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Single Use of Endodontic Instruments

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Abstract

Endodontic treatment procedures have been carried out with single use hand and rotary files for the last 10 years in the United Kingdom. This practice was developed with the decisions based on guidance regarding the transmission of infectious disease, specifically prions which have been reported as not sterilised with current infection control measures. This article looks at the evidence base behind this following the current guidelines. The risk of fracture of files leading to treatment failure is also considered in the consideration for the single use of endodontic instruments.

Keywords: *Endodontic; Single Use; Fracture*

Introduction

There is currently no agreed worldwide protocol or guidance regarding a policy of the single-use of endodontic instruments. Following guidance by the Chief Dental Officer in England in 2007, a policy was made for endodontic instruments to be single-use only which was adopted by all United Kingdom (UK) countries. The primary reason given for this was the risk of variant Creutzfeldt-Jakob Disease (vCJD) transmission via these instruments. This is contrasted by North America where a contrary policy was drawn up by a special committee of the American Association of Endodontics and the Canadian Academy of Endodontics in 2011 who concluded that the risk of vCJD was not enough to warrant endodontic instruments to be single-use and sterilisation of those instruments is still carried out.

Looking elsewhere, there is no mention on single-use or sterilisation in the European Society of Endodontology guidelines so it has been considered there is no universal policy on this however a paper released in 2007 by the Robert Koch Institute in Berlin considered endodontic instruments to be a higher or critical risk with regards to infection control [1]. The Australian Dental Association guidelines for infection control [2] have a detailed description of the sterilisation protocol of endodontic instruments confirming no single use policy in Australia.

Beyond the current cross-infection control aspects for which policy for single use in endodontics may be adopted, there are other factors affecting re-use of instruments. Arens., *et al*. [3] investigated new instruments being used and analysed for defects. It was found that there were some defects and some instruments fractured after a single use and although the authors felt it was not essential, a policy of single use was advocated for maximum safety. Despite the findings of defects with endodontic files after use, a cohort study by Shen., *et al.* [4-6] stated that a file fracture rate was influenced more by the way in which they were used than the number of uses. Furthermore the systematic review by Panitvisai., *et al*. [7] concluded that a fractured instrument may not be a significant factor in success of endodontic treatments.

This essay will review the literature opinion on whether the aspects of fatigue and fracture are considerable in a policy for single-use of endodontic instruments as well as addressing the aspect of cutting efficiency which has been a reason manufacturers such as Densply Maillefer [8] have been promoting single use of instruments.

Infection Control

The UK Department of Health guidance on single-use endodontic instruments in 2007 was primarily based on guidance regarding vCJD as the prion proteins associated with this are resistant to decontamination processes and the cross-infection risk is higher than expected previously [9,10].

In contrast papers such as Palcios-Sanchez., *et al.* [11] and Azarpazhooh and Fillery [12] highlight that there appears to be little evidence to suggest that there is a significant risk of contracting vCJD from a dental setting. Weightman and Lines [13] gave quantification of the risk being 10 times lower than a tonsillectomy but did mention the difficulty of cleaning and stressed the importance of effective decontamination. Azarpazhooh and Fillery [12] stated there were no reports of vCJD associated with dental procedures and prions had not been found in dental pulp which minimises endodontic risk. The paper did also look at prevalence and the significantly higher incidence in the UK compared to the rest of the world may explain the enforced single-use policy. Despite vCJD not considered as high risk a single-use policy for endodontic instruments may still be important from a general cross-infection perspective.

As mentioned by Reams., *et al.* [14] if organic matter is not first removed from endodontic files "any method of sterilisation may be ineffective." Smith., *et al*. [15] considered the difficulty in cleaning endodontic files due to their intricate nature of their design. Electron microscopy analysed endodontic files for contamination following a decontamination process from general practitioners and a university hospital. 41% of files were shown to having some contamination rendering them to be discarded. The authors revealed a huge difference between the general practice sterilisation- 76% and 14% with the hospital setting where an ultrasonic bath was also used. The authors recommended single-use of instruments for endodontics if considered reasonable within costs. One of the limitations of the paper included a small sample size. This was addressed by the author in 2005 and a larger study involving 22 practices assessed 220 endodontic files showing all files to have some level of contamination. The sample practices did not have a single-use policy and the results highlight the cleaning of endodontic files is not adequate.

