Forensic Odontology in the 21ˢᵗ Century

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Abstract:
Dentistry is using the new technologies or going to use the new technologies in the times to come. Some of these technologies are established now and their use is increasing while others are still under research and just being introduced for trials and are not being used commonly in the day to day to day practice. In this paper, it is being visualized how these latest techniques are being used or may be helpful to the field of Forensic Odontology which too is gradually developing in the global scenario.

Keywords: Artificial Intelligence, Latest techniques in forensic Odontology; machine learning; intraoral camera

Introduction :

Latest techniques are becoming fancy in every field and the field of dentistry and Forensic Odontology will not be an exception. There is a need to know what is the latest in dentistry and how can it be utilized in forensic dentistry.

In dentistry we are seeing the introduction of new technologies which are handheld portable X-ray devices, insertion of microchips in dental implants, Artificial Intelligence [AI], Smart toothbrushes, Augmented Reality [AR], Virtual Reality [VR], Teledentistry, Computer-assisted designing and 3D printing, Intraoral camera, Regenerative dentistry, CRISPR and Cone Beam computed tomography. A new procedure introduced is Virtopsy of the Head and neck which can solve many issues in a non-invasive way. There is much software that can help in the identification of the teeth and can be useful in Forensic Odontology.

Handheld portable X-ray devices:

Handheld portable X-ray devices are becoming commonly used by dentists and it has their advantages and disadvantages and should be used carefully. It is powered by a battery and can be used while being held in the hand Handheld X-ray machines have been used for Disaster Victim Identification in various incidences of mass disasters. The use of handheld X-ray machines has been established in Tsunami victims in 2005 with the advantage that it can be brought very near to the body and can be very helpful along with digital imaging and management system to the forensic odontologists for identification purposes.

Cone Beam Computed Tomography:

Cone Beam Computed Tomography [CBCT] is now being used in forensic dentistry. It can help to detect and record

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maxillofacial trauma, especially fractures. This recording is better compared to the CT and routine radiographs. It helps to record better the root fractures, displacements, laxation of the teeth and alveolar fractures. This has also been used to determine sex from the pulp volume of the teeth.

Microchips:

Microchips in dental implants and dentures can help in the identification. these chips can withstand the pressures of mastication and can be helpful in the identification of unknown bodies. Microchips can store more data as compared to the Square Codes on the implants but these were less resistant to the heat as compared to the square codes and were costly too.

Artificial Intelligence:

Artificial Intelligence [AI] includes machine learning [ML] and deep learning [DL] and ultimately by feature learning and mapping does human interpretation and action. It imitates the brain as a similar artificial neuronal network [ANN] is created. Convolutional Neuronal Network [CNN] and ANN can find patterns within the data gathered on teeth. It is the development of a machine that can work like a human brain. In addition to machine learning and deep learning AI also includes cognitive computing, computer vision and natural language processing.

Artificial intelligence can help in saving data that is being generated by the routine practice from which required information can be extracted which will help in the diagnosis. It can retrieve data from the records and analyse it. It can extract data from the radiographs and recognize the patterns. By analysing the big data can help to conclude quickly. It can innovatively help in the research.
In dentistry, it can be of use in the identification as it can help in identifying normal structures. It can detect small changes which may not be visible to the naked eye and this may help in the identification. AI is bound to affect the different dimensions of life and Forensic Odontology will not be an exception.

Augmented Realities:

Augmented realities are related to AI and can visualize the smiles of persons in real-time

Augmented realities tell us in advance how the dental treatment will change the look and if its features are stored and a person after taking the treatment needs identification then the observed features can be matched with this stored data

Virtual Reality:

This can be used for learning in dentistry and Forensic Odontology students may find it very useful in learning especially about mass disasters where they cannot be present every time and it will avoid all the bad smells and the risk of catching infections which an actual investigator is always prone to it.

Computer-assisted designing and 3D printing:

3D Scans are useful for studying and detecting dental anomalies which will be able to help in the identification.

With3D printing it is possible to make dental casts, In case of comparison and analysis of bite marks dental casts are needed for which we make negatives and positives and if 3D technology is used it will be very easy to make the dental casts and that too very accurate and quick. This will help the process of identification from the bite marks

Smart Toothbrush:

These have sensors that can send the data and it may be of immense help in the humanitarian forensic work later on if this data can be used properly as the data present in it will be the latest data since the last brush used rather than the last dentist visit.

Intraoral camera:

Intraoral cameras are very useful to see the inside of the mouth and examine the teeth and their use is quite prevalent in dental practice. If it can be used clinically its use in the dead body may be as useful as it in the living conditions whenever the autopsy dental examination is needed especially in mass disaster conditions. It will be convenient and time-saving as well as all the findings can be recorded as a piece of valuable evidence.

Teledentistry:

Sometimes forensic odontologists may not be available at every crime scene where ever they are needed. Using teledentistry can greatly help the investigations as the investigator can get useful input from the forensic odontologists.

Postmortem photographs can be taken with an oral camera which can be operated remotely and in one study 97% of identification was done using remote videos with an intraoral camera.

Virtopsy of head and neck:

Virdentopsy can be helpful in the identification process. It can be especially useful in pandemic conditions to avoid the transmission of the disease. It can also be useful in the recording of injuries in the oral cavity. Combined with teledentistry forensic odontologists sitting at a distance can be very helpful.

