INTRODUCTION

Removal of vital and necrotic remnants of pulp tissues, microorganisms, and microbial toxins from the root canal system is essential for endodontic success. Although this might be achieved through chemomechanical debridement, it is impossible to shape and clean the root canal completely because of the complex nature of root canal anatomy. Even with the use of rotary instrumentation, the nickel-titanium instruments currently available, they act only on the central body of the canal, leaving canal fins, isthmus and cul-de-sacs untouched after completion of the preparation. These areas might harbor tissue debris, microbes, and their by-products, which might prevent close adaptation of the obturation material and result in persistent periradicular inflammation. Therefore, irrigation is an essential part of root canal debridement because it allows for cleaning beyond what might be achieved by root canal instrumentation alone.

However, there is no unique irrigant that can meet all these requirements, even with the use of methods such as lowering the pH, increasing the temperature, as well as addition of surfactants to increase the wetting efficacy of the irrigant. Thus, in contemporary endodontic practice, dual irrigants such as sodium hypochlorite (NaOCl) with ethylenediaminetetraacetic acid (EDTA) or chlorhexidine (CHX) are often used as initial and final rinses to complement the shortcomings that are associated with the use of a single irrigant. More importantly, these irrigants must be brought into direct contact with the entire canal wall surfaces for effective action, particularly for the apical portions of small root canals. Throughout the history of endodontics, endeavours have continuously been made to develop more effective irrigant delivery and agitation systems for root canal irrigation. These systems might be divided into 2 broad categories, manual agitation techniques and machine-assisted agitation devices. The objective of this review article is to present an overview of various manual agitation techniques.

IRRIGATION WITH NEEDLES/CANNULAS

Conventional irrigation with syringes has been advocated as an efficient method of irrigant delivery before the advent of passive ultrasonic activation. Plastic syringes of different sizes (1–20 mL) are most commonly used for irrigation. Although large-volume syringes potentially allow some time-savings, they are more difficult to control for pressure and accidents may happen. Therefore, to maximize safety and control, use of 1-5ml syringes is recommended instead of the larger ones. This technique is still widely accepted by both general practitioners and endodontists. The technique involves dispensing of an irrigant into a canal through needles/cannulas of variable gauges, either passively or with agitation. The latter is achieved by moving the needle up and down the canal space. Some of these needles are designed to dispense an irrigant through their most distal ends, whereas others are designed to deliver an irrigant laterally through closed-ended, side-vented channels. The latter design has been proposed to improve the hydrodynamic activation of an irrigant and reduce the chance of apical extrusion. It is crucial that the needle/cannula should remain loose inside the canal during irrigation. This allows the irrigant to reflux and causes more debris to be displaced coronally, while avoiding the inadvertent expression of the irrigant into periapical tissues. One of the advantages of syringe irrigation is that it allows comparatively easy control of the depth of needle penetration within the canal and the volume of irrigant flushed through the canal. Nevertheless,
the mechanical flushing action created by conventional hand-held syringe needle irrigation is relatively weak. After conventional syringe needle irrigation, inaccessible canal extensions and irregularities are likely to harbor debris and bacteria, thereby making thorough canal debridement difficult.\textsuperscript{13-15} Factors that have been shown to improve the efficacy of syringe needle irrigation include closer proximity of the irrigation needle to the apex, larger irrigation volume, and smaller-gauge.\textsuperscript{16-18} Syringe irrigation is that it allows comparatively easy control of the depth of needle penetration within the canal and the volume of irrigant flushed through the canal. Nevertheless, the mechanical flushing action created by conventional hand-held syringe needle irrigation is relatively weak. After conventional syringe needle irrigation, inaccessible canal extensions and irregularities are likely to harbor debris and bacteria, thereby making thorough canal debridement difficult.\textsuperscript{13-15} Factors that have been shown to improve the efficacy of syringe needle irrigation include closer proximity of the irrigation needle to the apex, larger irrigation volume, and smaller-gauge.\textsuperscript{16-18} Syringe irrigation is that it allows comparatively easy control of the depth of needle penetration within the canal and the volume of irrigant flushed through the canal. Nevertheless, the mechanical flushing action created by conventional hand-held syringe needle irrigation is relatively weak. After conventional syringe needle irrigation, inaccessible canal extensions and irregularities are likely to harbor debris and bacteria, thereby making thorough canal debridement difficult.\textsuperscript{13-15} Factors that have been shown to improve the efficacy of syringe needle irrigation include closer proximity of the irrigation needle to the apex, larger irrigation volume, and smaller-gauge.\textsuperscript{16-18} Syringe irrigation is that it allows comparatively easy control of the depth of needle penetration within the canal and the volume of irrigant flushed through the canal. Nevertheless, the mechanical flushing action created by conventional hand-held syringe needle irrigation is relatively weak. After conventional syringe needle irrigation, inaccessible canal extensions and irregularities are likely to harbor debris and bacteria, thereby making thorough canal debridement difficult.\textsuperscript{13-15} Factors that have been shown to improve the efficacy of syringe needle irrigation include closer proximity of the irrigation needle to the apex, larger irrigation volume, and smaller-gauge.\textsuperscript{16-18} Syringe irrigation is that it allows comparatively easy control of the depth of needle penetration within the canal and the volume of irrigant flushed through the canal. Nevertheless, the mechanical flushing action created by conventional hand-held syringe needle irrigation is relatively weak. After conventional syringe needle irrigation, inaccessible canal extensions and irregularities are likely to harbor debris and bacteria, thereby making thorough canal debridement difficult.\textsuperscript{13-15} Factors that have been shown to improve the efficacy of syringe needle irrigation include closer proximity of the irrigation needle to the apex, larger irrigation volume, and smaller-gauge.\textsuperscript{16-18}

