Peer-reviewed paper; submitted September 2017; accepted January 2018

New Zealand general dental practitioners' preferred methods for the restoration of root-canal-treated teeth

Looi S, Chua KR, Murray C, Chandler NP

Abstract

Background and objectives: Root canal treatment enables patients to retain teeth previously considered unsaveable. In many cases, placement of a post is necessary for the retention of the final restoration placed on the tooth. The aim of this study was to investigate New Zealand (NZ) general dental practitioners' (GDPs) preferred methods for the restoration of root-canal-treated teeth, in particular their use of post types and core materials when restoring these teeth.

Methods: Following ethical approval and Māori consultation, an online survey and participant information sheet was emailed to all NZ registered GDPs with a valid email address. Data were statistically analyzed in SPSS version 22.0 with the alpha value set at 0.05.

Results: The participation rate was 26.5% (327/1233). Over half used posts when restoring root-canal-treated teeth (63.3%). Most did not think that every root filled tooth should receive a post, and 86.0% did not believe a post would reinforce a tooth and reduce the chance of root fracture. GDPs' views on post selection were mixed, with ease of use the most important factor. The ParaPost (Coltene) was the most commonly used prefabricated metal post (65.7%) and a composite/glass fibre post (RelyX, 3M ESPE) the most popular non-metallic type (25.1%). Despite the wide range of luting cements available, resin modified glass ionomers and composite resins were the most popular. Composite resin was the most common material used for core buildup.

Conclusions: Ease of use was the key factor when selecting the type of post. Fibre posts for restoring incisors and prefabricated metallic posts for molars were the most common types used by NZ GDPs when restoring root treated teeth. This study showed that NZ GDPs' practices are in line with treatment practices of dentists elsewhere.

Introduction

There has been an increasing demand for root canal treatment as patients aim to retain their teeth throughout life (Vernazza et al., 2015). The restoration of these teeth sometimes presents a challenge (Baba and Goodacre, 2014). They may be weaker and more prone to fracture due to loss of tooth structure from previous carious lesions, trauma or endodontic access (Onofre et al., 2015). Morgano and colleagues (1994) suggested a corono-radicular stabilisation technique which includes a coronal radicular core, custom cast metal post or prefabricated intra-radicular post to achieve adequate retention for the final restoration and to maximize fracture resistance of these teeth. Today, while it is recognised that root filled teeth with a crown will have a lower fracture rate, some cavities with up to three surfaces may be restored with an adhesive composite system (Dammashke et al., 2013).

Generally, the function of a post is solely to retain a core and not to reinforce a root-canal-treated-tooth (Naumann et al., 2006). Careful planning is needed before deciding on the use of a post, as post space preparation can result in perforation and/or root fracture. With many prefabricated systems marketed, the conventional cast metal post and core is no longer the only available option. Due to the wide range of materials available, general dental practitioners (GDPs) have a difficult task keeping their knowledge updated on materials. These restorations are commonplace in general dental practice, and there is now a textbook devoted specifically to the topic (Baba, 2013).

National studies of this subject have been carried out in many countries including the USA, Northern Ireland, Sweden, Switzerland, Saudi Arabia, Germany and Brazil (Morgano et al., 1994; Hussey and Killough, 1995; Eckerbom and Magnusson, 2001; Kon et al., 2013; Akbar, 2014; Habib et al., 2014; Naumann et al., 2015; Onefre et al., 2015). No research of this kind has been carried out in NZ. This study investigated the current approaches and preferred methods of restoring root-canal-treated teeth in the NZ setting.

Methods

Ethical approval was obtained from the University of Otago Human Ethics Committee (D15/369) and Māori consultation was sought from the Ngāi Tahu Research Consultation Committee according to the University's Policy for Research Consultation with Māori. The study population included all GDPs registered with the Dental Council and with a valid email address in March 2015. The 1233 eligible participants were contacted by email. They were sent a cover letter, a participant information sheet giving a brief explanation of the study, and a link to the online survey using Google Forms. Respondents were informed that returning the completed questionnaire would imply consent. For those few who had problems viewing the questionnaire, a paper copy with a self-addressed return envelope was provided. After one month, a second wave was sent out to those who had not responded, followed by a third and final wave one

month later. All participation was voluntary and anonymous. To increase participation, respondents were invited to enter a prize draw.

