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An Audit of the Quality of Root Canal Treatments Performed by Undergraduate Dental Students on Single-rooted Teeth in Glasgow Dental Hospital and School

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Abstract - *The aim of this investigation was to assess the technical quality of root canal treatments performed by undergraduate dental students on single rooted teeth at the Glasgow Dental Hospital and School. One hundred radiographs of single rooted teeth that had root canal treatment were randomly selected and examined under even illumination in a darkened room using x2 magnification. Of 100 teeth, 20 had voids, and one was perforated. The remaining 79 teeth were assessed using predetermined criteria, and 80% (n=63) were judged to be 'acceptable', 5% (n=4) were 'under-filled', and 15% (n=12) were 'over-filled'. The quality of root canal fillings performed in single rooted teeth by undergraduate dental students at the Glasgow Dental Hospital and School was found to comparable to, or better than, that reported from other international institutions.*

KEYWORDS: Undergraduate, Endodontics, Quality, Root treatment, Radiographic.

INTRODUCTION

Provision of high quality root canal therapy is essential when managing pulpal or periapical disease[1]. It is a treatment that general dental practitioners are regularly called upon to perform, and is a recognised competency in contemporary dental education[2]. Root canal therapy is a predictable form of dental treatment with reported success rates as high as 94%[3,4]. It is usually performed in three stages. First, the neurovascular tissues are removed from the root canal system, following which the root canal system is shaped and cleaned of all infective and pro-inflammatory material, and then obturated. The purpose of the root canal obturation is to seal the root canal system in order to prevent micro organisms from entering and re-infecting it. The obturation may also 'entomb' any residual bacteria and prevent the percolation of tissue fluids back into the root canal system that could provide a culture medium for their growth[5]. Some authors have found an association between the quality of obturation and the subsequent survival of the root canal filled tooth[4-11] . However, it has also been shown that even if the canals are not obturated, there can be clinical signs of success[12].

Contemporary educational guidelines define the competencies that undergraduate dental students are expected to achieve in the field of endodontics. The General Dental Council document, 'The First Five Years' states, "dental students on graduation must be competent in non-surgical [endodontic] treatment of single-rooted and multi-rooted teeth"[13]. The European Society of Endodontology has produced 'Undergraduate Curriculum Guidelines for Endodontology', which advises that new graduates must '…demonstrate satisfactory non-surgical root canal treatment of single-rooted and multi rooted teeth …[including]… obturation of the root canal system…[1]. The Association for Dental Education in Europe has recently published guidelines to promote the harmonisation of dental education in Europe. These state that new graduates must "be competent to perform endodontic treatment on uncomplicated single and uncomplicated multi-rooted teeth"[2]. Despite the existence of these guidelines there is evidence that the technical quality of root canal treatments completed in general dental practice is less than ideal[14-16]. It has been suggested that this inadequacy is a reflection of insufficient clinical and didactic teaching during undergraduate dental degree programmes[17]. Recent surveys have highlighted that there is less teaching of endodontics in the United Kingdom than in other countries in Western Continental Europe, Scandinavia or the USA[18,19].

There is a tendency for general dental practitioners not to perform root canal treatments on multi-rooted teeth, but instead to refer these to specialist practitioners in endodontics. General dental practitioners therefore tend to perform more root canal treatments on single-rooted teeth than on multi-rooted teeth. There is significant government expenditure to support the provision of root canal treatments in a primary dental care setting. For example, in Scotland, over £5 million was spent in the year ending March 2005 for the provision of root canal treatments in single rooted teeth under the terms of the General Dental Services Act[20]. There are no data available pertaining to the amount of money spent by patients for similar private

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treatments.

Given this significant investment, it is important to examine the effectiveness of implementation of educational guidelines, with a view to improving the quality of such treatment in general dental practice. The aim of this study, therefore, was to assess the radiographic quality of root canal fillings performed by undergraduate dental students in Glasgow on single rooted teeth.

MATERIALS AND METHODS

This study was performed as an audit, the aim of which was to improve the quality of endodontic care at Glasgow Dental Hospital and School. Utilising student records, case notes of those patients who underwent root treatment by undergraduate dental students in the Glasgow Dental Hospital and School in 2003-2004 were retrieved. The inclusion criteria for this selection were:

- each case had to include root canal treatment completed on a single-rooted tooth
- each treatment was completed by a different undergraduate dental student

These case notes were reviewed and further inclusion criteria were applied:

- a post obturation radiograph was present
- the post obturation radiographs had been taken using a long cone/paralleling technique
- the post obturation radiograph showed the entire length of the root and the periapical area

Following this process, the first 100 case notes to meet the above criteria were selected for investigation. The academic stage of the student operator could be deduced from the academic year list related to the date of treatment completed. The radiographs under investigation were examined with even illumination in a darkened room at x2 magnification by two observers. All information was collected in anonymised form, examiners were blinded as to the identity of the patients involved. The classification system used by Lynch & Burke in a recent study were applied[21], namely root canal fillings were classified according to the relationship of the root canal filling to the apex of the tooth. A transparent ruler was used to assess the distance between the end of the root canal filling material and the radiographic apex of the tooth.