Perakaki, Mellor and Qualtrough [16] investigated the comparison of an ultrasonic bath with a washer disinfector in cleaning endodontic files prior to the UK legislation. Although the authors concluded in favour of a washer disinfector in the study, their final statement was concern in all cases that organic debris still remained on the files. The recommendation of this paper was advocating a single use policy in endodontics. This was a larger sample size than the Smith., *et al.* [15] paper however the files were used *in vitro* and 15 root canals were cleaned each with 6 files and each file was counted in the sample size. Sonntag and Peters [17] was also a large study with 140 files used in a similar way and concluded that single-use instruments are recommended for endodontics considering cross-infection control.

Cutting Efficiency

A single-use policy may be beneficial in treatment time due to cutting efficiency. Seago., *et al.* [18] investigated the cutting efficiency of 60 files using bovine cortical bone and monitoring how well the files were able to maintain the forces required to work efficiently. A comparison was made between different numbers of file uses. The study showed a statistically significant decrease in cutting efficiency with file use but the results were not proportional to the number of uses and a limitation was that the sample size was small.

Rapisarda., *et al.* [19] looked into the effect of the sterilisation process on endodontic files and found that autoclaving led to surface defects and a reduction in cutting efficiency. This was measured by the amount of debris generating from using files in a plastic block. The paper highlighted the increased time taken to carry out a procedure with a re-used file.

Haikel., *et al.* [20] also looked into the aspect of cutting efficiency of stainless steel files and split 390 files into groups which involved a variety of disinfection protocols. The cutting efficiency was considered by looking at forces generated in acrylic blocks following the disinfection. In all cases compared to the control of no disinfection, there was a significant loss of cutting efficiency in all file types.

Kazemi, Stenman and Spangberg [21] looked at the machining efficiency of endodontic files in cutting dentine specimens and acrylic glass and made comparisons to stainless steel. The results showed a loss of cutting efficiency. Authors state "the instruments lost 10% to

20% of their machining ability after one run in dentin." Although this is a logical finding the degree to which the wear has occurred may be considerable and adds weight to the argument in favour of when deciding on a policy for single-use instruments.

In contrast to these papers Alapati., *et al.* [22] investigated new and used endodontic instruments under an electron microscope and although finding some flattening they did not demonstrate there being substantial change in the cutting tip of the files suggesting that there was not such a loss of cutting efficiency. The study did use a maximum of six uses for the files. It did however highlight tooth deposits while had adhered to the files which confirms the concerns in the papers looking at infection control and also surface flaws which will be looked into the below section on fatigue and file fracture.

Fracture of files - cyclic fatigue

Where a single use policy is not adopted there appears to be no consensus on number of uses for a file due to the aspects of cyclic fatigue and torsional fracture which occur. File fracture is not a desired outcome of endodontic treatment, removing the file is a potentially difficult process and there is the aspect of time taken, effective control of pathogens and less success rate of treatment [7,23,24].

Where a file has been used a number of times the stress build up leads to deterioration. Which then means a file may fracture and this is known as cyclic fatigue. Where a file builds up stress due to pressure in a very small or curved canal there is a risk of fracture and this is known as torsional fracture [25]. The literature was searched at to investigate the issues with cyclic fatigue and also to determine whether file fracture is still an issue with a single-use policy as single-use instruments may be equally likely to fracture by torsional fatigue. If cyclic fatigue is a considerable factor it may add weight to recommending a single-use policy in endodontics.

Making comparisons as to whether file separation occurs via cyclic fatigue or torsional fatigue can be difficult considering the paper by Capar., *et al*. [24] stating that file separation is likely based on a combination of cyclic and torsional stresses. This was also touched upon by Kim., *et al*. [26,27] whose studies involved subjecting files to cyclic fatigue prior to torsional resistance testing and compared to a control group with no precycling there was more likelihood of a used file separating where they had been previously used.

Setzer and Böhme [28] applied cyclic fatigue to endodontic files as well as torsional stress in a customised device to make a comparative study. They showed that the stress distributed from the area of the torsional stress to the area undergoing cyclic fatigue and fractures occurred in the curvature of the canal. The study used three file systems and only 10 files but it is the reader's interpretation here that the paper may suggest that reusing files in a straight canal is less potentially problematic than new files in a curved canal and it is the canal curvature and the torsional stress being more of a factor in file separation. This view was also supported in a previous paper by Alapati., *et al*. [22] and Sattapan., *et al.* [29] reported torsional fracture in 56% of fractured files while cyclic fatigue occurred in 44%.

In contrast prolonged use of rotary files was shown to have more likelihood of fracture when considering the cyclic fatigue resistance by Gambarini [30,31]. A review paper in 2009 by Plotino., *et al. [*32] highlighted the fact that there is disparity in study methods reviewing cyclic fatigue. The authors recommended a need for standardisation to make conclusive comments to decide whether cyclic fatigue is a factor in deciding on a single-use policy.

