. This was followed by a further pilot survey on a group of GDPs and endodontists to facilitate sample size calculation. The sample size comprised 330 systematically selected GDPs, and all endodontic specialists working in the UK (170). The questionnaire comprised both close-ended and partially close-ended questions in four categories:

- Demographics: five non-numbered questions (four closed-ended and one partially closed-ended).
- Pattern of practice and experience of instruments fracture: 17 questions (14 closed-ended and three partially closed-ended).
- Management of fractured instruments: six questions (four closed-ended and two partially closed-ended).
- Unsuccessful management of fractured instruments: four closed-ended questions.

The questionnaire was accompanied by a covering letter signed by the main investigator. The covering letter explained the aims and objectives of the study and indicated that all information would remain confidential and anonymous. Also it stated that respondents would be entered into a prize draw. A prepaid envelope was included with the address of the main investigator. The prepaid envelope was returned to the main researcher who only had access to the data collection form number but not the sample list itself. After each mailing, a list of numbers of those who responded was given to a third person unrelated to the study and a new list prepared for the next mailing. Nonrespondents were sent another two mailings (first and second reminders) comprising a differently worded covering letter; a prepaid envelope; and another copy of the questionnaire. After collecting the responses, data were entered into SPSS 14 for Windows software (SPSS Inc., Chicago, IL, USA). They were analysed using chi-square and Linear-by-Linear Association tests at the 0.05 level of significance. Fifty (GDPs and endodontists) who completely responded to the questionnaire were randomly allocated 50 prizes (monetary and dental samples).

Results

Response rate details

Practitioners or responses included in the survey sample were divided into three groups as follows:

- Usable responses: included respondents who partially (CP) or completely (CC) completed the questionnaire.
- Nonrespondents: included those who did not respond to the study or returned blank copies.
- Ineligible sample: included those who changed address; had addresses outside of the UK; were retired; did not perform root canal treatment (RCT); or were registered in other specialities.

The completion (initial) response rate was as follows:

- Overall initial response rate: 357/500 = 71.4%.
- General dental practitioners initial response rate: 222/330 = 67.27%.
- Endodontists initial response rate: 135/170 = 79.4%.

Of the original sample size (500) and according to the criteria described above, 24 (17 GDPs and seven endodontists) proved to be ineligible. One GDP refused to participate and returned a blank questionnaire. Ineligible cases were not considered when the final response rate was calculated (Locker 2000, Parashos & Messer 2004). Thus, the response rate achieved in this survey study was as follows:

- Total sample size: 500−24 = 476 (overall response rate of: 357/476 = 75%).
- General dental practitioners sample size: 330−17 = 313 (response rate of: 222/313 = 70.92%).
- Endodontists sample size: 170−7 = 163 (response rate of: 135/163 = 82.82%).

Year of graduation

The year of graduation ranged from 1955 to 2006 (Table 1). The proportion of GDPs graduating between 1997 and 2006 (27.5%) was significantly higher than that of endodontists (5.9%). Nevertheless, there were no significant differences between the four groups of year of graduation for all respondents regarding their experience of instrument fracture ($\chi^2 = 5.93$, d.f. = 3, $P = 0.204$). The results did not show linear correlation between practice experience (years after graduation) and experience of instrument fracture either within the whole sample (Linear-by-Linear Association = 2.78, d.f. = 1, $P = 0.095$) or within both groups of GDPs ($P = 0.242$) and endodontists ($P = 0.577$).

Table 1 Respondents details regarding year of graduation

Range	GDPs	Endodontists	Total
1997–2006	27.5% (80.3)	5.9% (87.5)	19.3% (81.2)
1987–1996	20.7% (82.6)	34.8% (95.9)	26.1% (89.2)[a]
1977–1986	27.5% (91.8)	37.8% (94.1)	31.4% (92.9)
Before 1977	24.3% (85.2)	21.5% (96.6)	23.2% (89.2)
Total	100% (85.1)	100% (94.8)	100% (88.8)

The values in the brackets represent proportion of respondents who experienced fracture of endodontic instruments.
[a]Significantly more endodontists experienced SEF than GDPs.
GDPs, general dental practitioners.