BRUSHES

Brushes are not directly used for delivering an irrigant into the canal spaces. They are adjuncts that have been designed for debridement of the canal walls or agitation of root canal irrigant. Recently, a 30-gauge irrigation needle covered with a brush (NaviTip FX; Ultradent Products Inc, South Jordan, UT) was introduced commercially. However, friction created between the brush bristles and the canal irregularities might result in the dislodgement of the radiolucent bristles in the canals that are not easily recognized by clinicians, even with the use of a surgical microscope.

MANUAL-DYNAMIC IRRIGATION

An irrigant must be in direct contact with the canal walls for effective action. However, it is often difficult for the irrigant to reach the apical portion of the canal because of the so-called vapour lock effect.\textsuperscript{19} Research has shown that gently moving a well fitting gutta-percha master cone up and down in short 2-3mm strokes (manual dynamic irrigation) within an instrumented canal can produce an effective hydrodynamic effect and significantly improve the displacement and exchange of any given reagent.\textsuperscript{20} This was recently confirmed by the studies of McGill\textsuperscript{21} and Huang et al\textsuperscript{22}. These studies demonstrated that manual-dynamic irrigation was significantly more effective than an automated-dynamic irrigation system (RinsEndo; Dürr Dental Co, Bietigheim-Bissingen, Germany) and static irrigation. Although manual-dynamic irrigation has been advocated as a method of canal irrigation as a result of its simplicity and cost-effectiveness, the laborious nature of this hand-activated procedure still hinders its application in routine clinical practice.
CONCLUSION

Effective irrigant delivery and agitation are prerequisites for successful endodontic treatment. This article presents an overview of the manual irrigant agitation methods currently available and their debridement efficacy. Technological advances during the last decade have brought to fruition new agitation devices that rely on various mechanisms of irrigant transfer, soft tissue debridement, and, depending on treatment philosophy, removal of smear layers. These devices might be divided into the manual and machine-assisted agitation systems. Overall, they appeared to have resulted in improved canal cleanliness when compared with conventional syringe needle irrigation.

REFERENCES