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Magnification in undergraduate endodontics teaching in the UK and Ireland: a survey of teaching leads in Endodontology

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Abstract

Aim To investigate the use of magnification in undergraduate endodontic teaching in dental schools within the UK and Ireland and identify factors that may impact on levels of adoption.

Methodology An electronic questionnaire was distributed to teaching leads in undergraduate endodontics in all UK and Ireland dental schools.

Results Completed questionnaires were received from 15 of 18 course leads. The study revealed magnification is not universally embedded within the undergraduate curricula and the majority of schools had no expectation for students to use magnification, although it was encouraged. The study provided insight into teaching staff factors, student factors and institutional factors that impact upon the adoption of magnification in undergraduate endodontic teaching. Although course leads utilised magnification in their own practice, this did not translate into institutional expectation for students to use magnification. Barriers to adoption of such an institutional expectation included cost and lack of staff training.

Conclusions Magnification has become viewed as an essential part of endodontic practice. The dental operating microscope has the most significant impact on endodontic visualisation, however, the use of dental loupes in non-surgical endodontics could be considered the minimum standard. The pedagogical dilemma faced by dental educators training undergraduates to behave in a manner that they themselves would not, cannot be rationalised on the basis of cost and lack of staff training. It is proposed that although significant, these barriers are not insurmountable and dental loupe use should become an expectation in undergraduate training in the UK and Ireland.

Introduction

Magnification has become viewed as an essential part of endodontic practice. It is clear from studies exploring the adoption of magnification in specialist practice that a significant shift has occurred. Studies of the use of the dental operating microscope (DOM) in specialist endodontic practice in the United States revealed an increase in use from 52% in 1999 (Mines *et al.* 1999) to 90% in 2007 (Kersten *et al.* 2008). It has more recently been stated by the American Association of Endodontists (AAE) in a position statement on the use of microscopes and other magnification techniques, that they anticipate that the percentage of DOM use in specialist practice will reach 100% (AAE 2012). They also define their position "that the microscope is an integral and important part of the performance of modern endodontic techniques". In part, the driving force behind such a radical change in practice has been education. The AAE has been a strong advocate for the integration of the microscope into specialist programmes through its support of incorporation of this standard into the Commission on Dental Accreditation (CODA) accreditation standards for advanced Speciality Education Programs in Endodontics.

In a general practice setting the use of magnification looks somewhat different, both in terms of frequency of use and the form of magnification employed, with dental loupes being favoured over the DOM. In a study of the use of magnification in a general practice setting in Scotland in 1999 only 9% of respondents routinely used magnification (Forgie *et al.* 1999). This has changed somewhat over the past few decades. In a more recent study, again looking at a British cohort, 44% of dental vocational trainers used loupes (Farook *et al.* 2013). In contrast only 28% of their trainees were using loupes. Of course this study population comprised of dental vocational trainers, may not be representative of the general dental practitioner in the UK.

One may ask what the barriers are for the introduction of magnification into practice and more specifically endodontic practice within a general practice setting. As evidence based practitioners we are constantly being asked to support our decisions with evidence, and ideally evidence of improved outcomes. It is with this in mind, that adoption of magnification hits its first hurdle. There is very little evidence to suggest improved outcomes when magnification is used. In a Cochrane Review of magnification and its effect on outcomes of endodontic therapy no articles were identified that met criteria for inclusion (Del Fabbro *et al.* 2015). The authors stated that it remained unknown if magnification affects outcome. This is in contrast to a previous meta-analysis of the literature that determined that the use of the DOM in surgical endodontics improved outcomes when compared with the use of loupes or unaided vision (Setzer *et al.* 2012). Despite the apparent sparsity of evidence of improved outcomes, it should be recognised that an evidence-base for practice is often very limited and as techniques advance so rapidly it becomes exceptionally difficult to perform and report prospective clinical trials. As highlighted previously,

DOM use amongst endodontists is almost universal, the benefits perceived by users being substantial. It would be unethical to carry out clinical trials to determine if DOM use has an impact upon outcomes.

