

A Review

Digital Evolution in Prosthodontics: Applications in Complete Denture fabrication

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Abstract

Digitization is not just a word it is a beginning of digital revolution in the world of Prosthodontics. Contemporary dentistry is all about doing functionally sound, aesthetically acceptable, minimized discomfort and less time-consuming practice. The scope of digitisation and technology in prosthodontics is endless. The new digital impression technique, jaw relation technique and denture fabrication technology bring about absolute digitization to the mode of prosthodontics. This article aims to discuss the applications of different digital technologies in Complete Denture fabrication.

Keywords: CAD/CAM complete dentures, Contemporary dentistry, Digitisation, Intraoral scanner.

Introduction

In 18th century, Dentistry was majorly about using waxes and plaster of Paris for impression making, hand driven dental equipment and later replaced by water driven equipment.⁽¹⁾ Earlier the conventional impression techniques has been used to register the 3-dimensional geometry of dental tissues.⁽²⁾ Back then there were selective treatment options due to limited dental materials and dental equipment. The contemporary dental practice has minimized error potential, reduced treatment time with better quality assurance and also provides next to natural aesthetics with digital approach.^(1,2) With the passing years this endless growth, emerged variety of treatment options for concerned complications. It is quiet challenging to keep pace with mounting research, but it is the need of hour.

More updated the knowledge, to provide better treatment to the patients a dental practitioner should keep their knowledge updated, which helps towards the upliftment of dental fraternity. To start with the very first step for fabrication of complete denture

done by impression materials conventionally, which is replaced by digital IOS (Intraoral Scanner).⁽³⁾ The introduction of IOS device in dental practice coincided with the development of CAD/CAM (computer-aided design and manufacturing) technology in dentistry.⁽⁴⁾ This review aims to search the literature related to use of the digital technology in every step of complete denture fabrication.

Need of Review

In contemporary dentistry, digitisation is being a huge part which needs to be understood well. The current literature involves few systematic reviews regarding the effect of rapidemerging digital technology in prosthodontics. It is important to know the series of development in digital sector as they either affect the contemporary practice or may have a remarkable futuristic outcome. Such reviews would help the dental fraternity to be updated with the latest

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technologies for the cause of betterment and cultivate a futuristic vision. The impact of digital technology in prosthodontics is widespread, as from maintaining the records of patient to clinical application, laboratory procedures, training students and practice management. It requires adequate knowledge to utilize the technology for the cause of betterment.

Data collection and analysis

A comprehensive search for literature is carried on health-related electronic databases like PubMed/Medline, Science Direct, Scopus and Google Scholar for the relevant studies. According to the inclusion and exclusion criteria articles are searched and screened. Articles with advantages and disadvantages of various techniques and their futuristic outcome are preferred. The articles published in English language only are reviewed.

Digitisation in patient documentation

Before 1800, physical examination played a minor role, diagnoses were solely based on subjective symptoms of the patient. The need of quantitative measurement in clinical medicine introduced by the French Clinical School and German laboratory medicine gave prompt to systematic recording of the patient-related data for didactic purpose. Medical records include sections for chief complaint, family history, patient habits, past medical history, present illness, physical examination, blood analysis, diagnosis and instructions.⁽⁵⁾ With increasing number of patients, hospitals suffer from problems of growing volume of records and unreliable availability of records for knowledge purpose. In the first decades of the 21st century, a major transition in documentation of patient-related data seen as clinical settings started adopting the electronic health record and electronic medical record as the solution for the problem with paper records.⁽⁶⁾

Digitisation in Diagnosis and Treatment Planning

Next important step after completing with medical and dental record is radiographic as well as hematologic investigation. Dental X rays have been an important diagnostic aid for the making right diagnosis to deliver a good treatment. Digital radiography provides immediate viewing of images as well as omits the use of chemical solutions and dark room for processing X ray films. Advent of digital radiography allows easier reading and diagnosis, comparison and subsequent viewing and also reduced radiation exposure by fewer retakes. The ease of storage and electronic sharing of digital images for communication with other practitioner for treatment planning.

Digital Complete Denture fabrication

1. Digital Impressions

In early 1980s, concept of digital impression making was introduced. In current dental practice impressions are made by conventional impression material like addition silicon, impression compound, polyether for recording hard and soft tissue of oral cavity. Conventional impression method include tray selection, impression making, disinfection which can be replaced by a single step using digital technology.

