



## Artificial Intelligence in Forensic Odontology

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### ABSTRACT-

Forensic odontology deals with the identification of an individual through remains, mainly including teeth and jawbones. The application of this science is mainly for medico-legal investigations, during mass disasters, and identifying the accidental remains by analyzing dental records. The technological advancements which mainly mimic the human brains have revolutionized dentistry. These artificial intelligence (AI) models can be trained and then applied for problem solving and decision making. The tremendous advancements in this field can be applied to forensic odontology as an adjunctive aid in providing reliable information. This review article aims to report the application and performance of AI technology in the ever-growing field of forensic odontology.

**Keywords:** Forensic Odontology, Artificial Intelligence, Artificial Neural Networks

### Introduction- What Is Artificial Intelligence?

Artificial intelligence is defined as a "field of science and engineering concerned with a computational understanding of what is commonly called intelligent behavior, and with the creation of artefacts that exhibit such behavior."<sup>1</sup>

Artificial intelligence can solve a problem beyond standard algorithmic solution by using prediction and pattern recognition and proves to be a particularly useful tool for specialties with strong visual components like pathology and radiology.<sup>2</sup>

The developments of medical artificial intelligence have been related to the development of AI programs like Artificial Neural networks (ANN), fuzzy expert systems, evolutionary computation and hybrid intelligence systems.<sup>3</sup>

- a. ANN's are inspired by the biological nervous system and consist of highly interconnected computer processors that are capable of data processing and knowledge representation.
- b. Fuzzy logic is a data handling methodology that permits ambiguity and hence is particularly suited to medical applications.
- c. Evolutionary computation is based on a natural evolution process that imitates the mechanism of natural selection and survival of the fittest in solving real world problems.

The advantages of these technologies can be combined together to produce hybrid intelligence systems which can work in a complementary manner.<sup>4</sup>

Artificial intelligence in forensic odontology leverages advanced computational techniques to enhance the

accuracy, speed and efficiency of various tasks within the discipline. In this context, AI can assist in the comparison of dental records, analysis of bite marks, age estimation, and the identification of unknown victims. By automating these processes and aiding forensic experts, AI not only expedites investigations but also reduces the scope of human error.

This article serves as a glimpse into the evolving intersection of artificial intelligence and forensic odontology, where technology plays a vital role, in advancing the fields capabilities and contributing to the resolution of complex cases.

### Historical Perspective

In the quest to create a model that mimics the model of the human brain, John McCarthy introduced the field of artificial intelligence in 1956.<sup>5</sup> In 1959, Arthur Samuel accelerated the development of AI by introducing the term "machine learning".<sup>6</sup> In 1972, an expert system emerged, the application of which was focused on the medical field.<sup>7</sup>

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Since the democratization of the Internet in 1991, global biomedical network infrastructures have been formed beyond the national level, and there has been a breakthrough in the development of AI in the medical sector.<sup>8</sup>

Subsequently, AI has made deep inroads into dentistry in the last few years and has been widely implemented in a wide range of dentistry specialties. The power of AI to mimic the precision and accuracy of trained specialists has found its application in the field of forensic odontology.

### Applications of AI in Forensic Odontology

#### 1. Dental identification:

Dental identification is considered one of the most reliable forms in human identification as teeth are well preserved, even in the presence of fire, trauma, or other destructive forces. Dental identification involves comparing dental records, including radiographs, dental charts and dental models, to determine a match. There are several ways in which AI can be helpful in tooth identification. AI can be trained to detect and number teeth on panoramic radiographs for automated charting purposes. It can also independently identify specific tooth types on radiographs with a high degree of precision and reliability.<sup>9</sup> Dental implant recognition is crucial in forensic identification and there is increasing research suggestive of recognizing the types of dental implants on radiographs.<sup>10</sup> AI can help analyze x-rays to identify and match individuals based on their teeth and jaws.<sup>11</sup> Magnet Forensics is a digital forensic investigative tool. Kroll computer forensics services examines physical and digital evidence.

#### 2. Age estimation:

Skeletal remains are often fragmented and difficult to identify. Teeth prove to be a source of identification in that they enable the estimation of age to set up a biological profile. The AI system can be trained to recognize patterns and features associated with different ages and then use this knowledge to estimate the age of an unknown person.<sup>12</sup> AI and machine learning models can be applied to the various dental age estimation methods like Demirjian's method, William's method and Cameriere method to predict the age.<sup>13</sup>

#### 3. Sex determination:

Sex determination is performed in a variety of situations, such as criminal investigations, in mass disasters and missing persons cases. AI and Artificial

Neural Networks can be used to analyze dental images such as x-rays, to determine a person's sex based on the size, shape and development of their teeth and jaws.<sup>14</sup>

#### 4. Facial reconstruction:

AI can be used to create 3D models of teeth and jaws for use in the facial reconstruction of unidentified remains.<sup>15</sup>

#### 5. Bite mark analysis:

It is now realized that bite marks have come to provide detail of a kind comparable with the infinitesimal detail that was previously thought likely to be provided only by fingerprints.<sup>16</sup> AI can help in bite mark analysis in several ways. It can be used to analyze and match bite marks; automation can improve the speed and accuracy of bite mark analysis; can predict certain dental diseases and conditions based on patient data; and can be used to search and match data in dental databases.<sup>12</sup>

#### 6. Chatbots: AI powered chatbots can be used to answer questions and educate people about forensic dentistry. ChatGPT is an emerging ChatBot.

### Limitations

We are currently living in a digital era and have abundant digital data stores in our institutions. Most of this data is kept in archives and can be used to enable the use of artificial intelligence. However, the personal and sensitive nature of health data raised the alarm in ethical issues for AI research. Further, AI has the capability to predict and classify but not making association the same way human brain does.<sup>2</sup>

### Discussion:

The boom in AI utilization in dentistry is accelerating. The opinion of many clinicians towards AI is still burdened with skepticism and they view it as a hyped trend with questionable credibility. However, the potential of AI in revolutionizing the field cannot be unseen.

A number of studies have been carried out to evaluate the efficacy and application of AI in forensic odontology.

Andrea Macarulla Rodriguez et al compared the performance of automated systems and forensic facial comparison experts to assess the potential of the machine to support the human expert in the court room. The results showed that the automated systems have better performance to detect non-matches than investigators.<sup>17</sup>

Andreas Heinrich et al concluded that operating with an automatic PR system and computer vision could be a



successful and reliable tool for identification purposes.<sup>18</sup>

Shinpei Matsuda et al demonstrated the usefulness of CNN for personal identification using small numbers of orthopantomographic images.<sup>19</sup>

Another study by Shihui Shen et al used 3 machine learning models to analyze orthopantomograms for dental age estimation. They showed that the accuracy of the ages estimated by these models were significantly decreased.<sup>20</sup>

Münevver Coruh Kilic et al evaluated the use of deep-learning approach for automated detection and numbering of deciduous teeth in children as depicted on panoramic radiographs. The results showed high rate of sensitivity and precision.<sup>21</sup>

### Conclusion

The technological advancements in recent times have gained utilization in the field of forensic dentistry. Artificial intelligence models can be trained and then applied for decision making and problem-solving purposes. The principal strengths of AI include the ability to process large amounts of data, find weaker and more complex patterns, and work better in less predictable environments. Thus, this field that serves as a blend of art and science has evolved greatly over the years and shows a promise to reach higher horizons. It would therefore seem that AI is an ideal approach to deal with many problems in forensic odontology, but its potential can only be unlocked by starting to address the ethical and legal challenges facing us.

**Conflicts Of Interest:** None.

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