When considering loupes alone, there are no studies to suggest improved outcomes. However, there are a small group of studies that have examined the effect of using loupes on the detection of root canal anatomy, identification of cracks, caries detection, detection of marginal discrepancies and cavity preparation. When considering aspects of endodontic practice, few studies exist. In a study exploring the use of magnification in detection of a second mesiobuccal (MB2) canal in maxillary first molars, the frequency of detection for the DOM, dental loupes, and no magnification groups was 71.1%, 62.5%, and 17.2%, respectively (Buhrley *et al.* 2002). Despite the DOM conferring a greater ability to detect the MB2 canal, it is clear that dental loupes also provide a significant advantage. In further support of the use of dental loupes in endodontic practice, in a study examining the effect that magnification has on vision in endodontics, it was demonstrated that although loupes with a light source could not provide any advantage in attempting to visualise root canals, dentists below 40 years of age could detect a canal orifice 0.06mm in diameter (Perrin *et al.* 2014). Possibly unsurprisingly, this advantage did not extend to dentists over this age, instead these practitioners relied upon the DOM to obtain a similar impact on vision. It is beyond dispute that identifying and thus treating the major anatomy of the root canal system is desired and thus improved visualisation would have its merits. The impact on the use of magnification to aid the detection of cracks in resected roots has also been explored (Slaton *et al.* 2003). Un-aided vision, dental loupe use, DOM use and Orascope use were examined. Despite a trend towards improved accuracy for ever increasing magnification, the sensitivity, specificity, and accuracy of identifying root-end cracks were stated to be lower than expected by the authors. Although the study suggested loupes improved accuracy over un-aided vision, this did not reach statistical significance.

From the preceding, the use of magnification would appear to confer an advantage in endodontic treatment. Although the use of the DOM has the most significant impact on endodontic visualisation, the use of dental loupes in non-surgical endodontics would seem at least the minimum standard. Surprisingly, despite this, as evidenced in the previously discussed surveys it is clear that magnification, whether DOM or dental loupes, has not been universally adopted in general practice settings. From the experiences in the United States in specialist training and the impact changes in education have clearly had on the integration of magnification into specialist practice, it could be suggested that exposure to magnification in undergraduate education may improve rates of adoption of magnification in the general practice setting.

The authors recognise the lack of specific guidance or indeed a position on the use of magnification in undergraduate endodontic education in the UK. In light of this and to inform the development of a position statement the aim of the present study was to explore the use of magnification in endodontic teaching in Dental Schools within the UK and Ireland and identify factors that may impact on levels of adoption.

Materials and methods

An electronic questionnaire was designed and distributed to teaching leads in undergraduate endodontics in the UK and Ireland. The questionnaire was designed to explore the use of magnification in undergraduate endodontic teaching (Table 1). A total of 18 course leads were contacted in 2018. Those contacted were members of the British Endodontic SocietyTeachers in Endodontology Group and represented all 18 dental schools throughout the UK and Ireland. Ethics approval was sought and received (University of Glasgow, College of Medical Veterinary and Life Sciences, Research Ethics Application number 200180011).

Results

Response

Completed questionnaires were received from 15 of the 18 course leads (83% response rate).

Course leads demographics

The respondents represented a somewhat diverse group when it came to the number of years post-qualification. The range of years of qualification were 1982-2012. The teaching leads were not exclusively registered as endodontic specialists, with two respondents not included in a Specialist Register. The course leads were asked to indicate the proportion of time they spend carrying out endodontic procedures (Figure 1). Two-thirds of respondents stated that they spend 50% or more of their time performing endodontic procedures.

Course leads use of magnification in endodontic clinical practice

Course leads were asked to state how often they used magnification in their own clinical practice of endodontics. All respondents reported using magnification for some or all procedures. The majority (87%) stated that they always use the dental operating microscope whilst performing endodontic procedures. The remainder reported using it for some procedures. The use of dental loupes was also explored, and for those that did not use the dental operating microscope exclusively then loupes were used.

Course leads were asked to indicate the reasons for their use of magnification in endodontic practice (Figure 2). All respondents cited improvements in vision and quality of work as reasons for use of magnification. Improved ergonomics (87%) and prevention of eye strain/fatigue (53%)

were also reported as motivating factors for the use of magnification. When asked about formal training on magnification that they had received, only 60% could recall having received such instruction.