Table 2 Respondents details for work patterns (multiple answers were available)

Patterns	Endodontists (%)	GDPs (%)	Total	
			Work	Do not work
Private practice	75.6	58.8	65.2% (96.6)	34.8% (75)[a]
NHS	22.2	71.9	53.1% (84.7)	46.9% (94)[a]
University	32.6	9	18% (89.1)	82% (89)

The values in the brackets represent proportion of those respondents who experienced fracture of endodontic instruments.
[a]A significant difference in experience of fracture of endodontic instruments between those who work and those who do not.
GDPs, general dental practitioners.

Patterns of work

Most respondents (65%) worked in private practice (Table 2). The proportion of respondents who worked in private practice and had experienced instrument fracture (96.6%) was significantly higher than the proportion of those who had experienced instrument fracture but did not work privately (75%) ($\chi^2 = 38.48$, d.f. = 1, $P < 0.001$). The majority of endodontists (75.6%) worked in private practice and this was significantly higher than that of GDPs (58.8%) ($\chi^2 = 10.33$, d.f. = 1, $P = 0.01$).

Number of cases per week

Whilst the highest proportion of endodontists performed more than 10 cases per week (45.9%), the lowest proportion of GDPs did so (4.5%) (Table 3). Experience of instrument fracture was positively correlated with the number of endodontic cases performed per week (Linear-by-Linear Association = 24.81, d.f. = 1, $P < 0.001$). Thus, experience of instrument fracture significantly increased as the number of endodontic cases performed per week increased. This was applied to both groups of GDPs and endodontists.

Use of hand instruments

Overall, 64.1% of respondents used stainless steel (SS) hand instruments (Table 4). The proportion of endodontists who used SS hand instruments (80%) was significantly higher compared with that of GDPs

Table 3 Number of root canal treatments performed per week

Respondents	1–2 cases	3–5 cases	6–10 cases	More than 10 cases	Total
GDPs	36.9% (74.4)	45.9% (89.2)	12.6% (100)	4.5% (90)	100% (85.1)
Endodontists	23.7% (81.3)	15.6% (100)	14.8% (95)	45.9% (100)	100% (94.8)
Total	31.9% (76.3)	34.5% (91.1)	13.4% (97.9)	20.2% (98.6)	100% (88.8)

The values in the brackets represent proportion of respondents who experienced SEF.
A significant difference was found between endodontists and GDPs in all categories except in those who perform 6–10 cases.
GDPs, general dental practitioners.

Table 4 Types and patterns of hand files use (multiple answers were available)

Respondents	SS files (%)	NiTi files (%)	Combine usage (%)
GDPs	54.5	63.1	18.5
Endodontists	80	69.6	49.6
Total	64.1[a]	65.5	30.3[a]

[a]A significant difference was found between endodontists and GDPs.
SS, stainless steel.
GDPs, general dental practitioners.
NiTi, nickel–titanium.

(54.5%) ($\chi^2 = 23.73$, d.f. = 1, $P < 0.001$). Nevertheless there was no significant difference between endodontists and GDPs regarding the use of NiTi hand instruments with overall use being 65.5% ($\chi^2 = 1.6$, d.f. = 1, $P = 0.205$). A total of 108 (30.3%) of respondents used both SS and NiTi hand instruments. A significantly higher proportion of endodontists (49.6%) used both hand instruments compared with the proportion of GDPs (18.5%) ($\chi^2 = 38.63$, d.f. = 1, $P < 0.001$).

