

Review

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Generations of apex locators: which generation are we in?

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Abstract

Endometrics is one of the key factors responsible for the success of endodontic therapy. Electronic determination of working length has gained enormous popularity, owing to its extreme accuracy and predictability. The literature is flooded with the self-proclaimed generations of the apex locators. This article is aimed at concise description of the actual scientific rationale behind the generations in order to diminish the related perplexity.

Keywords: Apex locators, endometrics, generations, working length

INTRODUCTION

Endometrics, the science of determining working length (WL) in endodontics holds high significance in the success of endodontic therapy. In the world of modern endodontics, the electronic WL determination by the use of electronic apex locators has become an integral component of the treatment protocol. The literature is full of the details regarding these fascinating electronic machines. However, the categorisation in the chronological order has somehow always been confusing. One of the convenient methods of segregating the apex locators is based on dividing them into different generations. This paper deals with simplifying the details of apex locators belonging to different generations so as to make it more easy and convenient for the readers. This particular classification is entirely based on the working principles of the apex locators. The clinical correlation can be interpreted from the fact that the more the machine can work in extreme environments and the more accurate it is, the better it is for the dental professionals.



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FIRST GENERATION APEX LOCATORS

These apex locators use the resistance method for determining the WL^[1]. Basically these instruments measured the opposition to the flow of direct current (resistance) and hence the name Resistance based apex locators. Initially an alternating current of 150 Hz Sine wave was used (Root canal meter, 1969) but the pain was felt by the patient due to high currents. Therefore modifications were made and new machines which used current less than 5 micro amperes were introduced (Endodontic Meter S II, Kobayashi, 1995). Since these machines were not found to be accurate, the research work continued to develop in this field.

SECOND GENERATION APEX LOCATORS

These apex locators use the Impedance method for determining the WL. Basically these instruments measure the opposition to the flow of alternating current (impedance) and hence the name Impedance based apex locators. These units utilize the current of a single frequency to perform the task. Formatron IV^[2], Sono Explorer^[3] and Endocater are a few examples of this generation, almost all having the similar drawback of inaccurate readings especially in the presence of irritants in the canal^[4,5].

THIRD GENERATION APEX LOCATORS

These apex locators use two frequencies instead of a single one to measure the impedance in order to determine the WL. With this scientific rationale these should be called “comparative impedance” type apex locators. However, the impedance of any given circuit is influenced by the frequency of the current flow, hence the name frequency based apex locators. The credit of being the first apex locator in this category goes to Endex^[6]. However it had the drawback of requiring calibration for each canal before use. Later came Root ZX, which did not require any calibration^[7]. It uses two different frequencies of 400 Hz and 8 kHz simultaneously to measure the impedance in the canal. Then it determines a quotient value by dividing 8 kHz impedance value by 400 Hz impedance value. The reading of minor diameter is revealed when the quotient value is 0.67^[8]. These apex locators had the upper hand over their predecessors in terms of accuracy and reliability. Other units falling into this category are AFA, Neosono Ultima EZ, Justy II, *etc.*

FOURTH GENERATION APEX LOCATORS

These apex locators use multiple frequencies (2-5 frequencies) to measure the impedance in order to determine the WL^[9]. Multi-frequency measurement system is used to calculate the distance from the tip of the file to the foramen by measuring changes in impedance between two electrodes. Unlike the third generation, these ones do not use the impedance value as a mathematical algorithm only to assess the WL but instead utilize the resistance and capacitance measurements and thereafter compare them with a database to measure the distance of the file to the apex of the canal. This technology presumably leads to less sampling error and more consistent readings. Canal pro apex locator (Coltene) belongs to this category. The measurements in Canal Pro apex locator are performed using AC signals at two frequencies. The frequencies are alternated rather than mixed, as it is done in other apex locators, thus canceling the need for signal filtering and eliminating the noise caused by non-ideal filters. The RMS (Root Mean Square) level of the signal is measured, rather than its amplitude or phase. The RMS value is much more immune to various kinds of noises than other parameters of the measured signal. The two-field display with file tracking over the whole canal length and enlarged apical Zoom makes this apex locator uniquely different from the existing third generation ones. The apex locators of this generation, so far, are the best in their category owing to their high accuracy and reliability. For a clinician, looking for high accuracy and reliability in their WL determination, the fourth generation apex locators would be the most ideal, for they can be trusted upon the most.

CONCLUSION AND FUTURE GENERATIONS

A couple of companies are coming up with new apex locators proclaiming to be of fifth (dual frequency ratio type) and sixth generations^[10]. However there is no clear distinction as how these ones are technically

different from the already existing fourth generation apex locators for which their superiority in performance is being claimed.

Therefore, before a seventh or eighth generation apex locator comes in, which could be a cordless one and proclaims it to be the most superior one, a critical analysis needs to be done regarding the technical specifications of all the apex locators beyond the fourth generation ones.

DECLARATIONS

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Not applicable.

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