**RECENT ADVANCES IN ENDODONTICS**

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Abstract:

Endodontics is a rapidly expanding branch of dentistry, including root canal therapy as a regular treatment option, the goals of which include the elimination of apical periodontitis of endodontic origin and ensuring the stability of results over time in order to avoid recurrence.1 The technical advances in the development of even more efficient and resistant endodontic instrument reached important results in the last few years with the adoption of NiTi alloys and thermal treatments, which could increase the flexibility and the resistance of the instruments.2 In general, root canal/endodontic treatment is usually considered as one of the most challenging practices in dentistry. However, recent technological advancements have resulted in a more predictable endodontic treatment with successful outcomes in challenging cases.

Introduction:

Artificial Intelligence in Endodontics:

The term “artificial intelligence” was coined in 1956 at a confer­ence in Dartmouth by John McCarthy. Machine learning, neural net­works, and deep learning are subsets of artificial intelligence. Neural networks (NNs) use artificial neurons that are like human neural networks and mimic the human brain in a mathematical model. NNs can simulate human cognitive skills like problem solving and human thinking abil­ities to name a few, which includes both learning and decision mak­ing.3 Neural networks basically have three layers: input layer (where information enters the system), hidden layer (where data are pro­cessed), and output layer (where the system decides what to do).4 The most used types of neural networks are artificial neural networks (ANN), convolutional neural networks (CNN), and recurrent neural networks. Deep learning is a part of neural networks where the com­puter learns on its own how to process the data.5

AI can be useful in detecting periapical lesions and root fractures, root canal system anatomy evaluation, predicting the viability of dental pulp stem cells, determining working length measurements, and predicting the success of retreatment procedures.6 Setzer et al. in their re­search used deep learning to detect periapical lesions on cone-beam computed tomographic (CBCT) images. The accuracy of finding the lesions was 93%.7 AI technology has also proven to be very effi­cient in comparison to periapical radiographs in diagnosing vertical root fractures on CBCT images.8

Guided Endodontics:

Endodontic treatment can often be challenging when cases of pulp canal obliteration (PCO) are encountered. PCO refers to the deposition of hard tissue within the root canal space and can occur as a result of trauma, following orthodontic treatment, in response to pulpal injuries, dental caries, restorative procedures or abfractions and in teeth of elderly patients.9 Recently, the concept of guided endodontics has been reported, in which computer-designed guides are used for access cavity preparation in order to achieve predictable and safe results.10

There are different types of guided endodontics: static guided endodontics (SGE) and dynamic guided endodontics (DGE). SGE is performed by obtaining a CBCT image of the patient’s upper or lower arch (depending on where the tooth to be treated is located). At the same time, a registration of the patient’s arch of interest is performed, which can be performed with an intraoral scanner or by obtaining an impression that will be scanned later. The two obtained images are superimposed through the aid of software, whereby a guide can be designed that will cover the tooth of interest (and some adjacent teeth). In this guide, a drill hole can be designed with a specific appropriate diameter and angulation to allow direct access to the calcified canal.11 DGE is based on the use of CBCT images with reference marks that are placed in the patient’s mouth on the side opposite to the side to be operated on (before performing the CBCT). With the help of a stereo camera connected to a dynamic navigation system, the trajectory of the drills into the pulp chamber and root canal is coordinated in real time. This way, the operator can follow everything he/she does on a monitor and can correct or adjust the angulation of the instruments as needed.12

It can be concluded that guided endodontics using static or dynamic navigation appears to be a safe and minimally invasive method for detecting calcified root canals

Magnification in Endodontics:

Magnification is chiefly driven by innovation and technology and has now radically changed how endodontic practice is currently being performed.13 Over the years, many magnification devices have been introduced as bridging tools between the naked eyes and the microscope. In fact, tools, such as an endoscope, magnifying glass, and intraoral camera, have largely been superseded by contemporary devices that seem to be more practical and convenient for application, such as loupes and dental operating microscope (DOM). The main differences between the two devices have been depicted in figure 1.14