Use of rotary systems

A total of 271 (75.9%) of respondents used rotary systems for root canal preparation. The vast majority of endodontists used rotary systems (92.6%) and this was significantly higher than that reported by GDPs (65%) ($\chi^2 = 33.039$, d.f. = 1, $P < 0.001$). Table 5 shows the three most common rotary systems used by the respondents. The proportion of endodontists using ProTaper (Dentsply Ltd, Surrey, UK) (81.6%) was significantly higher than that of GDPs (39.7%) ($\chi^2 = 48.829$, d.f. = 1, $P < 0.001$); 68 (25.1%) of respondents use (or used) more than one rotary system. A significantly higher proportion of endodontists (32%) used more than one rotary system compared with that of GDPs (19.2%) ($\chi^2 = 5.890$, d.f. = 1, $P = 0.015$).

Hands-on courses

A total of 283 (79.3%) of respondents had attended hands-on training courses. A significantly higher proportion of endodontists (89.6%) had attended courses compared with GDPs (73%) ($\chi^2 = 14.175$, d.f. = 1, $P < 0.001$). Moreover, the proportion of endodontists attending more than six courses (35%) was significantly greater than that of GDPs (10.4%) ($\chi^2 = 34.068$, d.f. = 2, $P < 0.001$).

Table 5 Details of respondents for use of rotary systems

Patterns and rotary systems used	GDPs (%)	Endodontists (%)	Total (%)
At least one rotary system	65.8	92.6	75.9[a]
Multiple use	19.2	32	25.1[a]
ProTaper	39.72	81.6	59.04[a]
ProFile	35.37	25.6	30.99
K3	17.68	12	15.12

[a]A significant difference was found between endodontists and GDPs.
GDPs, general dental practitioners.

Table 6 Patterns of endodontic files examination (multiple answers were available)

Patterns	Endodontists (%)	GDPs (%)	Total (%)
Before treatment	84.4	72.5	77
Regularly during treatment	88.1	55.4	67.8
After treatment	45.9	27	34.2
Occasionally during treatment	6.7	23.9	17.4
Before sterilization	11.9	5.9	8.1
After sterilization	6.7	4.1	5
Both before and during regularly	75.2	42	55.3

A significant difference was found between endodontists and GDPs in all patterns except after file sterilization.
GDPs, general dental practitioners.

Instrument examination

Participants were asked when they usually examine instruments. Answers were categorized into six closed-ended responses (Table 6). The majority of respondents (77%) indicated that they examined instruments *before treatment*. The proportion of endodontists doing so (84.4%) was significantly higher than that of GDPs (72.5%) ($\chi^2 = 6.744$, d.f. = 1, $P = 0.009$); 67.8% of respondents used to examine instruments *regularly* during treatment. A significantly higher proportion of endodontists (88.1%) examined instruments regularly during treatment compared with GDPs (55.4%) ($\chi^2 = 41.217$, d.f. = 1, $P < 0.001$). Results showed that 184 (55.3%) of respondents examine endodontic instruments both before and regularly during endodontic treatment. The proportion of endodontists following this combined pattern of instrument examination (75.2%) was significantly higher than that of GDPs (42%) ($\chi^2 = 35.586$, d.f. = 1, $P < 0.001$).

Use of magnification for instrument examination

The question regarding the use of magnification to examine endodontic instruments had three answers

(always, sometimes and never). Overall, 36.8% of respondents *always* use magnification to examine instruments. A significantly higher proportion of endodontists (63.4%) *always* use magnification compared with GDPs (20.7%) ($\chi^2 = 93.869$, d.f. = 2, $P < 0.001$). The overall proportion of respondents who *sometimes* use magnification was (23.6%) with no significant difference between endodontists and GDPs.

