Artificial Intelligence In Endodontics

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Abstract

Advances in technology lead to the evolution of artificial intelligence which is gaining more attention everywhere. Patient information and data has increased hugely, so there is need to use some intelligent software to save and use this data. Artificial intelligence (AI) helps in taking patient's history to data processing and uses this information from the data for diagnosis. Like this AI has many applications in dental and medical sciences. AI showed improved efficiency, accuracy, and precision at very low cost in health care and has significantly increased its usage in various applications in dentistry, especially endodontics. AI can replace the role of a dental surgeon with this advancement in future for betterment of dental practice.

Keywords: Artificial Intelligence, Deep Learning, Future Dentistry, Endodontics

Introduction

Artificial intelligence (AI) mimics the human brain with maze of neurons interconnected with each other and helps in transmitting signals to the whole body. It has various applications in medical field & dentistry. In dentistry also, particularly endodontics it has showed more accuracy & efficiency.[1]

Methodology:

For data collection search was carried out online on various sites: Pubmed, Medline, Research Gate, and EBSCO. For search-words and phrases - 'Artificial intelligence', 'Artificial intelligence in dentistry', and 'Artificial intelligence in Endodontics' were used in various combinations. The selected items comprised of research and review articles. Among those articles, applications of AI in the field of Dentistry & Endodontics are considered.

John McCarthy in 1956 coined the term Artificial intelligence[2] & Richard Bellman defined AI as the automation of processes related to human cognitive capacities such as learning, decision making, and problem solving.[3]

Various algorithms adapted in learning in artificial intelligence are -

Machine learning, Neural networks [Artificial neural networks (ANN) & convolutional neural networks (CNN) etc.,], Deep learning, Data science & Big data.[4]
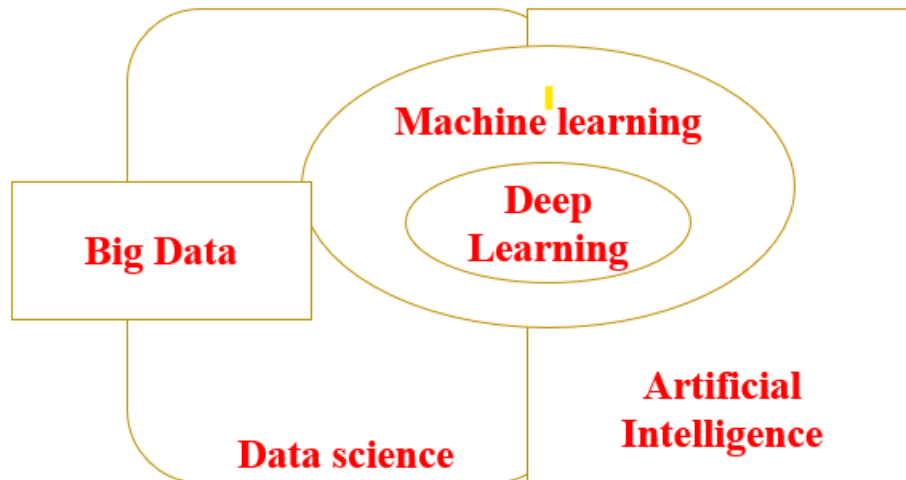
Artificial Intelligence In Dentistry:

Used in various departments like -

1. Diagnostic dentistry - Vast amounts of patient data is recorded through digital IOPA (Intra Oral Peri Apical X ray), 3D scans etc…., AI is needed to gather and compute the data for prompt diagnosis and treatment of oral disease in different fields of dentistry & also to identify patient at risk of development of oral precancers or oral cancers.[5]

2. Radiology – AI when integrated with imaging methods like MRI and Cone beam computed tomography it can identify even the minute deviations from normal which remains unnoticed by human eye.[6] Machine learning algorithms detects abnormal or normal lymph node in head and neck image by analysing thousands of such images which can be labelled as normal or abnormal.[6]

3. Periodontics – Artificial neural networks categorize the patients into aggressive periodontitis and chronic periodontitis based on their immune response profile by using data.[7]

4. Orthodontics – AI is used in various phases, starting from diagnosis to treatment planning and follow-ups. 3D scans and virtual models are helpful in assessing craniofacial and dental abnormalities. By using these 3D scans, aligners can be printed, and treatment can be customized.

