DETECTION AND PLASMA CLEANING OF POTENTIALLY INFECTIVE CONTAMINATION FROM SURGICAL INSTRUMENTS

A.G. Whittaker*, G.A. Campbell, P. Richardson, A.C. Jones, R.L. Baxter, H.C.Baxter.
School of Chemistry, University of Edinburgh, West Mains Road, Edinburgh, EH9 3JJ, Scotland, UK.

The transmissible spongiform encephalopathies (TSEs), or prion diseases, are a rare group of fatal diseases that include in humans, familial, sporadic and acquired Creutzfeldt Jacob disease (CJD). The disease is characterised by accumulation of an abnormal form of prion protein in the central nervous system[1]. The risks of iatrogenic transmission of CJD is a topic of growing concern in health care since the infectious agent shows a marked resistance to conventional chemical and thermal decontamination procedures[2]. There is definite evidence of CJD transmission by growth hormone therapy and a number of surgical routes including dura mater grafts and corneal implants[3,4]. The importance attached to the potential threat posed by transmission of CJD by surgical instruments has led the Department of Health in the UK to stress the importance of decontamination procedures[5]. Residual contamination on reprocessed surgical and dental instruments represents a significant problem in contamination control many countries' health services. There is particular concern surrounding the iatrogenic transmission of Creutzfeld-Jakob Disease (CJD) as clear evidence of cases of iatrogenic CJD arising from surgery exist, in which neurosurgical instrument contamination has been implicated. Moreover, using animal models, it has been definitively shown that transmission of infectivity can occur *via* stainless steel surfaces. Cases arising from surgery, where contaminated instruments have been implicated, are rare, but this should be considered in the context that the time lag between infection and appearance of the disease may be many years

Currently there is no accepted procedure for the removal of prion infectivity from surgical or dental instruments. Conventional processes such as autoclaving, exposure to ionising radiation, formaldehyde treatment and sonication are ineffective. Recent assessment showed the levels of gross contaminating matter remaining on endodontic files, after routine dental practice and dental hospital decontamination procedure[6]. Significant amounts of material remain even after rigorous cleaning highlights the need to develop new methods of decontamination. Here we describe a preliminary study on the decontamination of surgical tools using radio frequency generated gas plasmas. Although plasma cleaning has been little investigated in the medical context, it is a well-established technique for the elimination of organic material from surfaces. At one extreme, the method is used by manufacturing industry for the solvent-free removal of machine oils from thermally robust machined components. At the other extreme, it is used by the semiconductor industry, to remove organic polymers from delicate electronic components[7].

As part of an interdisciplinary team, we have investigated the decontamination and screening of surgical instruments. A reactive gas plasma has been shown to be an effective method of removing residual contamination from dental instruments, and the methods used have been employed in the decontamination of general surgical instruments. In contrast to other practical methods of cleaning, the reactive gas plasma leaves no residue, and generates no waste that could be considered in any way hazardous. In contrast to conventional methods of cleaning, such as the use of solvents or aggressive chemicals, plasma cleaning leaves no residue, and when optimised, typically generates only CO_2, H_2O and N_2 as a gaseous waste. Gas plasma sterilisation has the potential advantages of having no toxic residue effects, reduced turnover time, and applicability for sterilisation of heat- and moisture-sensitive instruments[8-10]. Its effectiveness has led to its use as a decontamination method from chemical and biological warfare agents[11-12].

In this paper, we present an evaluation of the degree of residual surface contamination remaining on surgical instruments that have been cleaned using the stringent procedures that are stipulated by the health authorities in most developed countries. The level of contamination is then compared to that obtained following radio-frequency gas plasma processing. The surface damage to the instruments and contamination levels are compared using Scanning Electron Microscopy, X-Ray Fluoresence and X-ray Photoelectron spectroscopy. The level of infective material is also compared using ninhydrin amino acid analysis and infectivity bioassay. The results to date show that plasma decontamination represents an effective, clean, and affordable adjunct to conventional hospital sterilisation methods.