Questionnaire

A self-administered, 24-question survey was constructed using a modified version of the questionnaire developed by Morgano et al. (1994). It was pretested on a group of Dental Faculty staff, and changes were then made to improve its wording and clarity. The questionnaire consisted of a mix of multiple-choice, open-ended, and 5-point Likert-style questions. The first section collected demographic data including age, sex, year and country of graduation, and the main type of current employment. The second part focused on the respondents' use of posts (type, frequency, choice of luting cement), together with the core materials used, and their philosophies for the treatment of root filled teeth.

Statistical analysis

Responses were automatically collected via Google Forms and transferred into an IBM Statistical Package for the Social Sciences database (SPSS Version 22.0, Chicago, IL, USA). They were double-checked and cleaned to ensure accuracy, and analysed using SPSS. The chi-square test was used to test the significance of the observed associations, with an alpha level of 0.05.

Results

Of the 1233 eligible participants, 327 responded, giving a response rate of 26.5%. The majority of the respondents were aged over 40 years (204, 62.4%), and self-employed in group practices (198, 60.6%), with more than half being male (195, 59.6%) and the majority being NZ graduates (255, 78.0%). Their socio-demographic characteristics are shown in Table 1.

Just fewer than two-thirds of the respondents used a post when restoring a root-canal-treated tooth (207, 63.3%). Fewer GDPs in the 21-29 age group used posts (39.7%) than older dentists, with those aged 50 and over using posts more frequently (70%, P<0.001). While a higher percentage of males reported using posts this did not reach statistical significance.

The frequency of post placement differed according to tooth type (Table 2). When asked whether they believed if every root-canal-treated tooth should receive a post, the response for incisors, canines, premolars and molars was 8.7%, 8.2%, 9.2% and 4.8% respectively.

The types of posts used to restore teeth by those who used them are presented in Table 3. Prefabricated non-metallic posts were mainly used in anterior teeth, while prefabricated metallic posts were generally used in posterior teeth. Over half (123, 59.4%) of those who used posts chose a parallel-sided post design.

Summary data on post preferences by manufacturer are shown in Table 4. ParaPost (Coltene) was the most commonly used prefabricated metallic post. RelyX (3M ESPE) was the most commonly used non-metallic post; this is a fibre type with a tapered shape. Ease of use, reliability and predictability were the main reasons for post selection. Dental conferences, courses and journals were the major sources for up-to-date information about the restoration of root-canal-treated teeth.

Over three-quarters (161, 77.8%) of those who used posts reported that they were confident when preparing the post space. A higher proportion of males than

Table 1 Socio-demographic characteristics of respondents compared with those of all practising GDPs and specialists (brackets contain column percentages unless otherwise indicated).

	Respondents	All practising GDPs and specialists[a]	P value[b]
Total number	327	2292	
Gender			
Male	195 (59.6)	1419 (61.9)	P = 0.428
Female	132 (40.4)	873 (38.1)	
Age group (in years)			
21-29	68 (20.8)	350 (15.3)	P = 0.100
30-39	55 (16.8)	470 (20.5)	
40-49	68 (20.8)	513 (22.4)	
50-59	82 (25.1)	571 (24.9)	
60 or older	54 (16.5)	388 (17.0)	
Country of primary degree			
New Zealand	255 (78.0)	1333 (67.6)	P = 0.0002
Other	72 (22.0)	639 (32.4)	
Employment type			
Private practice	290 (88.7)	1715 (74.8)[c]	P = 0.756
Non-private practice	37 (11.3)	232 (10.1)	

[a] Respondents have been compared with "All practising GDPs and specialists" as the data for GPDs only was not available for all categories in the Dental Council Workforce Analysis 2013-2015.

[b] P-value indicates the statistical significance between respondents and all practising GPDs and specialists.

[c] the sum of responses does not equal 100% because 345 did not reply to this Workforce Survey question.

Table 2 The provision of posts in root-canal-treated teeth (brackets contain row percentages unless otherwise indicated).

Use of Posts	Never	Rarely/occasionally	Frequently/very frequently
Incisor	3 (1.4)	149 (72.0)	55 (26.6)
Canine	10 (4.8)	158 (76.3)	39 (18.8)
Premolar	12 (5.8)	151 (73.0)	44 (21.2)
Maxillary molar	33 (15.9)	158 (76.3)	16 (7.7)
Mandibular molar	35 (16.9)	155 (74.9)	17 (8.2)

Table 3 Type of post used in root canals (brackets contain column percentages unless otherwise indicated).

