EDITORIAL

Advancing Endodontics through Kinematics

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World Journal of Dentistry (2023): 10.5005/jp-journals-10015-2268

The field of endodontics has witnessed significant advancements over the years, revolutionizing the way of manufacturing nickel-titanium (NiTi) rotary instruments and motors.[1,2] Among the myriad techniques and tools employed since the introduction of NiTi alloy as the material of choice for manufacturing engine-driven rotary or reciprocating instruments, kinematics has emerged as a prominent player, offering a deeper understanding of the dynamic nature of endodontic procedures and increasing the safety and effectiveness of root canal instrumentation.[3] Regarding this, manufacturers have moved towards developing safer instruments and instrumentation motions since their fracture during root canal shaping is still one of the major concerns of endodontists.

As described by Gambarini et al., endodontic kinematics can be divided according to several factors such as the direction of rotation, angle of rotation, and combination of motion.[3] First of all, kinematics can be divided into continuous rotation (CR), when the instruments rotate a full revolution (360°) in one direction [clockwise (CW) or counter-CW (CCW)] depending on the flute orientation) and reciprocating motion (RM) in which the instrument continuously changes the verse of rotation describing a specific angle in the cutting direction and another specific angle in the noncutting direction. This group can be further divided according to the difference in angle amplitude in the cutting and noncutting directions. According to this, the term alternate reciprocation (AR) has been described as the motion in which the two reciprocating angles are equal (CW = CCW) and usually <90°, thus, the result is not a full rotation. On the contrary, the term rotating reciprocation (RR) has been described as the motion in which the cutting angle of reciprocation is greater than the noncutting angle (CW > CCW or CCW > CW), resulting in a full rotation after some reciprocating cycles.[4,5] To be clearer, all endodontic instruments could be used in CR or RM, however, the direction of rotation and the greater angle of reciprocation (in the RR motions) must be chosen according to the cutting orientation of the flutes. Generally, the endodontic instruments designed to be used in CR are cut in a CW direction, while those designed for RMs cut in a counter-CW direction. In the last decade, endodontic motor manufacturers have introduced innovative motors, called open motors, that allow clinicians to customize the angle of reciprocation, the rotational speed, and the torque limit even with the RMs. Recently, combined motions have been developed. They consist of the alternation between CR and RM (both AR and RR) according to different parameters such as torque developed during instrumentation, friction, energy used by the motor, instrument used, etc. Some of these combined kinematics are—the TFA® Adaptive motion (Kerr Endodontics, Orange, California) which starts with a CR and automatically changes into an RR motion when the endodontic files meet friction; the optimum torque reverse (J. Morita, Kyoto, Japan), starts with a continuous CW rotation of the instrument but once the preset torque values are exceeded (trigger torque), the files automatically start a RR motion with angles 90° CCW and 180° CW;[6] the optimum glide path combines AR and RR motions, the file firstly starts with an alternated kinematic with the same angle and automatically starts to reciprocate without any trigger.[7,8] Adjunctively to the above-mentioned kinematics, some manufacturers have introduced specific handpieces able to simulate the up-and-down movement during the instrumentation of root canals, generating vertical kinematics. Despite this, to date, few data are available in the scientific literature.[7]

In the last decades, the effective improvements arising from innovative kinematics have been thoroughly investigated, however, despite the plethora of *in vitro* and laboratory studies, *in vivo* and clinical studies are still scarce. It is now clear that AR, RR and combined kinematics improve life span, cycle fatigue resistance and maintain the instrument below the yield strength arising from torsional stresses.[9–11] However, conflicting results have been found regarding the effect of AR and RR on debris extrusion and cutting efficiency since it is not possible to separate the pure effect of kinematics from the other factors in the current studies.[7,12,13] Moreover, the AR and RR motion seems to be associated with increased postoperative pain after root canal treatments, however, as stated by de Silveira et al., further randomized clinical trials are needed to fully address this point.[14,15]

In light of the above, this editorial is a call to action to thoroughly investigate the effect of different kinematics during different clinical scenarios through *in vivo* studies, which could be able to define the effective enhancements of AR and RR in comparison to the CR.

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How to cite this article: Di Nardo D, Abbagnale R, Pagnoni F, *et al.* Advancing Endodontics through Kinematics. World J Dent 2023;14(6):479–480.

Source of support: Nil

Conflict of interest: None

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