Root canal fillings were classified as:

- 'Acceptable': the root canal filling material is within the root canal system and within 2 mm of the radiographic apex;
- 'Under-filled': the root canal filling material is >2mm short of the radiographic apex;
- 'Over-filled': the root canal filling material is extruded beyond the radiographic apex.

From the radiographs, the presence of fractured instruments, voids, or perforations was noted. The obturation technique was recorded from the case notes. The selection of a distance from the apex of 2mm or less and of adequate density of the root canal filling is based on previous studies [11,14,22-24]. Given the relatively small sample size, descriptive statistics are reported.

RESULTS

The types of teeth examined in this investigation are shown in Table 1. Seventy-three teeth were maxillary, and twenty-seven were from the mandibular. The most common tooth was the maxillary lateral incisor (n=29), followed by the maxillary central incisor (n=18).

All canals had been prepared using a balanced force technique, and canals were obturated using cold lateral compaction with gutta percha and sealer. There was no evidence of fractured instruments. One tooth had a perforation (1%) (tooth 43), and twenty teeth (20%) had voids present within the root canal filling (Table 2). Of the remaining 79 teeth, 63 (80%) were classified as being 'acceptable', 4 (15%) were classified as being 'under-filled', and 12 (15%) were classified as being 'over-filled' (Table 3).

The root canal treatments had been carried out by thirty-five students in their fourth year and sixty-five students in their fifth year. Chi-squared testing revealed no significant differences in the quality of treatment performed by either 4th or 5th year dental students.

DISCUSSION

Studies published in the international literature have shown that the technical standard of root canal treatment completed by general dental practitioners is often less than ideal. One study [25] stated that only 10% of root canal treatments carried out by general dentists under the terms of the UK National Health Service fulfilled criteria for standards of care as defined by the European Society of Endodontology[5]. There are various possible reasons for this, but they generally centre on financial or educational concerns.

It has been implied that financial concerns directly affect the quality of root treatments performed by general dental practitioners under the terms of the General Dental Services Act. Some suggest that if the level of remuneration for the general dental practitioner was increased, so then would the quality of treatment. This may not be an entirely valid argument, as investigations by McColl *et al*.[26] have found that increasing the degree of remuneration for endodontic treatment alone may not lead to an increase in quality. Furthermore, borrowing from another field within restorative dentistry, investigations into the quality of prescription and fabrication of fixed and removable prosthodontics in general dental practice, found that the remunerative scheme (i.e. 'private' or 'NHS') may not be as related to increased quality as educational factors[27-29,36]. The chief criticism of educational factors is that there is insufficient exposure to root canal therapy at an undergraduate level. As previously mentioned, there is less teaching of preclinical and clinical undergraduate endodontics in the UK compared to other countries such as the USA, Western Continental Europe, and Scandinavia[19]. Studies of undergraduate curricula in endodontics in the United Kingdom have commented on the limited time available for teaching of root canal treatment, poor staff to student ratios, and the lack of specialist endodontists as clinical teachers[18,19,30]. These studies have shown that whilst in other countries teaching of undergraduate endodontics is performed by specialist endodontists, in the United Kingdom the subject is normally taught by academic consultants with a special

Table 1. *Distribution of teeth examined in this sample.*

Tooth type	*N*
Maxillary central incisors	18
Maxillary lateral incisors	29
Maxillary canines	16
Maxillary second premolars	10
Mandibular central incisors	3
Mandibular lateral incisors	7
Mandibular canines	5
Mandibular first premolars	4
Mandibular second premolars	8
Total	100

Table 2. *Occurrence of voids.*

Tooth type	*n*	*%*
Maxillary central incisors	7	35
Maxillary lateral incisors	6	30
Maxillary canines	3	15
Maxillary second premolars	2	10
Mandibular central incisors	0	0
Mandibular lateral incisors	0	0
Mandibular canines	0	0
Mandibular first premolars	1	5
Mandibular second premolars	1	5
Total	20	100

Table 3. Assessment of root canal obturation for those teeth without voids or perforations

Tooth Type	*'Acceptable'*		*'Under-filled'*		*'Over-filled'*		*Total*
	n	*%*	*n*	*%*	*n*	*%*	
Maxillary central incisor	9	82	1	9	1	9	11
Maxillary lateral incisor	17	74	1	4	5	22	23
Maxillary canine	11	84	1	8	1	8	13
Maxillary second premolar	8	100	0	0	0	0	8
Mandibular central incisor	2	67	0	0	1	33	3
Mandibular lateral incisor	5	72	1	14	1	14	7
Mandibular canine	3	75	0	0	1	25	4
Mandibular first premolar	3	100	0	0	0	0	3
Mandibular second premolar	5	71	0	0	2	29	7
Total	63	80%	4	5%	12	15%	79

interest in endodontics, accompanied by part-time teachers who are usually general dental practitioners [18,19,30]. Possibly arising from this, there is evidence to show that vocational trainees lack confidence when performing root canal treatments[31]. A survey in the United Kingdom in 1999 reported that 20% of complaints against new graduates related to root canal treatments[32]. There seems to be a departure from the principles of 'good practice' learned by dental students in endodontics at dental school once they enter independent dental practice[33,34]. Perhaps increasing the number of postgraduate learning opportunities such as courses and workshops would help general dental practitioners maintain and develop skills.