Type of post	Incisors	Canine	Premolars	Molars
Prefabricated metallic	57 (27.5)	71 (34.3)	83 (40.1)	99 (47.8)
Cast post	42 (20.3)	47 (22.7)	37 (17.9)	26 (12.6)
Glass fibre / composite	90 (43.5)	77 (37.2)	70 (33.8)	62 (30.0)
Ceramic	4 (1.9)	3 (1.4)	4 (1.9)	3 (1.4)
Zirconia	3 (1.4)	0 (0.0)	0 (0.0)	0 (0.0)
Carbon fibre	10 (4.8)	8 (3.9)	8 (3.9)	5 (2.4)
Other	1 (0.5)	1 (0.5)	5 (2.4)	12 (5.8)

females reported being confident or extremely confident when preparing a root canal for a post (85.3% and 63.0% respectively, (P = 0.001). There were no significant confidence findings with respect to practitioner age, country of primary degree and employment type. The majority (166, 80.1%) retained 4-5 mm of gutta-percha (GP) in the root canal. Almost two-thirds (126, 60.9%) of respondents believed the placement of a post and core with a ferrule design increased the fracture resistance of a root-canal-treated tooth. Most did not believe that a post would reinforce the tooth and reduce the chances of its fracture (178, 86.0%).

The type of luting cement used by respondents is shown in Table 5. Composite resin and resin modified glass ionomer cements (RMGIC) were routinely used to cement most posts. Zinc phosphate and polycarboxylate were not used by any respondents.

As shown in Table 6, the most commonly used material for constructing a core on a prefabricated post was composite resin. Gold was preferred by more than one-third of respondents (70, 37.4%) for a laboratory-fabricated cast post and core.

Discussion

This nationwide web-based survey was designed to determine the current approaches and preferred methods for the restoration of root-canal-treated teeth among NZ GDPs, and their views on post placement in different teeth. This is the first NZ study on this topic. Posts cemented with a glass ionomer-based or a composite resin cement was the chief finding. Ease of use was the key factor in selection of materials.

Traditional approaches used to assess the knowledge, views and attitudes of healthcare professionals have included face-to-face or telephone interviews and hardcopy questionnaires (Van Gelder et al., 2010). However, these approaches increasingly fail to generate qualitatively good results within financial parameters (Ekman and Litton, 2006). An electronic survey is one of the three most fundamental advances in survey technology in the twentieth century with most healthcare professionals having access to the web (Braithwaite 2003). Significant advantages of web-based surveys are the reduction of costs and time required for implementations, the high reliability of data collection and transfer into data analyzing programs and the rapid display of response rate (Greenlaw and Brown-Welty, 2009). A recognised limitation of web-based surveys is the relatively lower response rate than traditional modes of data collection and, unfortunately, the anonymous nature of a web-based survey does not allow for a reminder mechanism (Edward et al., 2009). Our response rate of 26.5% was low, however it fell within the expected 25-30% rate from an email survey (Kittleson, 1997) and was within the range reported by recent dental online studies, including some carried out in NZ (Azarpazhooh et al., 2013; Friedlander et al., 2015; Jeganath et al., 2016). A second limitation of this study was that a comparison of demographic data between responders and non-responders was not possible and therefore non-response bias could not be ruled out. However, with respect to age, gender, country of graduation and employment type, the sample appeared to be representative of NZ GDPs in 2015 (Dental Council NZ, 2017). An accurate comparison of respondents and the practising NZ GDP population presented difficulties as the data for “GDPs only” was not available in the Workforce Analysis for all categories. For this reason, Table 1 presents the data for all practising

Table 4 Post system preferences (brackets contain column percentages unless otherwise indicated).