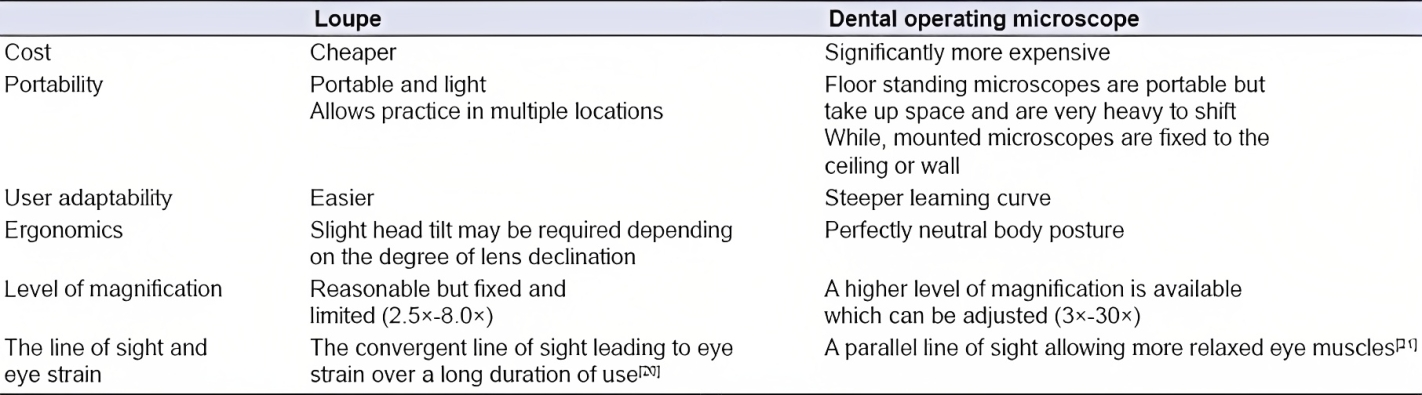


Figure – 1: Differences between loupes and DOM

The enhanced vision and illumination can facilitate the following:14

* Diagnosing caries and minute cracks
* Conservative access opening
* Identifying obscure anatomy
* Managing sclerosed canals
* Confirming canal cleanliness prior to obturation
* Outlining and removing pulp stones
* Managing perforation and tooth resorption
* Retrieving silver point, separated instrument, and fractured post
* Smaller osteotomy, magnified inspection of resected surface, as well as retropreparation and retrofill in endodontic microsurgery.

Endodontic Imaging:

The advent of cone beam computed tomography (CBCT) has resulted in widespread adoption of this technology for three-dimensional image capture/processing. Computed tomography greatly enhances diagnostic yield in certain situations where two-dimensional conventional radiographic studies have limitations. Shortest scan times should be used with the smallest field of view and the smallest available voxel size without compromising on the signal to noise ratio.15

The existing literature supports the use of CBCT in clinical endodontics for selected diagnostic tasks, on a case-by-case basis, following a thorough clinical evaluation. Some of the potential applications of CBCT include diagnoses related to the following: Initial diagnosis where nonspecific signs and symptoms exist, dental anomalies and developmental disturbances, presence of anatomic variations, calcified canals, broken instruments, vertical root fractures, failure of prior treatment, nonsurgical and surgical retreatments, select cases of trauma, resorption (external and internal), and implant placement.16

Root Canal Disinfection:

Complexities of the root canal systems, in addition to the structure and composition of the dentin, are key challenges for effective disinfection in endodontics. The inability of antimicrobials to eliminate biofilm bacteria in the anatomical complexities and uninstrumented portions of the root canal would compromise their efficacy in root canal treatment. Thus, steps taken to improve the delivery of irrigant (irrigation dynamics) within the root canal system are crucial to achieve the maximum efficacy out of the antimicrobials.15

Antimicrobial photodynamic therapy (APDT) is a two-step procedure that involves the application of a photosensitizer (PS) (step-1), followed by light illumination (step 2) of the sensitized tissue, which would generate a toxic photochemistry on the target cell, leading to microbial killing.17 Currently, APDT is considered not an alternative but a possible supplement to the existing protocols for root canal disinfection.18

Ozone treatment has unique properties ranging from antimicrobial, immunostimulant, analgesic, and antihypnotic to detoxicating, bioenergetic, and biosynthetic activities. Ozone can be utilized as an antimicrobial in endodontics. Ozone is efficacious when recommended in sufficient concentration, time and conveyed accurately into root canals after conventional cleaning, shaping, and irrigation has been accomplished. At the point, when a root canal was disinfected using ozone water with sonification, the antimicrobial adequacy was similar to 2.5% NaOCl. Ozone was seen as viable against disease‑causing microorganisms such as *Enterococcus* *faecalis*, *Candida albicans*, *Peptostreptococcus,* and *Pseudomonas* *aeruginosa*. Ozone likewise kills the particular anaerobic odor related to some incessantly tainted teeth.19

CONCLUSION:

Contemporary endodontics has seen an unprecedented advance in technology and materials. Jointly, these advances are aimed at improving the state of the art and science of endodontic treatment.

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