Pattern of instrument discard

In total 252 (70.6%) of respondents discarded endodontic instruments after a certain number of uses and this was the most common pattern (Table 7). The vast majority of endodontists (94.1%) discarded instruments after a certain number of uses and this was significantly higher than the proportion of GDPs (56.3%) ($\chi^2 = 57.67$, d.f. = 1, $P < 0.001$); 113 (44.8%) of respondents discarded instruments after single use with a significant higher proportion of endodontists (57.5%) compared with that of GDPs (32%) doing so ($\chi^2 = 16.54$, d.f. = 1, $P < 0.001$). Only 52 (20.6%) of respondents discarded instruments after six or more times of use with a significantly higher proportion of GDPs (27.2%) compared with that of endodontists (14.2%) ($\chi^2 = 6.528$, d.f. = 1, $P = 0.011$). Although only 27.2% of all respondents discarded used instruments after observing defects by magnification, a reasonable proportion of endodontists (40%) adopted this pattern of instrument discard and this was significantly higher than that of GDPs (19.4%) ($\chi^2 = 18.05$, d.f. = 1, $P < 0.001$).

Factors contributing to instrument fracture

Factors considered to contribute to fracture of endodontic instruments were categorized into five groups. Respondents were asked to rank groups of factors from the most important as one to the least important as five. Overall there was an agreement between endodontists and GDPs. Factors related to the operator (i.e. experience, frequency of instruments usage) were considered as the most significant aspects that contribute to endodontic instrument fracture (54.6%). The second were factors related to root canal anatomy (i.e. canal size, curvature) (49%). However, factors related to the manufacturers (i.e. method and conditions of manufacturing) and the environment (i.e. irrigants, instruments sterilization) were considered as the least important (fourth and fifth respectively). Factors related to instrument design were considered of moderate importance (third).

Table 7 Pattern of endodontic file discard (multiple answers were available)

Patterns	Endodontists (%)	GDPs (%)	Total (%)
After certain number of use	94.1	56.3	70.6
After naked-eye defects	32.6	64.9	52.7
After magnified defects	40	19.4	27.2
Other patterns	8.1	1.4	3.9
After single use	57.5	32	44.8
After 2–5 times of use	26.8	40	33.3
After 6 or more times of use	14.2	27.2	20.6

A significant difference was found between endodontists and GDPs in all patterns.
GDPs, general dental practitioners.

Experience of instrument fracture

A key question in the survey asked whether or not participants had experienced endodontic instruments fracture. In case of an affirmative answer, respondents were asked two further questions to specify what type of instruments (hand or rotary) were involved (multiple responses were available). A total of 317 (88.8%) of respondents had experienced fracture of endodontic instruments (Table 8). A significantly higher proportion of endodontists (94.8%) had experienced instrument fracture compared with GDPs (85.1%) ($\chi^2 = 7.906$, d.f. = 1, $P = 0.005$). Of the 317 respondents who had experienced instrument fracture, 237 (74.76%) had experienced fracture of hand instruments. There was no significant difference between endodontists and GDPs (73.43% and 75.66% respectively) ($\chi^2 = 1.023$, d.f. = 1, $P = 0.312$).

Table 8 Respondents details regarding their experience of file's separation (multiple answers were available)

File separation	Endodontists	GDPs	Total
Experience of files fracture	128 (94.8%)	189 (85.1%)	317 (88.8%)[a]
Experience of hand files fracture	94 (73.4%)	143 (75.7%)	237 (74.8%)
Experience of rotary file fracture	119 (92.96%)	124 (65.6%)	243 (76.7%)[a]
Experience of rotary files fracture within rotary systems users	117 (93.6%)	116 (79.5%)	233 (85.97%)[a]

[a]A significant difference was found between endodontists and GDPs.
GDPs, general dental practitioners.

Of the 317 who had experienced instrument fracture, 243 respondents (76.6%) had experienced fracture of rotary instruments. Results showed a significant difference in the use of rotary systems and experience of rotary instrument fracture between endodontists and GDPs.

Experience of rotary instrument fracture by all respondents
Of the 271 respondents using rotary instruments, 233 (86%) had experienced rotary instrument fracture.