Course leads teaching practice

Course leads were then asked to describe aspects of their teaching practice. Firstly, they were asked to state whether they were aware of the current European Society of Endodontology (ESE) curriculum guidelines regarding magnification. Sixty percent were aware of these. The remaining respondents either were unsure or unaware of these guidelines on the use of magnification in undergraduate teaching. The study cohort were asked to state the amount of time spent teaching endodontics. The majority (73%) committed more than a quarter of their teaching time to endodontics.

Institutional engagement with magnification

When questioned about their institutional policies and course curricula the 53% of course leads stated magnification was part of the official endodontic curriculum. When questioned about whether they thought magnification should be part of the official curriculum for undergraduate teaching 87% stated that it should be, the remainder were unsure.

Undergraduates were not expected to use loupes in 87% of institutions. However, in all institutions, students were encouraged to use magnification during endodontic procedures. When asked at what stage magnification is encouraged, 50% stated that it was not until the later years that this was done. Only a third encouraged it during clinical skills training.

All schools have dental operating microscopes available for use by undergraduates. In 53% of schools these are available in pre-clinical skills. All schools have them available chairside on teaching clinics.

Barriers to the use of magnification in undergraduate endodontic teaching

Course leads were asked to consider the potential barriers to adoption of magnification in the teaching of undergraduate endodontics (Table 2). Several respondents cited cost and staff training as barriers. Eighty percent of course leads highlighted that mechanisms were in place to facilitate the personal use of magnification for undergraduate use. These include availability of loupe samples for use in clinical techniques and arranging opportunities for loupe suppliers to meet with the students.

Other comments

Respondents were asked to provide any other comments on the use of magnification in undergraduate endodontic teaching. The statements made addressed issues of staff training ("We need to train all clinical supervisors then incorporate formally into curriculum"), an indication that some schools have invested heavily in making magnification available ("We have invested

heavily in magnification. There is always DOM availability for students, and not just for endo."), also the level of student engagement with loupe purchase and the perceived benefits. ("All students have the opportunity to use loupes during clinical skills update course in year 4. They can purchase but rarely do so. My feeling is that those who do have loupes appreciate better light as much as anything and are usually streets ahead of the others.")

Discussion

As stated previously, the benefits of magnification in endodontics in the form of the DOM is without dispute. One could argue that this is the gold standard for vision in endodontics. However, it is clear that the majority of practitioners in a general practice setting would not have access to such facilities. Therefore, it may be more appropriate to consider the question - what is the minimum standard of vision in endodontics? It is apparent from the preceding review of endodontic visualisation that there are several clear advantages to the use of dental loupes in endodontics. It would not seem inappropriate to propose that the minimum standard of vision should therefore be dental loupes. It is clear however, that current levels of adoption of dental loupes within the UK is at present limited. Farook *et al.* (2013) had identified that despite some 44% of dental vocational trainers using dental loupes, only 10% had used loupes whilst they were trainees. Although the authors had also established that there had been an increase in trainee use compared to that of the trainers during their own training period, the numbers were still relatively low, and most had only adopted loupe use close to commencing their training posts. The authors stated that the continued poor uptake of dental loupes may reflect a lack of understanding and exposure to magnification during undergraduate education.

The ESE in their Undergraduate Curriculum Guidelines for Endodontology, set out that students should "Have knowledge of the benefits and use of magnification and enhanced illumination in endodontic practice" (ESE 2013). The terms used within the ESE guidelines follow those adopted by the Association for Dental Education in Europe (ADEE) in their Profile and Competencies of the Graduating European Dentist (Cowpe *et al.* 2010). Thus, given the terms applied to magnification, it is suggested that upon graduation the student should be able to demonstrate a sound theoretical knowledge and understanding of the use of magnification, but only limited practical experience. With this in mind and the clear failure to adopt magnification in endodontic practice amongst general dental practitioners, the present study aimed to explore the use of magnification in undergraduate endodontic practice and gain insight into the any barriers to magnification use that may be present during training.