Regenerative Dentistry:

Forensic Odontologists should know that there is regenerative dentistry that can allow the tooth to heal itself when the teeth are filled with material that can act as stem cells. Knowledge of this is a must for forensic odontologists to remember that this is possible while comparing the antemortem data with the post-mortem data.

Clustered Regularly Interspaced Short Palindromic Repeats [CRISPR]:

This is the gene modification where bacteria present in the mouth can be modified or genes can be modified to prevent some dental diseases.

Phylogenetic diversity in individuals is fairly constant in a person but it differs from person to person and this could help in the identification by comparing this if antemortem data is known and especially if the data is a recent one.

Softwares:

Much such software has been developed which is being used for comparing antemortem dental data with the post-mortem dental data and is used in the identification. In Australia, David is being used while Interpol is using DVI System International from Plass Data® and in North America WinID® is being used. Computer-Assisted Post Mortem Identification (CAPMI) is also used. It is available for free to the government and humanitarian agencies.

Software is also being used in bite marks comparison. The computer-based superimposition technique with Adobe Photoshop is an accurate and also cost-effective way of identification from the bite marks, computerized superimposition technique can also be used for Palatal rugoscopy and can be an effective way of recognition if the antemortem pattern is available. Dental Print© was also found to be accurate and useful, Sidex is Next Generation Software and is an economical, easy and accurate way.

GIMP 2.10 were effective even in fractured mandibles to compare the antemortem dental radiographic records with the post-mortem dental radiographic records.

It is also used in craniofacial reconstruction when the only skull is found or the body is unidentified and it has a skull and mandible. This is based on the thickness of the tissue at different places and different landmarks of the face .

Computerized facial reconstruction gives better results as it is more objective as compared to more subjective drawings. It has many tools including the shape of the nose eyes, facial contours, eyebrows, lips and hairstyles; and can give various colours and shades to the face.

Electron microscopes:

It helps to study the plaques to say the person was vegetarian or non-vegetarian. This may help in the identification of whether the person is known vegetarian or non-vegetarian.

Scanning Electron Microscopy with Energy Dispersive X-ray Spectroscopy (SEM/EDS) :

For morphological analysis of the enamel, both grounded and ungrounded and noting the ultrastructural's features by field emission scanning electron microscope. It is a matter to think about whether these features can be used for identification or not.

Portable X-ray Fluorescence spectrometer (XRF) :

This can be used to determine the brands of different resins. This may also help in the identification as the uniqueness of the resins used in restorative dentistry may help in the identification as these resins have the property to withstand the effect of extreme heat like cremation. Portable XRF machines can be of great use in such circumstances to identify the resins if antemortem data is available even in the cremated remains.

Further creation of the data for these reasons using SEM/EDS can be of immense help in the identification in future.

X-ray Synchrotron Microtomography:

Mineralization of dental enamel and mineral organization proceed at the same time but mature differently This is used to study the evolvement of the environment. Need to think about can this maturation process be useful in identification.

Material and Methods:

A search was done on the Goggle scholar for the latest technologies in dentistry and forensic Odontology and abstracts were read and those which could be correlated were studied. Some of the missing gaps were searched on Google search and also included in this paper.

Discussion:

Though Artificial intelligence is developing at a very fast past pace still it will take a long time and shortly it is not going to replace forensic odontologists. Its role is going to be complimentary.

Many companies have started using AI in dentistry but still, Artificial General Intelligence [AGI] has not been developed which is more like a human brain.

New algorithms in AI will develop which will help in Forensic Odontology but we need to think along these lines and should start working on it.

Dental decay and periodontal disease can be better detected from dental radiographs so similarly periodontosis will be better detected by AI which may be of help to determine the age. As AI can learn specific patterns more research will help in ultimately finding easy solutions for age determination and errors may be reduced.

All the features mentioned in Gustafson's method and their modifications may be better researched and studied by AI to give us a lesser error.

Limitations to the AI will be insufficient data and inaccurate data which may take a long time to improve to apply to Forensic Odontology because it needs precision to be applicable in medicolegal cases.

Intraoral cameras can be very helpful when required for teledentistry and the help of forensic odontologists is required especially in mass disasters who can use this and give valuable inputs.

Forensic odontologists will have to keep in mind the regenerative dentistry if such treatment has been taken by the patient because the antemortem records may be different from the observed findings at the post-mortem examination and this will have to be kept in mind while comparing and giving the final opinion
Identification is also possible by studying the pattern of the bacteria in the mouth and CRISPR which can change the pattern of the bacteria in the mouth should be kept in mind in the times to come if a pattern of the bacteria is being used to identify.

Conclusion:

Many new techniques are coming into dentistry and there is a need to think that how these can be useful in forensic dentistry. Artificial intelligence is going to impact forensic Odontology in a big way in the years to come. An intraoral camera is especially going to be helpful in mass disasters when the forensic odontologists are not available nearby and their help can be taken by teledentistry. Regenerative dentistry when used will also be a challenge for forensic odontologists. Forensic odontologists must know the latest techniques so that they can be amalgamated into the future practice of Forensic Odontology.

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