Plotino., *et al.* [33] with some similar authors as the 2009 paper looked into the aspect of cyclic fatigue and autoclave sterilisation and found a difference between unsterilized and sterilised files however they state "Repeated cycles of autoclave sterilization do not seem to influence the mechanical properties of NiTi endodontic instruments."

Where there are no single-use policies for endodontic instruments there are some literature papers investigating how to reduce the issues associated with cyclic fatigue. Kuhn and Jordan [34] had a suggestion to improve the lifespan of endodontic files. This includes treatments to the files before and after machining to improve fatigue resistance. Kim [26,27] looked at reciprocation and this was shown to increase resistance to cyclic fatigue and torsional fracture. Gambarini [30,31] showed that low torque will reduce the chance of cyclic fatigue. It is a consideration that if the instruments can be altered and used with certain protocols then fatigue may be less of a concern from a re-use perspective.

Fracture of files – torsional fatigue

Considering torsional fatigue causing fracture, Svec and Powers [35] found the torsional moment of rotary files was the same for used and new files so both equally likely to fracture. They stated that unless there was visible distortion the files they could be used multiple times without fear of fracture.

Sattapan., *et al*. [29] conducted a study which analysed 378 files which had been discarded by a specialist endodontic practice. These were seen under magnification and the type of fracture was identified by comparison with characteristic deformation on test files which were fractured from cyclic fatigue or torsional fatigue. They showed that more fractures occurred by torsional fracture at 39.9% and flexural fatigue in 9.3%. These results included files which did not fracture but showed deformation.

Ya Shen, Coil and Haapasalo (2013) looked at defects in nickel titanium files in a large study that analysed 3706 files which were discarded over a 4 year period. Their results showed a very small percentage of files which were defective. In comparison between torsional failure and fatigue failure the authors found the files failed mostly due to torsional failure through analysis under an electron microscope. Despite the incidence rate of failure the authors felt a fractured instrument was significant enough for the authors to recommend a single-use policy for smaller diameter files. Similar findings were by the same author Ya Shen., *et al.* in 2009 where they found torsional failure in 85% of files fractured in a research study.

The recommendation for single-use files for the smaller diameter files was also stated by Inan and Gonulol [36] however it was interesting that this study had a much higher rate of instrument fracture from cyclic fatigue and the method of monitoring was the same as Sattapan [29] which showed quite different results. A higher number of files (593) had been used in this study and the finding of 71% of failures from cyclic fatigue was concluded by stating that the manufacturers' recommendations on number of file use should not be exceeded. The number of safe uses is difficult to quantify and a study by O'Hoy., *et al.* [37] looked at decontamination processes effect on cyclic fatigue and torsional fatigue with a moderate sample size of 140 and stated that up to 10 cycles can be run without significantly affecting the risk of file fracture.

Currently the single-use policy that exists is based on precaution with regards to the factors discussed. Parashos, Gordon, Messer [38] following a large study involving a sample size 7159 files concluded that "single use for prudence ignores the fact that instrument fracture is a complex multifactorial clinical problem. Instruments can still fracture during first use." Based on systematic review by Panitvisai in 2010 they discussed the evidence base showing that even if a file fractures it does not significantly affect the outcome of treatment. If pre-existing infection is present the prognosis of a tooth may be compromised however this is more due to the fact of effective disinfection rather than a file having separated. This view was concurred by Spili [39] who reported a success rate of 92% from a literature search involving 8460 cases following a fractured instrument during treatment [40-44].

Conclusion

Shen., *et al.* [4,5] considered file fracture and cross infection as mentioned in this essay and conducted a study using 2327 files over a 12 month period which were all used as single-use. They showed fracture incidence at 0.26% or less and distortion frequency at 2.9% or less. There was only one incidence of a fracture from cyclic fatigue and three with torsional fracture. There was distortion, micro cracks and debris on the instruments following usual protocols which confirms findings of previous papers regarding re-use of files.

This paper concurs with the thoughts of the author following the review of literature in the various subjects associated with a single use policy. A single use policy is based on risk management. The risks are in cross infection, file fracture and ineffective filing from less cutting efficiency. Weighing up the cons of single use instruments seems to cost only. All other factors weigh in favour of the single-use policy. If cost benefit is considered and deemed acceptable then it should be a recommended guideline and eliminates doubts altogether about re-using files from whichever aspect it is considered.

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