Endodontic course leads for all dental schools in the UK and Ireland were contacted in the present study. The response rate for this study exceeded eighty percent, therefore the

information presented here can be considered a valid representation of the use of magnification in undergraduate dental education within the UK and Ireland. The study provides important insight into staff factors, student factors and institutional factors that may impact upon the adoption of magnification in endodontic teaching practice.

When considering the integration of magnification into undergraduate education, it is important to understand the background, training and clinical practice of the course developers and teachers. The respondents varied in their years of qualification. It has previously been stated that date of qualification may have an impact on the use of magnification (Forgie *et al.* 1999, Mines *et al.* 1999). Previous studies have provided conflicting results. Amongst general dental practitioners, adoption of magnification appeared to positively correlate with increasing years since graduation. Those further from graduation being more likely to adopt the use of magnification (Forgie *et al.* 1999). In a study of endodontists the likelihood of using magnification was inversely correlated with the length of service (Mines *et al.* 1999). Interestingly, in the present study those that only sometimes used the DOM were amongst those most recently graduated. It should be noted that in this group, loupes were used in instances when the DOM was not utilised. Of the respondents, a significant proportion had not received any formal training on magnification. This latter finding is somewhat worrisome considering this group represents both a group of specialists and non-specialists charged with providing endodontic treatments of greater complexity and providing education to future dental professionals. Clearly, it does not mean that they are not equipped to discharge these responsibilities, but certainly may indicate an oversight in postgraduate training amongst these individuals and could explain in part the finding that DOM use is not universal in all endodontic encounters in their own clinical practice.

When asked the reasons for their use of magnification in endodontic practice, the respondents cited four main factors – improved vision; improved quality of work; improved ergonomics and prevention of eye strain. These responses align very well with previously determined reasons for magnification use (Meraner *et al.* 2008). One could argue that improved quality of work may be rather subjective. What is quality and how can it be measured? It is likely that the respondents are indicating a perceived improvement in quality of technical work. Surrogate markers for quality improvements of this nature may include improved diagnosis, procedural improvements or outcomes. In the context of this investigation, considering dental loupes the minimum standard of vision, quality improvements should be evident with the use dental loupes. As already stated, there are limited studies providing evidence of such improvements in endodontics, however, studies exist that have looked at the impact loupes use has on other restorative procedures(Forgie *et al.* 2001, 2002, Haak *et al.* 2002). Although limited, some evidence does

exists for improved technical quality of work. However, it is clear that further studies may be of benefit to confirm an improvement of this nature.

As highlighted, the ESE guidelines state that magnification should be included in dental curricula. Although guidelines and not standards, they can be viewed as recommended best practice. The current standards laid out for undergraduate dental education in the UK, Preparing for Practice, does not make mention of the use of magnification (General Dental Council 2015). When asked if they were aware of the current ESE curriculum guidelines regarding magnification, only sixty percent were. This is somewhat surprising, and certainly highlights a need for improved dissemination of the guidelines amongst endodontic educators. Although the development of undergraduate courses in the UK are driven by the GDC standards, it is clear that additional value can be gained from drawing upon guidelines that are derived independently and by a panel of experts from current research and evidence. The lack of awareness of the ESE guidelines amongst those driving endodontic curricula in UK dental schools, may at least partly explain the finding that only 53% of respondents stated magnification was part of the official endodontic curriculum at their institution. This however, is not an indication of a lack of desire to introduce magnification as part of the official curriculum, with the majority of respondents stating that it should be.

In only one dental school was there an institutional expectation for undergraduates to use loupes. In all schools that responded, loupe use was encouraged during endodontic procedures, however, this encouragement was not always acted upon by students. This was highlighted when asked for other comments on the use of magnification. One course lead had stated “All students have the opportunity to use loupes during clinical skills update course in year 4. They can purchase but rarely do so.” This finding is prevalent and although not reported in the current study, in the authors’ experience this holds true. Interestingly, use of magnification tended to be encouraged only in the later stages of the undergraduate course. In an evaluation of the effect of loupes in preparing cavities amongst final year dental students, magnification improved the standard of cavity preparation (Narula *et al.* 2015). However, the students found the use of loupes increased the difficulty of cutting a cavity. It was concluded that experience of loupe use would be important to increase ease of use. Likewise, as stated previously, Forgie *et al.* (2002) suggested that experience has a positive impact upon performance of tasks using magnification. Therefore, it would seem more appropriate that magnification use should be at earlier time points during undergraduate training and ideally in clinical techniques. In the current study the availability of DOMs was also explored. All schools have dental operating microscopes available for use by undergraduates. Just over half had these available in clinical techniques. All schools have them available chairside on teaching clinics. Despite being available, they are not fully utilised.