Experience of rotary instrument fracture within the GDPs group
Of the 146 of GDPs using rotary systems, 116 (79.5%) had experienced rotary instrument fracture. The proportion of GDPs who had experienced rotary instrument fracture (79.5%) was significantly higher than the proportion of GDPs who had not (20.5%) ($\chi^2 = 95.193$, d.f. = 1, $P < 0.001$).

Experience of rotary instrument fracture within endodontists group
Of the 125 endodontists using rotary systems, 117 (93.6%) had experienced rotary instrument fracture. The proportion of endodontists who had experienced rotary instrument fracture (93.6%) was significantly higher than the proportion of endodontists who had not (6.4%) ($\chi^2 = 48.010$, d.f. = 1, $P < 0.001$).

Number of fractured instruments experienced

Most GDPs (56.1%) had experienced 1–5 fractured instruments and this proportion was significantly higher than that reported by the endodontists group (32%) ($\chi^2 = 18.281$, d.f. = 2, $P < 0.001$) (Table 9). On the other hand, the proportion of endodontists who reported more than 10 fractured instruments (44.5%) was significantly higher than that reported by GDPs (26.5%); 63 (19.9%) of respondents had experienced 6–10 of instrument fracture with no significant between endodontists and GDPs.

Table 9 Number of separated files

Respondents	1–5 (%)	6–10 (%)	More than 10 (%)
GDPs	56.1	17.5	26.5
Endodontists	32	23.4	44.5
Total (100%)	46.4[a]	19.9	33.8[a]

[a]A significant difference was found between endodontists and GDPs.
GDPs, general dental practitioners.

Metal alloy of fractured instruments

Overall, 313 respondents answered this question and four of those who had experienced instrument fracture (two GDPs and two endodontists) did not respond; 174 (55.6%) of respondents reported that most separated instruments were NiTi instruments (Table 10). A significantly higher proportion of endodontists had experienced NiTi instrument fracture (75.4%) compared with that of GDPs (42.2%). However, the proportion of GDPs who reported fracture of SS instruments (57.8%) was significantly higher than of endodontists (24.6%) ($\chi^2 = 33.51$, d.f. = 1, $P < 0.001$).

Discussion

Improvements in endodontic instrument design, alloy and instrumentation techniques have occurred over the last few decades. However, fracture of endodontic instruments remains a problem and may occur suddenly and unexpectedly (Hulsmann & Schinkel 1999). Although many studies have addressed this issue (Hulsmann & Schinkel 1999, Parashos *et al.* 2004, Spili *et al.* 2005), little is known about attitudes and opinions of dental practitioners (Barbakow & Lutz 1997, Parashos & Messer 2004). Survey studies are a research tool that provides information about opinions, attitudes and behaviour of respondents (Lydeard 1991). However, it is known that such a research tool should involve not only a carefully planned and prepared set of questions and a representative sample size, but also optimize response rates (Lydeard 1991). A high response rate is essential to validate survey data (Gough & Hall 1977). Small random samples with high response rates are more valuable than large nonrandom samples or those with low response rates (Evans 1991). Various authors recommend different response rates with a range of 70–80% to minimize the risk of bias (Gough & Hall 1977, Evans 1991, Brennan *et al.* 2000). However, it was claimed that a response rate of 50–70% is acceptable for dental surveys and that a

Table 10 Alloy's type of separated files

Respondents	Stainless steel	Nickel–Titanium (%)
GDPs	57.8	42.2
Endodontists	24.6	75.4
Total (100%)	44.4	55.6

A significant difference was found between endodontists and GDPs.
GDPs, general dental practitioners.

response rate as low as 43% may still have minimal nonresponse bias (Hovland *et al.* 1980). In this study, an overall response rate of 75% was achieved (70.9% for GDPs and 82.8% for endodontists). Nonresponse bias was assessed and no significant difference was found between the proportion of early respondents who had experienced instrument fracture and the proportion of late respondents. Thus, the results of this study can be considered to be representative of all dental practitioners in the UK.

