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NEW GENERATION ELECTRONIC APEXLOCATORS ARE AN ADVANTAGE OF INNOVATIVE TECHNOLOGIES IN CLINICAL ENDODONTICS.

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Annotation.
Modern clinical endodontics is focused on achieving high precision processing and filling of root canals, which is directly related to the correct determination of the working length. Errors in determining the apical border of preparation can lead to overexpansion of the canal, traumatization of the periapical tissues, or, conversely, to insufficient treatment of the infected space. New generation electronic apexlocators are high-tech devices based on multi-frequency analysis of tissue electrical impedance, allowing precise determination of the position of the apical constriction regardless of clinical conditions. The purpose of this article is to analyze the technological features of modern apexlocators and to substantiate their advantages in clinical practice. The physical principles of operation, comparative characteristics of generations of devices, the impact on the quality of treatment and prognosis are considered. The results of the analysis indicate that the introduction of a new generation of apexlocators significantly increases the accuracy of measurements, reduces radiation exposure and minimizes the risk of complications.

Keywords: clinical endodontics, electronic apexlocator, working length, apical constriction, innovative technologies, digital dentistry, impedance analysis.

Introduction.

The success of endodontic treatment is largely determined by adequate mechanical and medical treatment of the root canal within the physiological apical narrowing. Determining the working length is a critical stage of treatment. Traditional methods based on X-ray inspection have a number of limitations: two-dimensionality of the image, distortion of anatomical structures, radiation exposure and dependence on the interpretation of the doctor.

The introduction of electronic apexlocators has become an important stage in the development of endodontics. Modern devices make it possible to obtain accurate data on the position of the instrument in the channel without additional radiographic exposure. The new generation of apexlocators is significantly superior to the early models in terms of the stability of indications and independence from clinical conditions (channel moisture, the presence of exudate or irrigants).

The purpose of the article is to systematize data on the principles of operation and clinical advantages of new—generation electronic apexlocators.

Theoretical foundations of the functioning of electronic apexlocators

Physical principles of measurement. Electronic apexlocators are based on measuring the electrical resistance (impedance) between an endodontic instrument inserted into the canal and an electrode located on the patient's mucous membrane.

The first-generation devices determined the apex based on constant tissue resistance (approximately 6.5 kOhm), but their accuracy depended on the dryness of the channel. Modern systems use multi-frequency impedance analysis and mathematical algorithms that make it possible to distinguish the anatomical structures of the root canal regardless of the presence of moisture.

Thus, the principle of operation of the new apexlocators is based not on absolute resistance values, but on the ratio of impedances at different current frequencies.

Classification of generations of apexlocators

1. The first generation of resistance devices (low accuracy, sensitivity to moisture).
2. Second generation — impedance devices (improved stability).
3. The third generation is multi—frequency apexlocators.
4. The fourth and subsequent generations are digital devices with automatic calibration and integration with endomotors.

Modern apexlocators belong to the latest generations and have a high degree of automation.

Technological features of the new generation of apexlocators

1. Multi-frequency analysis. The use of several frequencies of the electrical signal makes it possible to eliminate the influence of electrolytes and irrigation solutions. This ensures the stability of the readings even in the presence of sodium hypochlorite or blood in the channel.
2. Digital data processing. Modern devices are equipped with microprocessors that analyze changes in impedance in real time. The results are displayed on a digital display with a graphical scale of the tool's progress.
3. Integration with endomotors. Some systems automatically stop tool rotation when the apical boundary is reached. This increases the safety of the procedure and reduces the risk of overexpansion.
4. Improved ergonomics. Its compactness, wireless technology, and intuitive interface facilitate clinical use and reduce specialist training time.

Clinical benefits

1. Improving the accuracy of determining the working length. Modern apexlocators demonstrate accuracy within ± 0.5 mm of the apical constriction, which meets clinical quality standards. This reduces the risk of the tool going beyond the root and minimizes inflammatory complications.
2. Reduced radiation exposure

The use of electronic methods makes it possible to reduce the number of control radiographs. This is especially important in the treatment of pregnant women and children.

3. Reduction of treatment time

Instant acquisition of tool position data speeds up the process of determining the working length and improves reception efficiency.

4. Improving the prognosis of treatment

Precise adherence to the apical boundary of the treatment contributes to the complete rehabilitation of the canal and reduces the likelihood of chronic inflammation of the periapical tissues.

Comparison with traditional methods. The X-ray method remains an important diagnostic tool, but it has limitations:

- the inability to accurately visualize the apical constriction;
- dependence on anatomical features;
- Image distortion;
- Radiation exposure.

Electronic apexlocators do not completely replace radiography, but they significantly increase accuracy and complement comprehensive diagnostics.

Limitations and development prospects

Despite the high accuracy, the readings of the apexlocators may be affected by:

- the presence of large perforations;
- the immature tip of the root;

• pronounced resorption.

Development prospects are associated with the introduction of artificial intelligence for automatic analysis of indications, integration with digital treatment protocols, and the creation of fully autonomous operating length control systems.

Discussion

An analysis of scientific data and clinical practice indicates that new-generation electronic apexlocators are an important component of innovative endodontics. Their use contributes to the standardization of procedures, reducing the number of iatrogenic complications and improving the quality of treatment.

The integration of digital technologies into dentistry creates new requirements for the training of specialists and the organization of the clinical process. An endodontist should be familiar with the principles of electronic systems and take into account their capabilities and limitations.

Conclusion.

New generation electronic apexlocators represent a significant achievement of innovative technologies in clinical endodontics. Their use ensures high accuracy in determining the working length, reduces radiation exposure and increases the safety of treatment.

The complex application of modern apexlocators in combination with digital diagnostic methods and mechanical treatment of channels forms the basis of high-tech, predictable and evidence-based endodontic practice. Further technology improvements are aimed at increasing process automation and integrating intelligent clinical decision support systems.

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