Certainly, they may be used for demonstration purposes, but not necessarily used by students whilst undertaking treatment. This was reported to be due in part to supervisors not being comfortable with or trained in the use of DOMs, the additional time required to deliver the teaching whilst using magnification and potentially due to safety concerns arising from introducing modifications to students' established work patterns.

Amongst the barriers to adoption of magnification in the teaching of undergraduate endodontics was cost. Clearly, the significant expenditure required to equip clinics with DOMs may well be prohibitive. When considering personal magnification, the cost of loupes similarly has been cited in a previous study as a hindrance to adoption of magnification (Farook *et al.* 2013). It is of note that respondents in the present study highlighted that mechanisms were in place to facilitate the personal use of magnification by undergraduates. These include availability of loupe samples for use in clinical techniques and encouraging interaction between loupe suppliers and students. The loupe market in the UK has become served by a more diverse group of suppliers which has led to a greater degree of competition and therefore more keenly priced products. It is of note that some suppliers have begun to provide "budget" options which has made access to loupes possible to some that previously could not have considered purchasing due to financial constraints.

In the current study, a lack of staff training was also highlighted as a barrier to the adoption of magnification. It is clear that magnification amongst course leads is almost universally embedded in their own practice. However, this is not mirrored by the wider teaching staff population. It is clear that in order for magnification to be adopted as a requirement in undergraduate education, all staff must be conversant in the use of magnification, as not only will they guide students in utilising magnification, but they should also serve as role models. There is a clear need for improved staff training in the use of magnification in their own clinical practice and how it can be utilised in the context of undergraduate education. It would be important to ensure buy-in from staff teaching endodontics. Interestingly, it has been previously reported that teaching staff have little desire to act as role models for the use of magnification (Meraner & Nase 2008). The reasons cited were numerous and included financial reasons and a lack of perceived benefit. It may well be that similar mechanisms for aiding students to overcome financial barriers would have to be developed for staff. The challenge of overcoming perceived benefit amongst teaching staff may be significant. Although it is clear that course leads practice with magnification and recognise the benefits this confers, other teaching staff may not. Education, exposure and expectation will have to be employed to facilitate staff adoption. Further studies of the teaching staff, other than teaching leads may be valuable in determining the most appropriate means of engaging this group.

Conclusions

The current study has provided valuable insight into the use of magnification in undergraduate endodontic teaching in the UK and Ireland. Magnification is not universally embedded within the undergraduate curricula and the majority of schools had no expectation for students to use magnification, although it was encouraged. Those that design and deliver endodontic teaching use magnification in their own practice of endodontics, however, this does not translate into institutional expectation for students to use magnification. Teaching staff factors, student factors and institutional factors have been identified that impact upon the adoption of magnification in this environment. Inadequate staff training and experience presents a significant barrier to the introduction of magnification use in undergraduate endodontic teaching. It is imperative that as part of any move towards embedding magnification in undergraduate teaching that staff training must be ensured and expectation set that they use magnification in their teaching practice. The "do as I say, not as I do" approach to endodontic teaching establishes a pedagogical dilemma for dental educators. Training undergraduates to practice endodontics without magnification, whilst they themselves would not, cannot be justified. If we state that the minimum standard of vision in endodontics is the use of loupes it is no longer appropriate to continue to teach undergraduates to perform endodontic procedures with the unaided eye. Failing to recognise this and act upon it cannot be rationalised on the basis of cost and lack of staff training, factors highlighted in this study that act as barriers to the use of magnification. It is proposed that although significant, these barriers are not insurmountable. The authors do not consider it appropriate to expect students to adopt DOM use universally for endodontic treatment, however, based upon the findings of this study and suggested benefits of dental loupes it is proposed that dental loupe use should become a requirement in undergraduate endodontic training within the UK and Ireland.