Survey questions with options	
Which of the following prefabricated metallic posts do you usually use in your practice?	
ParaPost (Coltene)	136 (65.7)
Flexipost (Essential Dental Systems)	15 (7.2)
OP-PO (Optident)	7 (3.4)
Radix-Anchor (Dentsply)	2 (1.0)
Surtex (Dentatus)	1 (0.5)
Mirapost (Hager &Werken)	1 (0.5)
IntegraPost (Premier Dental)	1 (0.5)
I do not use prefabricated metallic posts	63 (30.4)
Which of the following prefabricated non-metallic posts do you usually use in your practice?	
RelyX (3M ESPE)	52 (25.1)
Luxapost (DMG)	36 (17.4)
ParaPost Fiber Lux (Coltene)	21 (10.1)
Radix Fiber Post (Dentsply)	19 (9.2)
Macro-Lock (RTD)	10 (4.8)
Rebilda Post (VOCO)	8 (3.9)
FRC Postec (IvovlarVivadent)	7 (3.4)
Optipost (Komet)	7 (3.4)
Unicore (Ultradent)	1 (0.5)
Achromat (Kerr)	1 (0.5)
I do not use prefabricated non-metallic posts	51 (24.2)
Why do you use your preferred posts chosen above?	
Ease of use	125 (60.4)
Reliability	99 (47.8)
Predictability	94 (45.4)
Cost	22 (10.6)
Availability	11 (5.3)
What sources do you use to get up-to-date information about the restoration of root canal treated teeth?	
Dental conferences/courses	173 (83.6)
Journals	164 (79.2)
Colleagues	102 (49.3)
Meetings	96 (46.4)
Internet	86 (41.5)
Textbooks	35 (16.9)

Note: The sum of positive responses does not equal 100% as more than one response was permitted.

GDPs and specialists. Statistical analysis showed that with respect to gender, age and employment type, the sample was representative (GDPs and specialists combined), but differed with respect to country of primary degree. The sample population has more NZ graduates and fewer overseas graduates than the 2015 NZ dentist and dental specialist workforce (P = 0.0001).

It has been recognised for decades that not all root-canal-treated teeth require a post, core and/or crown (Hussey and Killough, 1995). Posts are indicated when there is insufficient residual tooth to retain the core to support the coronal restoration (Morgano et al., 2004; Desai and Chandler, 2009; Manocci and Cowie, 2014). The majority of dentists (63.3%) used posts when restoring these teeth, and most of them did not believe that every root filled tooth should receive a post. Similar findings were found with GDPs in the USA (Morgano et al., 1994), Northern Ireland (Hussey and Killough, 1995), Germany (Naumann et al., 2006), and Saudi Arabia (Akbar, 2014).

Several studies have shown that the use of a root canal post does not increase the fracture resistance of the tooth (Guzy and Nicholls, 1979; Trope et al., 1985; Morgano, 1996; Heydecke et al., 2001). Conversely, the preparation of a post space and the placement of a post can weaken the root, may lead to root fracture, and could represent a risk of perforation. The majority of participants (86.0%) did not believe that a root canal post reinforced a root-canal-treated tooth and reduced the chance of root fracture. This is in agreement with studies in Northern Ireland (Hussey and Killough, 1995), Sweden (Eckerbom and Magnusson, 2001), and Switzerland (Kon et al., 2013), which reported figures of 75.0%, 71.0%, and 54.0%, respectively. However, in the USA (Morgano et al., 1994), Saudi Arabia (Habib et al., 2014) and Germany (Naumann et al., 2015), dentists have been more convinced of a reinforcing effect.

The ferrule is defined by the 360 degree reinforcing ring encircling the sound tooth structure apical to the margin of the core (Sorensen and Engelman, 1990; Stankiewicz and Wilson, 2002; Schwartz and Robbins, 2004). A number of studies have shown improved fracture resistance of root-canal-treated teeth with ferrules (Sorensen and Engelman, 1990, Stankiewicz and Wilson, 2002). The presence of a uniform 2 mm ferrule produces the most favourable resistance to tooth fracture and decreases the weakening effect of a post (Libman and Nicholls, 1995; Morgano, 1996; Shillingburg et al., 1997). It was pleasing to see that the majority of NZ respondents (60.9%) believed in the 'ferrule effect'. This finding was in agreement with studies from the USA (Morgano et al., 1994), Sweden (Eckerbom and Magnusson, 2001), Saudi Arabia (Habib et al., 2014) and Germany (Naumann et al., 2015).

