The effect of ultrasonic irrigation variables on the dimensions of artificial root canals

Author: James Prichard

Aim: To investigate the effects of power setting, type of irrigant and duration of ultrasonic irrigant agitation with Irrisafe™ on the mean percentage change in the cross-sectional area and diameter of artificial root canals in an in-vitro model.

Methodology

Twenty-five extracted anterior human teeth were collected and split into 2 halves, each of which was embedded in epoxy resin. The external root surfaces were polished to produce flat, smooth dentine surfaces. A pilot score was used as a guide to prepare an artificial canal using rotary instruments to a size 30/.06. The root canals were randomly assigned to five groups. Group 1: irrigation with 2.5 per cent NaOCl, ultrasonic agitation at power setting 7 (n=5); Group 2: irrigation with 17 per cent EDTA, ultrasonic agitation at power setting 7 (n=5). Groups 3, 4, and 5 were irrigated with 2.5 per cent NaOCl, 17 per cent EDTA, 2.5 per cent NaOCl, with ultrasonic agitation at power setting 4 (n=5), 7 (n=5) and 10 (n=5) respectively. Irrigant was delivered with a syringe and ultrasonically agitated with a P5 Satelec® and Irrisafe™ tips. Canal area and depth were measured at 17, 16 and 9 mm from the canal orifice at baseline and after 1, 2, and 5 minutes of ultrasonic agitation.

This study came about as a result of a presentation that Chris Stock, Godfrey Cutts and I made to Prof Kish Gulabivala. We showed him a protocol for shaping and then cleaning root canals using Irrisafe. He announced that all steel instruments and tips remove dentine and cut root canals, so I set out to prove him wrong!

I would like to express my thanks to Prof Gulabivala for the idea behind this project and the incredible opportunity he afforded me.

Contemporary endodontics falls into three distinct categories:

1. Preparation (mechanical shaping)
2. Irrigation (syringe flushing and adjunctive cleaning)
3. Obturation (sealing the root canals in three dimensions)

The existence of several morphologically different micro-organisms was shown to be associated with necrotic pulps as early as 1984 by W.D. Millar. Bacteria in the root canal system has been shown to cause apical periodontitis in gnotobiotic rats (Kakehashi et al. 1965). Sundqvist demonstrated that 18 out of 19 traumatised but intact teeth associated with periapical radiolucencies gave positive bacterial cultures (Sundqvist 1975).

Schilder (1967) suggested that the root canal be cleaned and then shaped to allow for three-dimensional obturation. However, at least thirty-
The World’s First Online
MSc in Restorative & Aesthetic Dentistry

Master of Science in
Restorative & Aesthetic Dentistry
‘The Best of Everything’

Two of the UK’s most respected education and academic organisations have joined forces to provide an innovative, technology driven MSc in Restorative and Aesthetic Dentistry. Smile-on, the UK’s pre-eminent healthcare education provider and the University of Manchester, one of the top twenty-five universities in the world, have had the prescience to collaborate in providing students with the best of everything – lecturers, online technology, live sessions and support.

Convenience
The majority of the learning resources on this programme will be online. The masters will combine interactive distance learning, webinars, live learning and print.

Ownership
The programme is designed to encourage the student to take responsibility for his/her own learning. The emphasis is on a self-directed learning approach.

Community
Students will be able to communicate with a diverse multi-ethnic global community of peers, with who they will also share residential get-togethers in fantastic settings around the world.

Opportunity
This innovative programme establishes the academic and clinical parameters and standards for restorative and aesthetic dentistry. Students will leave with a world recognised MSc.

Call Smile-on to find out more:
tel: 020 7400 8989 | email: info@smile-on.com
web: www.smile-on.com/msc
eight per cent of the root canal surface could remain uninstrumented during root canal treatment (Peters et al. 2001) and 70 per cent more debris remained following instrumentation when compared with instrumentation and irrigation (Baker et al. 1975).

Furthermore the landmark studies of Bystöm and Sundqvist (1981, 1983) demonstrated a 100-1000 fold decrease in bacterial counts when 0.5 per cent Sodium Hypochlorite (NaOCl) was introduced instead of saline. Therefore it has generally been accepted that a chemomechanical approach to root canal debridement is required to significantly reduce the bacterial load that may encourage more predictable healing.

The role of root canal preparation has therefore undergone a shift from one primarily fulfilling a debriding function to one regarded more as establishing radicular access to the complex root canal system, for irrigation and obturation (Gulabivala et al. 2005).

Root canal irrigants should be biologically compatible, chemically able to remove both organic and inorganic substrates, be antibacterial, demonstrate good surface wetting, have no adverse effects on remaining tooth structure and be easy to use and effective within clinical parameters (Gulabivala et al. 2005).