Conflict of Interest statement

The authors have stated explicitly that there are no conflicts of interest in connection with this article.

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Figure Legends

Figure 1 Proportion of time spent carrying out endodontic procedures

Figure 2 Reasons for use of magnification in endodontic practice

Table 1 Questionnaire delivered to endodontic course leads

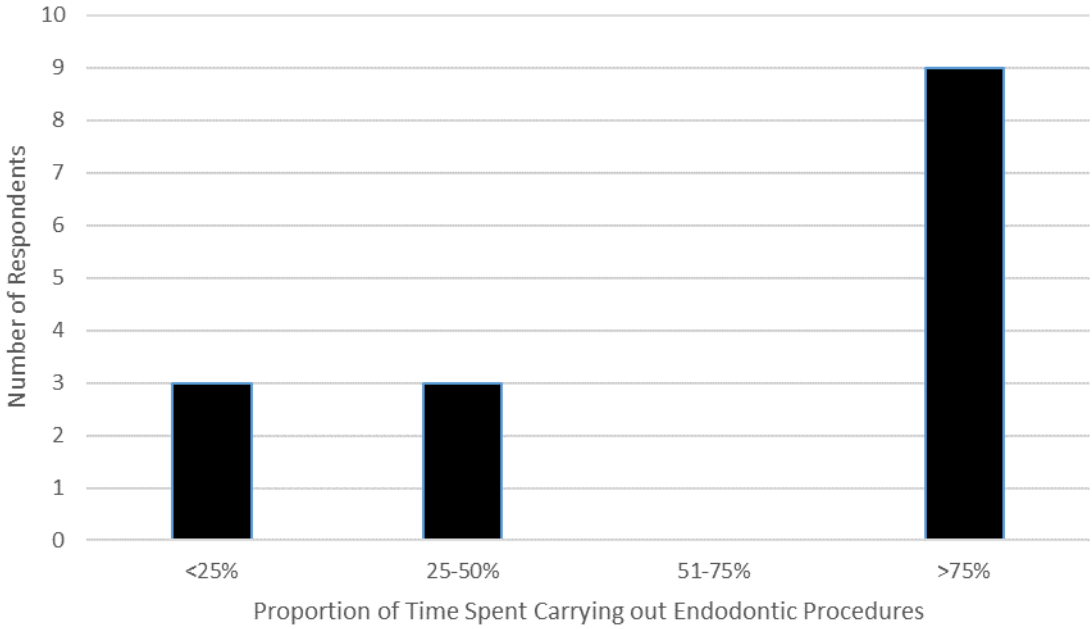
Question 1	What year did you qualify?
Question 2	What country do you work in?
Question 3	What proportion of your clinical time is spent carrying out endodontic procedures?
Question 4	How often do you use loupes for endodontic treatment? • Always • Sometimes/some procedures • Never
Question 5	How often do you use a dental operating microscope (DOM) for endodontic treatment? • Always • Sometimes/some procedures • Never
Question 6	Why do you use loupes/DOM? • Improved vision • Improved ergonomics • Prevent eye strain/fatigue • Improved quality of work • Do not use • Other
Question 7	Have you ever had any formal training on magnification? • Yes • No • Not sure
Question 8	Are you aware of the current European Society of Endodontology curricula guidelines regarding magnification for undergraduates? • Yes • No • Not sure
Question 9	What proportion of your teaching time is spent teaching undergraduate endodontics? • <25%

	• 25-50% • 50-75% • >75%
Question 10	Is magnification part of your official endodontic curriculum? • Yes • No • Not sure
Question 11	Do you think magnification should be part of the official curriculum for undergraduate endodontic teaching? • Yes • No • Not sure • Already part of curriculum
Question 12	Are undergraduate students in your institution expected to use dental loupes for endodontic procedures? • Yes • No • Not sure
Question 13	If yes, at what stage is magnification introduced? • Start of undergraduate teaching • Pre-clinical skills • First patient contact • Later years • Other
Question 14	If not an institutional expectation, do you encourage undergraduate students to use magnification for endodontic procedures? • Yes • No • Not sure • Already an institutional expectation
Question 15	Are DOMs used to facilitate teaching by demonstration in clinical skills? • Always • Sometimes