The criteria on which GDPs base their decisions to choose either a custom-fabricated or a prefabricated post have been unclear (Fernandes et al., 2003; Bolla et al., 2007). The custom-fabricated cast post and core has been used for decades, with a survival rate of 90% over eight years (Jung et al., 2007). This alternative was the treatment of choice for 80.0% of Northern Ireland dentists (Hussey and Killough, 1995). Gold has been widely used as a cast post material due to its high biocompatibility, high corrosion resistance, and high rigidity. It was pleasing to see that many respondents (37.4%) chose gold as the alloy for cast post/cores. The predominant use of prefabricated posts by NZ GDPs correlates well with findings in the USA (Morgano et al., 1994), Sweden (Eckerbom and Magnusson, 2001), Switzerland (Kon et al., 2013), Saudi Arabia (Habib et al., 2014), Germany (Naumann et al., 2015) and Brazil (Onefre et al., 2015). The ParaPost is the metallic post system taught at the School of Dentistry at the University of Otago. However, there is a trend towards the use of dental materials with moduli of elasticity similar to dentine (Mannocci and Cowie 2014), with the modulus of a fibre post lower than that of a metal equivalent. The survey revealed that the materials preferred for prefabricated posts are dependent on tooth type. Many participants (47.8%) placed prefabricated metallic posts in molar teeth and glass-fibre posts in incisor teeth (43.5%).

The use of parallel-sided prefabricated posts was common among NZ participants (59.4%), similar to GDPs in the USA (Morgano et al., 1994) and Saudi Arabia (Habib et al., 2014). By contrast, GDPs in Sweden (Eckerbom and Magnusson, 2001) and Germany (Naumann et al., 2006) prefer to use tapered and screw-type posts respectively. Johnson and Sakumura (1978) and Standlee

Table 5 Type of luting cement used to cement post (brackets contain column percentages unless otherwise indicated).

	Incisors	Canines	Premolars	Molars
Cement				
Zinc phosphate	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Glass ionomer	41 (19.8)	44 (21.3)	52 (25.1)	53 (25.6)
Resin modified glass ionomer	77 (37.2)	82 (39.6)	73 (35.3)	73 (35.3)
Composite resin	83 (40.1)	75 (36.2)	73 (35.3)	70 (33.8)
Polycarboxylate	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Other	6 (2.9)	6 (2.9)	9 (4.3)	11 (5.3)

Table 6 Core material use with prefabricated posts (brackets contain column percentages unless otherwise indicated).

	Incisors	Canines	Premolars	Molars
Core Material				
Amalgam	0 (0.0)	0 (0.0)	25 (12.1)	58 (28)
Composite	189 (91.3)	190 (91.8)	164 (79.2)	123 (59.4)
Glass ionomer	5 (2.4)	3 (1.4)	5 (2.4)	9 (4.3)
Resin modified glass ionomer	9 (4.3)	10 (4.8)	11 (5.3)	12 (5.8)
Other	4 (1.9)	4 (1.9)	2 (1.0)	5 (2.4)

et al. (1978) reported that parallel-sided post designs are more retentive and produce less risk of root fractures than tapered posts. A tapered post conforms better to the natural root form and the canal configuration, thus permitting optimal preservation of tooth structure apically. It does, however, produce a wedging effect, with stress concentration at the coronal portion of the root and lower retentive strength, resulting in a lower success rate than with parallel-sided posts (Standlee et al., 1978; Sorensen and Martinoff, 1984). Among fibre posts, parallel-side designs have been shown to be more retentive than tapered shapes, although the physical features of these posts are less significant than those of metallic posts due to their greater reliance on bonding mechanisms (Qualtrough et al., 2003). The most popular fibre post in this survey was a tapered type.

Each clinical situation is unique, and root anatomy differs from tooth to tooth. Dentists should consider conditions such as root taper, proximal root invaginations, root curvatures and the angle of the crown to the root during the preparation of a post space in order to avoid perforation. It is generally accepted that post length should be equal to two-thirds of the length of remaining root, or that 3 to 6 mm of GP must be preserved to maintain the apical seal (De Cleen, 1993). More NZ GDPs (80.1%) left an appropriate amount of GP than those from Northern Ireland (3-4 mm, 23.0%: Hussey and Killough, 1995) and Saudi Arabia (3-5 mm, 53.5%: Akbar, 2014).

A 2014 survey of final year BDS students at the University of Otago found 43.9% to be either confident or very confident in post and core retained crown procedures with no gender difference noted (Murray and Chandler, 2016). The majority of users of posts (77.8%) in the present survey were confident when preparing a post space and it was interesting to note that males were significantly more confident.