Penetration of irrigants into the root canal is a function of irrigating needle diameter in relation to preparation size (Ram 1977), and placement of the needle closer to the working length increased the efficiency of irrigation (Abou-Rass et Piccinino 1982, Sedgeley et al. 2005).

Improvement of the efficiency of irrigation especially in the apical third of the root canal system has been attempted by agitating the irrigant. The use of hand-files, pumping of well adapted GP cones (manual dynamic), continuous irrigation during rotary instrumentation and sonic and passive ultrasonic devices have all been described (Gu et al. 2009).

Richman first described the use of ultrasonics in endodontics in 1957. Endosonics was a term first described by Martin and Cunningham (1984) and referred to the simultaneous preparation and irrigation of root canals. Passive ultrasonic irrigation (PUI) was first described by Weller et al. (1980) and relates to the non-cutting action of the ultrasonically activated file. The free movement of the file or wire allowed irrigant to penetrate more easily into the apical part of the root canal (Krell et al. 1988).

However significant problems were encountered with k-files as they produce irregular shapes and apical perforations (Stock 1991, Lumley et al. 1992), straightened canals (Chenail et Teplitsky 1985, 1988) and ledged simulated root canals (Al Jadaa et al. 2009).

Irrisafe™ (from Acteon UK) is a stainless steel instrument that is non-cutting, parallel sided and available in two lengths (21 and 25mm) and two tip sizes (ISO 20 and 25) and designed to be used after root canal shaping is complete to agitate freshly delivered irrigants.

“Endosonics was a term first described by Martin Cunningham (1984) and referred to the simultaneous preparation and irrigation of root canals”
It can be pre-bent in curved canals and introduced to 1mm short of the working length. It should fit loosely within the prepared canal shape so that the movement of the irrigant around the tip is uninhibited and the tip can vibrate freely. Once inserted, the power is activated and the violent movement of the irrigant "scubs" the walls of the canal thereby implying the effective removal of dentine debris, micro-organisms (biofilm and planktonic bacteria) and organic tissue from the root canal (van der Sluis 2007).

The technique requires that the NaOCl irrigant is delivered in 3ml bolus via a syringe fitted with a side vented needle and then Irrisafe™ is inserted and activated for 20 seconds. This is repeated three times. In oval canals the tip can be moved towards the walls (avoiding contact dampening) to encourage fluid movement into these areas.

Ideally EDTA liquid is then inserted and agitated for a further 20 seconds before a final flush of NaOCl is performed.

The canal(s) can then be dried and obturation carried out according to preference.

The results of the study

The mean percentage change in cross-sectional area and diameter in descending order were: Group 2 - 52.7 per cent and 26.2 per cent; Group 5 - 42.6 per cent and 25.8 per cent; Group 4 - 23.2 per cent and 9.4 per cent; Group 3 - 14.6 per cent and 5.1 per cent; Group 1 - 6.5 per cent and 3.8 per cent. Linear regression analysis of the data from Groups 1, 2 and 4 revealed that canal dimensions were significantly affected by irrigant regime (p=0.0001), corono-apical level (p=0.009) and duration of irrigant agitation (p<0.0001). Analysis of the data from Groups 3, 4 and 5 revealed that both corono-apical level (p=0.009) and duration of agitation of the irrigant (p<0.0001) significantly affected the increase in canal dimensions.

Conclusions

The test model established that there is a clinically insignificant change in root canal dimensions when manufacturer’s instructions were followed (Group 4). Irrigant choice and combination, duration of agitation and corono-apical level all had a significant effect on the dimensions of the artificial root canal.

**Key features of IrriSafe**

- Driven by the Newtron® range of piezoelectric generators, IrriSafe™ generates micro-cavitation and micro-currents that spread through the canal system. It is the best instrument for the passive ultrasonic irrigation currently available
- The irrigant effect is amplified not only by the mechanical activation provided by the vibration, but also by the heating effect of the ultrasonics, that intensifies the sodium hypochlorite dissolution and debridement properties
- Non-cutting edges to prevent any damage to the root canal anatomy
- IrriSafe is more efficient than smooth wires, because its loops generate turbulences and optimise the irrigant activation
- The blunt-end prevents any perforation to the apex or to the canal walls
- The special steel benefits from a specific surface treatment that provides the instrument with a better resistance and transmission of the ultrasonic vibrations and a complete compatibility with sodium hypochlorite, versus nickel-titanium ultrasonic wires.
- Godfrey Cutts and I run an annual two-day endodontic re-treatment course, throughout which we also use Acteon’s Endo Success Kit. This ultrasonic tips kit has been designed as a solution for the problems most often encountered during non-surgical endodontic treatments. The new titanium-niobium alloy allows optimum use of ultrasound in the trickiest situations. The current trend in surgical techniques is to offer minimally – or even non-invasive protocols. By using an operating microscope, together with high-tech micro-instruments, it is now possible to treat the entire root canal.