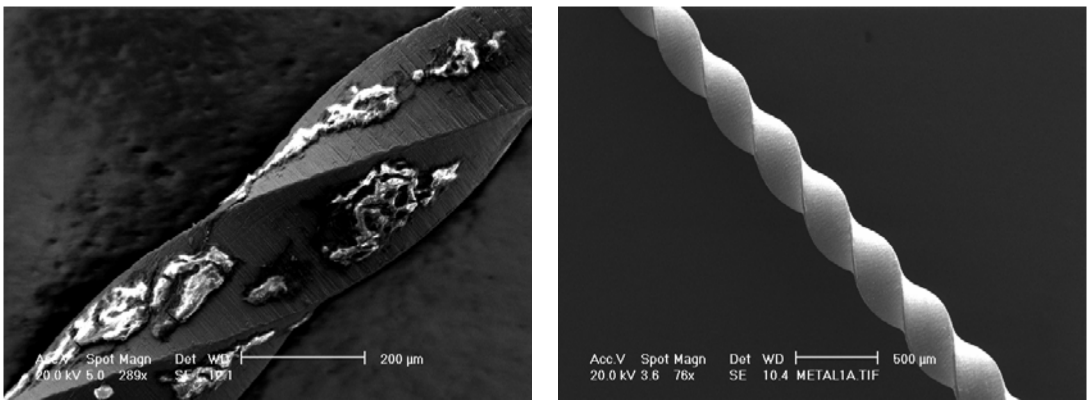

Figure 1. A sterilised orthodontic file, showing gross proteinaceous contamination (left) and after following plasma decontamination (right).[13]

REFERENCES

1. Prusiner SB. Molecular biology of prion diseases. Science 1991;252:1515-22.
2. Taylor DM. Resistance of Transmissible Spongiform Encephalopathiey Agents to Decontamination. In: Rabenau HF, Cinatl J, Doerr HW, editors. Prions A chalange for Science, Medicine and Public Health System.; 2001: Contrib. Microb. Basel, Karger,; 2001. p. 58-67.
3. Takashima S, Tateishi J, Taguchi Y, Inoue H. Creutzfeldt-Jakob disease with florid plaques after cadaveric dural graft in a Japanese woman. Lancet. 1997;350:865-866.
4. Lang CJ, Heckmann JG, Neundorfer B. CJD via dural and corneal transplants. J Neurol Sci 1998;160:128-139.
5. Mayor S. UK government advises tighter measures to reduce risk of CJD transmission during neurosurgery. BJM 2003;326:517.
6. Smith A, Dickson M, Aitken J, Bagg J. Contaminated dental instruments. J Hosp Infect. 2002;51:233-235.
7. Stansfield BL, Fujita H, Sugawara M. Plasma Etching: Fundamentals and Applications (Series on Semiconductor Science and Technology, 7) by. Oxford: Oxford University Press; 1998.
8. Southwood LL BG. Instrument sterilization, skin preparation, and wound management. Veterinary Clinics of North America-Equine Practice. 1996;12(2):173.

9. Montie TC, Kelly-Wintenberg K, Roth JR. An overview of research using the one atmosphere uniform glow discharge plasma (OAUGDP) for sterilization of surfaces and materials. IEEE Transactions on Plasma Science 2000;28(1):41-50.
10. Ayliffe G. Decontamination of minimally invasive surgical endoscopes and accessories. Journal of Hospital Infection 2000;45(4):263-277.
11. Birmingham JG, Hammerstrom DJ. Bacterial decontamination using ambient pressure nonthermal discharges. IEEE Transactions on Plasma Science 2000;28(1):51-55.
12. Herrmann HW, Henins I, Park J, Selwyn GS. Decontamination of chemical and biological warfare, (CBW) agents using an atmospheric pressure plasma jet (APPJ). Physics of Plasmas 1999;6(5):2284-2289.
13. Whittaker AG, Graham EM, Baxter RL, Jones AC, Meek G, Campbell GA, Aitken A, Baxter HC. *Journal of Hospital Infection* January 2004.