Zinc phosphate cements have had a long history of success (Morgano, 2004) but decreased in popularity after the 1970s. While our NZ respondents did not use them at all, it was the preferred material by GDPs in earlier studies in Northern Ireland (Hussey and Killough, 1995) and Sweden (Eckerbom and Magnusson, 2001). That lack of popularity may be due to its high solubility in oral fluids and lack of true adhesion (Morgano, 2004). A recent review in Germany (Naumann et al., 2015) also showed a drastically decreased use of zinc phosphate and the increasing popularity of resin cements. Composite resin and RMGIC are the most popular materials used in NZ. They display good retention, less leakage and the ability to provide short-term strengthening of the root (Morgano, 2004). Studies have also shown that posts cemented with resin cement are more resistant to cyclic loading than those cemented with zinc phosphate or RMGIC (Junge at al., 1998). Nonetheless, it is a more technique sensitive, and steps must be performed quickly and carefully during cementation (Schwartz and Robbins, 2004), with all post cementation procedures isolated using a dental dam.

Most teeth require root canal treatment as a result of extensive caries, restorations or trauma, where a core build-up is necessary in teeth with insufficient structure to support the final restoration (Christensen 1996). Although amalgam has been used successfully for many years, composite resin was shown to be in common use in the current study. These findings are similar to those from the USA (Morgano et al., 1994), Sweden (Eckerbom and Magnusson, 2001) and Germany (Naumann et al., 2015), 45.0%, 68.0% and 75.0% respectively.

Composite resin is a popular core material because of its ease of use, aesthetics and the possibility of preparing and finishing it immediately (Fedorowicz et al., 2012). NZ GDPs never used amalgam for cores in incisors and canines. This may be due to unacceptable aesthetics, especially under the newer ceramic restorations.

Conclusion

This study has shown that, in the restoration of root-canal-treated teeth, NZ GDPs' practices are in line with treatment practices of dentists elsewhere. There are, however, possibilities for improvement, such as the incorporation of a ferrule whenever possible as part of preparation design and retaining an appropriate amount of GP at the root apex. Results of this study may be useful in provoking discussion and further teaching and research among GDPs regarding their current choices and beliefs in this area. We suggest that this could be an interesting and informative topic to be included in a national conference in the future.

Acknowledgment

The practitioners who took part in the survey are sincerely thanked. 3M Oral Care New Zealand kindly provided a participation incentive for this study.

Authors

Samson Looi, BDS
Sir John Walsh Research Institute, Faculty of Dentistry, University of Otago

Khun Rui Chua, BDS
Sir John Walsh Research Institute, Faculty of Dentistry, University of Otago

Colleen Murray, BChD (Hons), BDS, PGDipClinDent, BEd (corresponding)
Department of Oral Rehabilitation, Faculty of Dentistry, University of Otago

Nicholas Chandler, BDS (Lond) MSc (Manc) PhD (Lond) LDSRCS (Eng) MRACDS (Endo) FDSRCPS (Glas) FDSRCS (Edin) FFDRCSI
Department of Oral Rehabilitation, Faculty of Dentistry, University of Otago

References

Akbar I (2014). Endodontically treated teeth by dentists in Northern Saudi Arabia. *Europ Scientific J* 10: 39-50.

Azarpazhooh A, Dao T, Figueiredo R, Krahn M, Friedman S (2013). A survey of dentists' preferences for the treatment of teeth with apical periodontitis. *J Endod* 39: 1226–1233.

Baba NZ (2013). *Contemporary Restoration of Endodontically Treated Teeth.* Chicago: Quintessence Publishing Co, Inc.

Baba NZ, Goodacre CJ (2014). Restoration of endodontically treated teeth: contemporary concepts and future perspectives. *Endod Topics* 31: 68-83.

Bolla M, Muller-Bolla M, Borg C, Lupi-Pegurier L, Laplanche O, Leforestier E (2007). Root canal posts for the restoration of root filled teeth. *Cochrane Database of Systematic Reviews* 1: CD004623.

Braithwaite D (2003). Using the internet to conduct surveys of health professionals: a valid alternative? *Family Practice* 20: 545–551.

Christensen GJ (1996). Posts: necessary or unnecessary? *J Amer Dent Assoc* 127: 1522-1526.