	• Never
Question 16	Are DOMs used to facilitate teaching by demonstration chairside? • Yes • No • Not sure
Question 17	Are DOMs available for undergraduate use at your institution? • Yes • No • Not sure
Question 18	What barriers, if any, do you perceive there to be for the use of magnification in endodontics amongst undergraduate students?
Question 19	Are there any mechanisms in place to facilitate the personal use of magnification for undergraduate students? • Yes • No • Not sure
Question 20	Any other comments?

Table 2 Responses to the question – "What barriers, if any, do you perceive there to be for the use of magnification in endodontics amongst undergraduate students?"

"Students fear of new equipment"
"Institutional buy in. We have been lucky, with approx 35 microscopes in the building"
"Supervisors may not be comfortable with using magnification"
"Cost and provision of training for academic staff"
"Not enough time"
"I think the learning process of the endodontic procedure in addition to the magnification will make the learning experience complicated and might be stressful for the students"
"Cost, training, space"
"There are none"
"Financial"
"Teachers not always comfortable. Sometimes students forget it's there."
"Safety concerns, availability of multiple DOM, training involved"
"Cost, resources to teach"
"Cost mainly. Limited number of supervisors who are comfortable using DoM"
"DOM availability. Staff suitably trained in use of DOMs"



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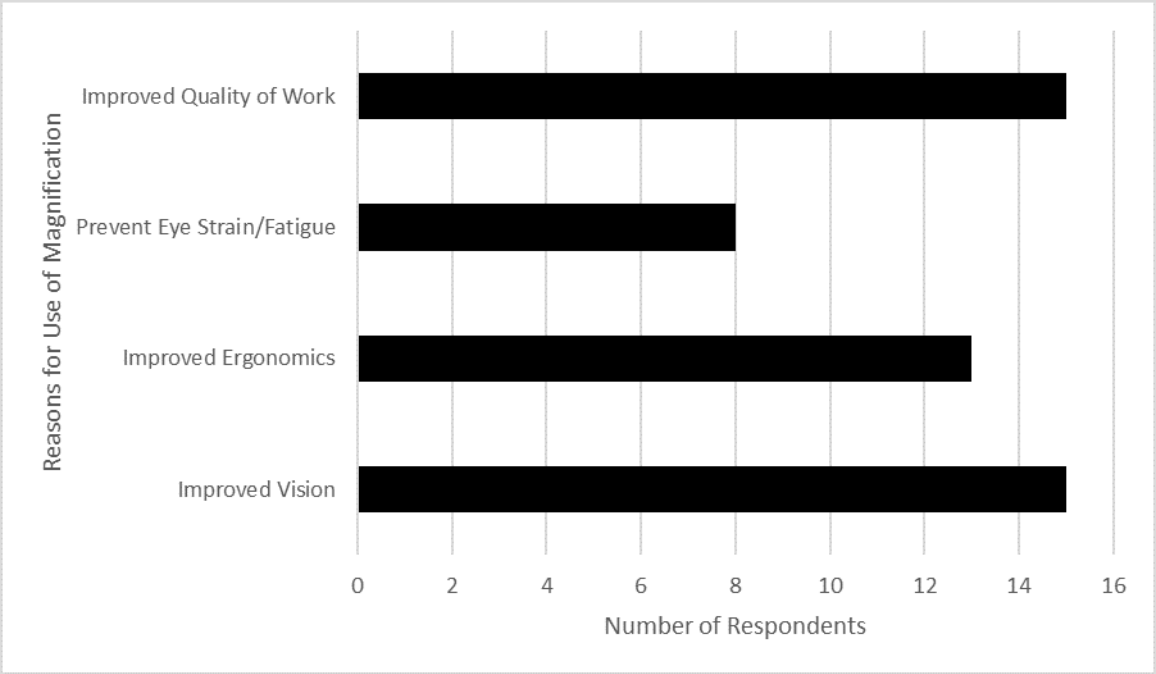

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