The year of graduation of respondents ranged from 1955 to 2006. A significantly higher proportion of GDPs graduated between 1997 and 2006 than that of endodontists. This might be explained by the fact that a period of at least 5 years must lapse after graduation before a dentist can be specialize and registered on the endodontic specialist list in the UK. This study showed no correlation between practice experience (years after graduation) and experience of instrument fracture neither within the whole sample nor within GDPs and endodontists groups.

The results of this survey revealed that the majority of endodontists (75.6%) work in private practice and that was significantly greater than for the GDPs group (58.8%). Subsequently, the results indicated that endodontists perform a significantly greater number of root canal treatments (RCTs) than do GDPs. Most endodontists (45.9%) perform more than 10 cases a week and this was significantly greater than GDPs (4.5%).

Continuing education courses in endodontics enable clinicians to update their knowledge and learn new instrumentation techniques (Barbakow & Lutz 1997). The majority of participants in this study (79.3%) had attended at least one hands-on training course for using rotary systems. Significantly, as expected, a higher proportion of endodontists (89.6%) had attended such courses compared with the GDPs group (73%). Moreover, significantly more endodontists (35%) had attended more than six courses compared with GDPs (10.4%). However, figures still show that GDPs do attend courses and incorporate rotary systems in their endodontic practice.

Parashos & Messer (2004) showed that 22% of GDPs and 64% of endodontists use rotary systems. Another survey about the use of the LightSpeed system reported overall usage by 58% of respondents (Barbakow & Lutz 1997). Rotary systems are popular and have been introduced into the undergraduate curriculum. A total of (75.9%) of all respondents use rotary systems for canal preparation. The vast majority of endodontists used rotary systems (92.6%) and this was significantly higher than that reported by GDPs (65%). Also, significantly more endodontists used SS instruments than GDPs (80% and 54.5% respectively). The more complex cases faced by endodontists face requires the use of SS instruments to overcome mishaps such as ledges and transportation.

This study revealed that dentists are generally aware of the need to examine instruments. The majority of respondents (77%) examine instruments *before* starting treatment, followed by *regular* examination during treatment (67.8%). The combination of both can be an efficient strategy. The results of this study revealed that 55.3% of respondents use this strategy. As expected, endodontists showed a higher awareness of the importance of instrument examination.

A further question covered the use of magnification for instrument examination; 36.8% of respondents *always* used magnification. This might suggest the need to emphasis the importance of using magnification to detect microdefects (Kuhn *et al.* 2001, Svec & Powers 2002, Peng *et al.* 2005). The proportion of endodontists who always use magnification was significantly higher than that of GDPs. However, the advantages of use of magnification should be introduced not only in postgraduate courses but also in continuing education and in undergraduate studies.

The most common pattern of endodontic instrument disposal was to discard them after a certain number of uses (70.6%). Whilst the vast majority of endodontists (93.3%) discarded instruments after a certain number of uses, a significantly lower proportion of GDPs (56.3%) did. This survey reflects the disagreement in the literature regarding the number of clinical use of endodontic instruments (Yared *et al.* 2000, Arens *et al.* 2003, Cheung *et al.* 2005, Peng *et al.* 2005). Clinically, it is very difficult to recommend a specific number of clinical use for endodontic instruments, hence single use was recommended (Arens *et al.* 2003). This survey showed that 44.8% of respondents discard instruments after single use with significantly more endodontists than GDPs doing so (57.5% and 32% respectively). On the other hand, the proportion (20.6%) who uses endodontic instruments more than six times (significantly more GDPs than endodontists) suggests the need to encourage dentists not to consider this pattern of use. Recently, single use of endodontic instruments has been recommended by the UK Chief Dental Officer for cross-infection control reasons. Such recommendation may help in reducing the incidence of instrument fracture.