Dammaschke T, Nykiel K, Sagheri D, Schäfer E (2013). Influence of coronal restorations on the fracture resistance of root canal-treated premolar and molar teeth: A retrospective study. *Aust Endod J* 39: 48-56.

DeCleen MJ (1993) The relationship between the root canal filling and post space preparation. *Int Endod J* 26: 53-58.

Dental Council (NZ) Dental Council Workforce Analysis 2013-2015. July 2017.

Desai S, Chandler N (2009). The restoration of permanent immature anterior teeth, root filled using MTA: A review. *J Dent* 37: 652-657.

Eckerbom M, Magnusson T (2001). Restoring endodontically treated teeth: A survery of current opinions among board-certified prosthodontists and general dental practitioners in Sweden. *Int J Prosthodont* 14(3): 245-249.

Edwards P, Roberts I, Clarke M, DiGuiseppi C (2009). Methods to increase response to postal and electronic questionnaires. *Cochrane Database of Systematic Reviews* 3: MR000008

Ekman A, Litton JE (2006). New times, new needs; epidemiology. *Europ J Epidemiol* 22: 285–292.

Fedorowicz Z, Carter B, de Souza RF, Chaves CA, Nasser M, Sequeira-Byron P (2012). Single crown versus conventional fillings for the restoration of root filled teeth. *Cochrane Database of Systematic Reviews* 5: CD 009109.

Fernandes AS, Shetty S, Coutinho I (2003). Factors determining post selection: A literature review. *J Prosthet Dent* 90: 556–556.

Friedlander L, McElroy K, Daniel B, Cullinan M, Hanlin S (2015). Direct pulp capping of permanent teeth in New Zealand general dental practice: A practice based research study. *N Z Dent J 111*: 58-64.

Greenlaw C, Brown-Welty S (2009). A comparison of Web-based and paper-based survey methods testing assumptions of survey mode and response cost. *Eval. Rev* 33: 464–480.

Guzy GE, Nicholls JI (1979). In vitro comparison of intact endodontically treated teeth with and without endo-post reinforcement. *J Prosthet Dent* 42: 39-44.

Habib SR, Rifaiy MQA, Alkunain J, Alhasan M, Albahrani J (2014). Concepts of restoring endodontically treated teeth among dentists in Saudi Arabia. *Saudi J Dent Res* 5: 15-20.

Heydecke G, Butz F, Strub JR (2001). Fracture strength and survival rate of endodontically treated maxillary incisors with approximal cavities after restoration with different post and core systems: An in-vitro study. *J Dent* 29: 427-433.

Hussey DL, Killough SA (1995). A survey of general dental practitioners' approach to the restoration of root filled teeth. *Int Endod J* 28: 91-94.

Jeganath J, Wong A, Chandler N, Murray C (2016). New Zealand general dentists' usage and views on caries detection methods. *NZ Dent J* 112: 81-87.

Johnson JK, Sakumura JS (1978). Dowel form and tensile force. *J Prosthet Dent* 40: 645-649.

Jung R E, Kalkstein O, Sailer I, Roos M, Hämmerle C H (2007). A comparison of composite post buildups and cast gold post-and-core buildups for the restoration of nonvital teeth after 5 to 10 years. *Int J Prosthodont* 20: 63–69.

Junge T, Nicholls JI, Philips KM, Libman WJ (1998). Load fatigue of compromised teeth: A comparison of 3 luting cements. *Int J Prosthodont* 11: 558-564.

Kittleson M (1997). Determining effective follow-up of e-mail surveys. *Am J Health Behavior* 21: 193-196.

Kon M, Zitzmann NU, Weiger R, Krastl G (2013). Postendodontic restoration: A survey among dentists in Switzerland. *Schweiz Monatsschr Zahnmed* 123: 1076–1088.

Libman WJ, Nicholls J1 (1995). Load fatigue of teeth restored with cast posts and cores and complete crown. *Int J Prosthodont* 8: 155-161.

Mannocci F, Cowie J (2014). Restoration of endodontically treated teeth. *Br Dent J* 216: 341-346.

Morgano SM, Hashem AF, Fotoohi K, Rose L (1994). A nationwide survey of contemporary philosophies and technique of restoring endodontically treated teeth. *J Prosthet Dent* 72: 259-267.

Morgano SM (1996). Restoration of pulpless teeth: Application of traditional principles in present and future contexts. *J Prosthet Dent* 75: 375-380.

