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Use of Endodontic Guide and 3D Printing in Endodontic Procedures: A Review Article

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ABSTRACT

The control or conduct of calcified canal is an effortful task during endodontic practice, which is why other clinical options have been find to improve their viewpoint.one of them, newfound is the use of guided procedures, which are thought-out to be cautious and accurate when finding calcified canals, thus diminishing the threat of operative errors and increasing the success of endodontic procedures. Root Canal Treatment (RCT) may necessitate eradicating most bacteria from the canal during biomechanical preparation. 3D printing which is being used in aerospace and defense art and design is now growing as a subject of greater passion in dentistry. 3D printing is used in various procedures in dentistry such as for framework in dental restorations, for manufacturing of drill guides in dental implants and in manufacturing of aligners or wire bending (robotically) in orthodontics, it can also be used in oral and maxillofacial surgery and in medical modeling. Recent advances in 3D printing or imaging such as Cone Beam Computed Tomography (CBCT), intraoral scanners along with CAD and CAM is of greater importance with respect to dentistry. To conclude endodontic guide along with the help of 3D printing techniques is thought to be safe and precise method for various endodontic and other dental procedures.

Key words: Guided access cavity, 3D printing, Cone Beam Computed Tomography (CBCT), Computer Aided Design (CAD), CAM

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INTRODUCTION

Pulp is the soft and living tissue present within the tooth in coronal and root portion. Transformation of this soft tissue into calcified or hard structure within the root canal space is known as pulp canal obliteration or calcification. Pulp canal obliteration is most often witnessed in elderly due to formation of dentin which can be secondary or tertiary in origin, which reduces the space in the root canal of a tooth. Tertiary dentin deposition is because of external injuries. Various causes of external injuries includes caries, tooth preparation during prosthetic treatment, wear of tooth enamel or from restoration or filling materials. Whereas in young individual when a pulp of vital tooth is exposed due to trauma or several other causes, the pulp leads to deposition of hard calcified tissue leading to narrowing of root canal space. Obliteration may occur in anterior teeth as well as in posterior teeth. Concussion, or sublaxation and laxation results in obliteration of root canal space in anterior teeth [1].

In corresponding cases discussed above, if root canal therapy is required, it is more difficult to treat a obliterated canal tooth than treating a tooth with a spacious and apparent canal. It will be difficult for a clinician to align access cavity in such tooth and obtaining the apical portion of the root during any periapical surgeries, on the other hand, can be difficult since it takes accuracy to reach the apical goal without injuring adjacent bodily components and therefore there will be a higher risk of treatment failure. Hence use of Intraoral Periapical Radiographs (IOPA) and CBCT is required in some or such cases [2].

The notion of guided endodontics is recently published, in which the use of computer based technologies that is guides designed by computers are employed for access cavity preparation, in order to obtain forseeable and safer results. Endodontic guide is also known as or the another name for it is Targeted Endodontic Treatment (TET). A dynamic or static guided method is possible. Guided endodontics can provide more expected treatment outcomes in circumstances of calcified canals and endodontic microsurgery than traditional treatment techniques. Static GE is a technique that combines CBCT with an optical impression to provide a plan for designing a virtual drill path after a clinical procedure of drilling with a guide [3].

LITERATURE REVIEW

During difficult circumstances, where traditional radiographs such as intraoral periapical radiographs and OPGs do not provide correct or enough information on the architecture of the tooth and its surrounding structures, CBCT can be used. The 3D information from CBCT can be mixed with information of teeth obtained from intraoral scanners in command to design and 3D print a guide for endodontic treatment [4].

The concept of guided endodontic access could help clinicians during treating a obliterated canal case and helps in avoiding the removal of unwanted tissues leading to a successful treatment plan and a better prognosis.

Protocol for the design of the 3D guide

Firstly the method of designing a 3D guide involves:

- Highly diagnostic CBCT of the patient.
- Intraoral impression of the patient.

So, after diagnosis and acquiring the CBCT of the patient, there are two ways to get the intraoral impression of the patient that is directly or indirectly [5]. By the help of intraoral scanner we can directly get the impression and indirectly by scanning the impression tray or plaster cast with an optical scanner.

Then using, a specialized image processing software, both the intraoral and CBCT scans are recorded using surface registration. After registrating, a template or guide is designed using a 3D guide design software. A template or guide is designed according to the pathway for treatment [6].

Indications or uses of guided endodontic therapy

- Pulp canal obliteration or calcification is the most common indication to use guided endodontic therapy. Calcification can either occur in anteriors or posteriors so it can be used in either ways.
- It can also be used in cases of DD with pulp canal obliteration and apical periodontitis.
- When removing a volume of dental tissues, guided endodontic therapy is more useful than conventional methods.
- CBCT guided therapy can also be used to remove or retrieve the broken part of endodontic instruments such as file from the root canal.
- It can also be indicated for removal of adhesive fibre post.