The results of this investigation have found that 63% of single-rooted root canal fillings performed by undergraduate students were of acceptable length and without voids, perforations, or fractured instruments. An audit of the technical quality of root canal treatments performed by undergraduate students in Wales showed that 13% were considered adequate [17]. A similar study performed in Jordan found that 47.4% of root canal fillings performed by undergraduate students were inadequate[35]. However, these two studies included multi-rooted teeth in their sample. A recent similar study by Lynch & Burke of single-rooted root canal fillings also found that 63% of these were of 'acceptable' length and without voids, perforations, or fractured instruments[21].

In Glasgow Dental Hospital and School, undergraduate

students receive thirty-two hours of teaching on endodontics in their preclinical year; five hours of lectures, and twenty-seven hours of laboratory "phantom head" practice. In addition, in their fourth year, undergraduate students receive four dedicated endodontic tutorials, while fifth in year fortnightly tutorials on endododontics, are provided preceding specialist clinics. This compares favourably with the other UK institutions that have on average eight hours of lectures (although this ranged from two to fourteen hours throughout the UK) [18]. The current staff to student ratio in the preclinical laboratory ('phantom head') is 12:1. The amount of pre-clinical laboratory teaching in Glasgow (32 hours) compares favourably with the amount of pre-clinical teaching in Eastern Europe (16 hours), and the rest of the UK (24 hours). However it is less than Western Continental Europe (38 hours), North America (41 hours) and Scandinavia, where undergraduate students receive 66 hours of pre-clinical laboratory training in endodontics[18]. The staff to student ratio for the pre-clinical laboratory course in Glasgow is 1:12, which is inkeeping with the UK average, although less than in Scandinavia (1:9), North America (1:9), and Western Continental Europe (1:8) [18].

All final year students have one clinic every two weeks under the close supervision (staff: student ratio 1:7) of an endodontic specialist. In these clinics the students have a one hour tutorial on endodontics followed by patient treatment. This corresponds well with worldwide undergraduate teaching supervision, and very favourably with the UK institutions where there is a lack of specialists involved in teaching[18]. The benefit of having specialist teaching staff in these clinics has been highlighted by Dummer[30]. He noted that staff with advanced specialist training invariably provide a higher and more uniform standard of teaching than generalists. The latter may be less well grounded in the literature and have less clinical experience of the discipline[19].

There are a number of limitations to this current audit. The study was based on only 100 non-random cases based on an audit of clinical practice notes. A more statistically robust approach would have perhaps added a greater degree of confidence in the accuracy of our findings. Secondly, the audit aimed to examine the quality of obturation by radiographic analysis. This is not entirely reflective of the quality of the treatment since it is a two dimensional image of a three dimensional structure and is not directly indicative of quality of disinfection. However, when a patient presents for an endodontic opinion, often the radiograph is key to assessing previous root canal treatment quality.

Thirdly, distinction was not made as to whether cases were re-root treatment or *de novo* cases. A high proportion of the cases seen on the undergraduate clinic are re-root treatments as many patients are referred from general dental practitioners via the consultant clinic following endodontic failure. This would perhaps suggest a greater degree of case complexity and may well have an impact on the overall success rate.

Finally, as this was a retrospective study in a secondary care facility, patients would be commonly referred back to their general dental practitioner. This means that we have little longitudinal follow-up data on success rates.

Glasgow Dental School is in the process of introducing a completely new undergraduate curriculum. One of the modifications to the present curriculum will be an increased focus on endodontology to reflect the increased quantity of root canal treatment performed in general dental practice. It is hoped that this will result in increased quality of root canal treatments performed by the undergraduate students within the dental hospital and subsequently throughout their careers. In time it is hoped that this increased teaching would result in better quality root canal treatment within general dental practice. Effectively, the duration and staff: student ratios for undergraduate teaching of endodontics at Glasgow, which are above current UK averages, are being revised to move closer to current international trends in dental edutcation.

The current teaching time and supervision for undergraduate endodontics is above the U.K. average and is being revised to keep it in line with the current undergraduate international standards.

Measuring the impact of these changes on the quality of root canal treatments carried out by general dental practitioners as a whole is a difficult challenge. This would require significant resources and an emphasis on study design to capture longer-term impacts of root canal treatment, as well as greater attention to research design and methodology.

CONCLUSION

This study has shown that in Glasgow Dental School, 63% of root canal treatments carried out on single rooted teeth by undergraduates were obturated to an appropriate length with no voids, perforations or fractured instruments.

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