Morgano SM, Rodrigues AHC, Sabrosa CE (2004). Restoration of endodontically treated teeth. *Dent Clin N Amer* 48: 397-416.

Murray C, Chandler N (2016). Final year dental students in New Zealand: Self-reported confidence levels prior to BDS graduation. *NZ Dent J* 122: 116-121.

Naumann M, Kiessling S, Seemann R (2006). Treatment concepts for restoration of endodontically treated teeth: A nationwide survey of dentists in Germany. *J Prosthet Dent* 96: 332-338.

Naumann M, Neuhaus KW, Kölpin M, Seemann R (2015). Why, when, and how general practitioners restore endodontically treated teeth: A representative survey in Germany. *Clin Oral Investig* 20: 253-259.

Onofre RF, Cenci TP, Opdam NJ, Demarco FF (2015). Preference for using posts to restore endodontically treated teeth: Finding from a survey with dentists. *Braz Oral Res* 29: 1-6.

Qualtrough AJE, Chandler NP, Purton DG (2003). A comparison of the retention of tooth-colored posts. *Quintessence Int* 34: 199-201.

Schwartz RS, Robbins JW (2004). Post placement and restoration of endodontically treated teeth: A literature review. *J Endod* 30: 289-301.

Shillingburg HT, Hobo S, Whitsett LD, Jacobi R, Brackett SE (1997). Fundamentals of Fixed Prosthodontics 3rd edition: Preparation of Extensively Damaged Teeth. Chicago: Quintessence, pp. 191.

Sorensen JA, Engelman MJ (1990). Ferrule design and fracture resistance of endodontically treated teeth. *J Prosthet Dent* 63: 529–536.
Sorensen JA, Martinoff JT (1984). Clinically significant factors in dowel design. *J Prosthet Dent* 52(1): 28-35.
Standlee JP, Caputo AA, Hanson EC (1978). Retention of endodontic dowels: Effects of cement, dowel length, diameter, and design. *J Prosthet Dent* 39: 401-405.
Stankiewicz NR, Wilson PR (2002). The ferrule effect: A literature review. *Int Endod J* 35: 575–581.
Trope M, Maltz DO, Tronstad L (1985). Resistance to fracture of restored endodontically treated teeth. *Endod Dent Traumatol* 1: 108-111.
Van Gelder MMHJ, Bretveld RW, Roeleveld N (2010). Web-based questionnaires: The future in epidemiology? *Amer J Epidemiol* 172: 1292–1298.
Vernazza CR, Steele JG, Whitworth JM et al. (2015) Factors affecting direction and strength of patient preferences for treatment of molar teeth with nonvital pulps. *Int Endod J* 48: 1137-1146.

Letter to the Editor

Re: Keratocystic Odontogenic Tumours: Three case reports outlining treatment of large lesions using decompression followed by surgical enucleation NZDJ 114: 29-34 2018

It is always interesting to see cases illustrating pathology of the oral and maxillofacial area in the pages of the Journal, since the vast majority of these lesions are seen initially by general dental practitioners, before being referred on for diagnosis and further management. However, it is important to ensure the current terminology is used. In 2017 the 4th edition of the WHO Classification of Head and Neck tumours was released and in this the term keratocystic odontogenic tumour was removed (El-Nagger et al 2017). This lesion reverts to its original title of odontogenic keratocyst (OKC). This is important as its former status as a benign tumour has ramifications for management which have not really been supported. The genetic alterations seen in OKC and used to make the argument for its classification as a tumour have also been detected in a number of innocuous lesions (Wright & Vered 2017) and the recurrent rates, with current treatment regimens, are not excessive (Speight & Takata 2017).

We acknowledge that this article was submitted in 2016, and accepted in Sept 2017.

Yours sincerely,
Alison Rich, Haizal Hussaini, Benedict Seo
Oral Pathology Centre, University of Otago

References

El-Nagger AK et al. ed. WHO Classification of Head and Neck Tumours. 4th ed Lyon IARC 2017
Speight PM, Takata T. New tumour entities in the 4th edition of the World Health Organization classification of head and neck tumours. Virchows Arch doi10.1007/s00428-017-2182-3 2017
Wright JM, Vered M. Update from the 4th edition of the World Health Organization classification of head and neck tumours. Head Neck Pathol 11: 68-77 2017