After these, a data algorithm is created that intelligently decides how the teeth of the patients should be moved, how much pressure should be applied and even also recognize the pressure points for that teeth. These aligners not only provide precise treatment but also reduces the chances of error and treatment time.[1]

5. Restorative / prosthetic dentistry - AI in prosthetic dentistry is the use of computer aided technology for perfect fit of prosthesis. AI based systems are used to design & for mulling of inlays, onlays, crowns and bridges. An accurate physical and robotic microsurgical treatment will guide for proper implant placement.[8]

Applications Of AI In Endodontics

A. **Diagnosis, Detection & Prognosis Of Periapical Lesions:**

Detection of a periapical lesion using radiographs leads to large variations between examiners. By using AI systems these variations between the examiners and bias can be reduced.[3]

There was excellent accuracy in detecting periapical lesions, missing canals, canal curvatures, vertical root fractures on CBCT images by using Deep learning segmentation. Accuracy was around 92.8%.[9]

AI in access cavity preparation is done by using Dynamic Navigation System (DNS) which provides real-time visual feedback Head-up display (HUD) technology by using data from a CBCT scan. This

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procedure includes jaw - tracker & optical tracking tag (jaw tracker attached to the patient's jaw & tracking tag to treatment instrument) which are superimposed on CBCT scan of the patient's jaw. DNS helps in preparing conservative access cavity by using this guidance. [10]

B. Working Length Determination

In Radiographic methods such as IOPA, RVG, CBCT working length is determined. Data from these are collected, stored & analysed in Artificial neural networks(ANN).

To locate the apical foramen on radiographs, Artificial neural networks(ANN) can act as a second opinion to enhance the accuracy of working length determination by radiography & also ANN can function as a decision-making system in various similar clinical situations.[11]

C. Biomechanical Preparation

A specially designed visual servo controller model, a visual-guided robotic endodontic therapeutic system was introduced in the field of Endodontics based on AI. Controlling the endodontic procedure with the help of a robotic device reduces the physical stress, human error and time factors for the operator, the traveling distance and time for the patient.

Clinician mounts this system on the teeth within patient's mouth, & the robot controller, and a root-canal image processor have control over its motion. Clinician with online monitoring and positioning control the multipurpose robotic system will perform various automatic treatment procedures like probing, drilling, filing and cleaning.[12]

D. Detection Of Root Fractures
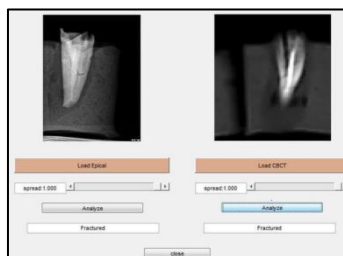
One of the serious complication that may result in either root resection or tooth extractions are Vertical root fractures (VRFs) which are about 2%–5% of crown/root fractures. These fractures are detected by using Radiographs and CBCT imaging.[2]. These root fractures are detected by Convolutional Neural Networks (CNN) model by using panoramic images, which function as a Computer Aiding Design tool. [13]

E. **Morphology Detection**

AI Learning models helps in extracting image patches from panoramic radiographs and inputting them into deep learning systems. This deep learning system showed high relevance in the differential diagnosis of a single or extra root in the distal roots of mandibular first molars, also used to detect surrounding bone, vital structures (sinus, nerve foramens etc.,)[14]

F. **Endodontic Surgery**

Dynamic navigation system will assist endodontists not only in biomechanical preparation, but also in endodontic surgeries by locating & preserving the vital structures nearer to the teeth.

To date, AI should meet the following:

1. Appointment scheduling, patient management and to recall schedules of the patient treatments based on the continuous needs and acquired medical information.

2. Health care records should be made available, so that AI can predict patient-specific drug-drug complications.

3. AI would be able to improve diagnosis and helpful to predict outcome based on the acquired information and data collection.

Benefits In Dentistry[1]

1. Performing tasks in no time.
2. Logical decisions which results in an accurate diagnosis.
3. Standardization of procedures

Disadvantages In Dentistry

1. System complexity.
2. Costly
3. Adequate training needed.
4. Data which is used for both training and testing result in data snooping bias.

5. The outcomes are not readily applicable.

Conclusion

In endodontics, AI is used in various clinical applications, particularly in the detection of periapical pathosis, root fractures, determination of working length, and prediction of disease. High quality evidence is needed to evaluate the performance of AI regarding its reliability, applicability, legal and ethical considerations, and cost effectiveness before adapting into routine clinical practice.

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