Advantages of guided endodontic therapy

- Clinician's chair time is greatly reduced. Therefore it is advantageous for both doctor and patient.
- For the management of cases of pulp canal obliteration following trauma, guided endodontic therapy can be a better and safer option.
- Guided endodontic therapy reduces the risk of perforation. Hence tooth can be saved from going into extraction.
- Treatment predictability is improved with the help of guided endodontic therapy.
- It reduces the risk of ledge formation and hence surrounding tissues such as dentin, cementum and periodontal ligament are not harmed.
- Guided endodontic therapy is minimally invasive and provides efficient preparation of access cavity.

Disadvantages of guided endodontic therapy

- Guided endodontic therapy appears to be time consuming because of various scans such as CBCT and optical scans and due to designing of stent.
- Guided endodontic therapy cannot be done in curved part of root canal, it only have access to straight root canals or straight portion of root canals.
- It is costlier as compared to conventional methods because of requirement of additional facilities such as scans and intraoral impressions. Many patients find this as unaffordable due to higher cost.
- As CBCT is a required procedure in endodontic guided therapy, radiation exposure is one of the major drawback of this therapy. Due to radiation exposure patient may land up getting new problems such as radiation caries or there will be increase risk of cancer in such patients.

3D printing in endodontic and dental practice: 3D printing technologies are not brand new but the term 3D printing is new [7]. The first patient treated with 3D printing technology was back in 1999. Computer Aided Design (CAD) is the root of 3D printing technologies. In dentistry with the help of CT, CBCT data we have ready access. CAD CAM technologies are being used for production of crown and bridge frameworks. For every patient this procedure is different or unique because of change in impression, change in tooth morphology etc [8].

DISCUSSION

Usage of 3D printing in dentistry

Restorative dentistry dental models: With the application of 3D printing and intraoral scanners, model casts are being prepared. It is not always necessary to prepare master models, 3D printing master models can also be used for fabrication of restoration for example adding a veneer material [9].

Use of 3D printing in digital orthodontics: In orthodontics, procedures like capturing patient's data, bending of wire (robotically), indirect bonding-bracket splints, manufacturing of aligners can be done with the help of CBCT or CAD CAM technologies.

In dental implants: In cases of complex geometry in bone morphology, use of 3D printing technique is effective [10].

Crown copings and partial denture frameworks in prosthodontics: In fixed or removable prosthesis, with the help of CAD and CAM technology, treatment can be planned and one can also design restorations. The scan data may be used to mill or print crown or bridge copings, implant abutments and bridge structures [11]. 3D printing may be used for manufacturing of metal structures in two ways: Direct way or indirect way. Indirectly printing is done by burn out resin or waxes. Indirect method is less costlier than direct method and also reduces the post processing time, hence indirect method is far better then direct method and can be used in fabrication of traditional casting alloys.

Oral and maxillofacial implants: 3D printing can be used in producing maxillofacial implants and it is also capable of producing complex geometries.

Advantages of 3D printing in endodontic procedures and other various fields :

- 3D printing provides flexible designs.
- It reduces the waste production.
- It can be useful in making complex geometrical forms.
- Not much costlier, hence it is a affordable technology.
- It is easy to use and also eco-friendly.

Disadvantages of 3D printing in dentistry:

- One of the major drawback of 3D printing is design inaccuracies and also copyright issues.
- There is a limited amount of material that can be used in 3D printing.
- Due to this technology, the number of jobs in manufacturing field will be reduced.

3D printing technologies and materials used: There are various types of printing technologies having their own advantages and disadvantages. Equipment cost, maintenance and functions are the common features between these technologies. Different techniqes are:

- Stereolithography
- Photojet
- DLP
- SLS
- Fused Deposition Modeling (FDM)
- Electron Beam Melting (EBM)

List of various materials used in 3D printing technologies are as follows:

- Sintered powder
- Thermoplastic material
- Light cured resin
- Plaster or cementaceous material, also known as powder binder

CONCLUSION

Guided endodontic procedures such as guided access cavity preparation in anterior or posteriors, guided post fibre removal, guided root canal treatment of obliterated or calcified pulp canal are promising approach with a high degree of predictability and a reduced risk of iatrogenic injury. Guided endodontic therapy is also found out to be a time saving method in tooth with pulp canal calcification. Furthermore research is to be conducted for it to be a current treatment option for the management of calcified or obliterated canals in anterior and posterior teeth.

3D imaging and modeling, as well as Computer Aided Design (CAD) technologies, are having a significant impact on all parts of dentistry. Making of complex geometrical forms, in the accurate way is only possible because of the help of 3D printing. although on the basis of affordability and its uses in various aspects of dentistry, '3D printers' are getting more n more useful, but the costs of operation, materials, maintenance and the necessity for qualified operators must all be taken into account. The convergence of scanning, visualization, CAD and 3D printing technology, as well as the profession's inherent curiosity and inventiveness, makes this a particularly exciting time to be in dentistry.

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