Opinions and beliefs of the respondents regarding the impact of groups of factors on instrument fracture in this study were consistent with findings of other studies that considered only rotary instruments. In this study, this question, as with most of other questions, took into consideration fracture of both rotary and hand instruments. Endodontists and GDPs revealed a consensus in their opinions. Factors related to operators (such as experience) were ranked as the most important. The second main factor was root canal anatomy. In a clinical study by Parashos *et al.* (2004) it was concluded that the most important influence on the rate of instruments defects was the operator. In another survey, respondents believed that excessive pressure on instruments, over-usage and complex root canal anatomy were the main three reasons for rotary instrument fracture (62%, 43% and 36% respectively) (Parashos & Messer 2004). The results of another survey showed that fracture of LightSpeed instruments was caused by excessive pressure (25%), incorrect insertion angle (17%) and by complicated root canal morphology (15%) (Barbakow & Lutz 1997). Whilst factors related to the endodontic instruments themselves were ranked as the third factor, those related to conditions of treatment and the manufacturer's procedures were considered to be the least important. Based on these findings it can be said that both endodontists and GDPs showed good knowledge and understanding of the influence of most factors on the occurrence of endodontic instrument fracture.

The majority of respondents (88.8%) had experienced endodontic instrument fracture. This might be explained by the fact that respondents were asked if they have experienced instrument fracture during their practice without specifying the period of time. A significantly higher proportion of endodontists (94.8%) had experienced instrument fracture compared with GDPs. It was shown that experience of instrument fracture is positively related to the number of RCTs performed per week and also the proportion of endodontists who performed more than 10 cases per week was significantly higher than that of GDPs. Thus, it is reasonable that a higher proportion of endodontists experienced instrument fracture compared with that of GDPs. Although the results showed a higher proportion of endodontists using SS hand instruments than GDPs, no significant difference was found between them related to hand instruments fracture. This might reflect the fact that endodontists have better skills and tactile sensation whilst using hand instruments for root canal instrumentation. Of the 271 respondents using rotary instruments, 233 (86%) had experienced fracture of rotary instruments. Ten (4.1%) respondents who had experienced fracture of rotary instruments did not use rotary systems. These respondents may have ceased using rotary systems, or experienced instrument fracture during a rotary systems course. However, the proportion of respondents who use rotary systems and had experienced rotary instrument fracture was still higher than that reported in other studies with a significant difference between endodontists and GDPs. Whilst Barbakow & Lutz (1997) reported that 76% of LightSpeed users had experienced instrument fracture, 74% of rotary systems users had experienced instrument fracture in a later survey by Parashos & Messer (2004). Interestingly, the vast majority of endodontists using rotary systems had experienced rotary instrument fracture (93.6%) which was significantly higher than that reported by GDPs (79.5%). The proportion of endodontists who had experienced more than 10 fractured instruments (44.5%) was significantly higher than that of GDPs (26.5%). Moreover, most of GDPs (56.1%) had experienced 1–5 fractured instruments which itself was significantly higher than that of endodontists (32%).

Conclusions

As expected, greater awareness, knowledge and understanding of most aspects related to fracture of endodontic instruments was apparent within the endodontists group. However, it was shown also that a significantly higher proportion of endodontists had experienced instrument fracture compared with that of the GDPs. This might be attributed first to the fact that endodontists perform a significantly greater number of RCTs than did GDPs. Secondly, the cases that endodontists have to deal with are more complex in nature. Finally, endodontists use rotary instruments more frequently than do GDPs.

Accordingly, the following conclusions can drawn:

- Both endodontists and GDPs were aware of most factors contributing to fracture of endodontic instruments.
- When practice experience and level of knowledge were similar, fracture of endodontic instruments was mainly dependent on the number of RCTs performed.
- Further questionnaire studies regarding some specific aspects of endodontic instrument fracture are required.

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