IOS (Intraoral scanner) is a device consist of a handheld camera, a computer and a software used for making digital impression more comfortably and faster than current impression technique.⁽⁷⁾ Intraoral scanner generate STL (Standard Tessellation language) file which is used for designing a 3-dimensional structure. Processed data can be stored and checked at subsequent follow ups. Digital impression will eliminate the issues like improper tray selection, potential distortion of impression before pouring, possibility of bubbles and enhance patient comfort and also reduce gag reflex.⁽⁸⁾

2. Digital Models

In this era of rapid evolution the way conventional impression techniques are replaced by digital impression techniques likewise traditional cast models are also replaced by digital models. The STL files generated after scanning the oral cavity are used for producing digital models (Fig.1). These digitally produced models eliminate the steps like disinfection of impression, vacuum mixing, pouring of impression, waiting for stone to set. These all are time consuming steps and are done by lab technician, so chances of human related errors are high. On the other hand the digital models that are precisely developed by computer aided designing and manufacturing. The digital impressions and digital models bring a complete digitisation to the mode of prosthodontics.

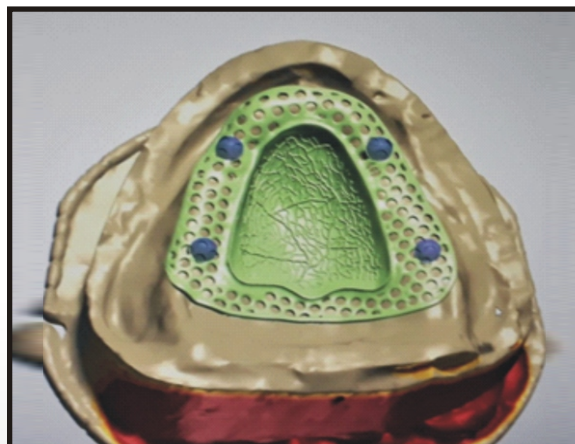


Fig. 1. Scanned digital model of edentulous maxillary arch

3. Virtual Articulators and Facebows

An essential tool has long been used in laboratory procedures for fabrication of prosthesis is mechanical articulator and facebow. Mechanical articulator (MA) is a physical instrument used for reproducing the maxillo-mandibular relation itself, the relation of jaws with skull base outside the oral cavity. Advancement of technology cause the shifting from mechanical device to a digital alternative, the Virtual Articulator (VA) first introduced in 2002.⁽⁹⁾ The virtual articulator precisely reproduces jaw relation in the virtual environment. Facebow is an important tool for mounting stone models in mechanical articulator likewise there is need for virtual facebow for assembling digital models in virtual articulators. The importance of facebows is to orient the arches with respect to reference plane from patient's head. The purpose of using virtual articulators and facebows is to reduce patient discomfort. It is less time consuming and also eliminates mounting and waiting for setting of plaster, chances of errors introduced in maxilla-mandibular relation while mounting the stone models.⁽¹⁰⁾

CAD/CAM Complete Denture Fabrication

Computer-engineered complete dentures (CECDs) are manufactured by computer-aided designing and manufacturing using two methods one is the subtractive manufacturing which involves milling of 3D models by removing the extra material from a solid volume, other one is additive manufacturing or 3D printing which involves successive layer-by-layer deposition of material to produce a 3D model.^(3,11) Fabrication of conventional complete denture consist of clinical steps along with laboratory steps and post-operative follow up visits. (Fig. 2) In prosthodontics subtractive technology is majorly used to fabricate removable dentures partial as well complete, full coverage crowns or partial veneers, implant abutments and maxillofacial prosthesis.⁽¹²⁾ CECDs offers several advantages, such as fewer clinical visits and laboratory steps with reduced chair time. (Fig. 3) The digitally fabricated dentures has superior strength, uniform thickness and proper fitting. However CECDs has some drawbacks also as it is difficult to assess occlusal vertical dimensions, maxillary anterior teeth incisal edge position and required lip support. Also CAD/CAM dentures are more expensive than conventional one. Technologies and techniques are constantly evolving to somehow minimize patient discomfort and enhance retention and aesthetics.⁽¹³⁾

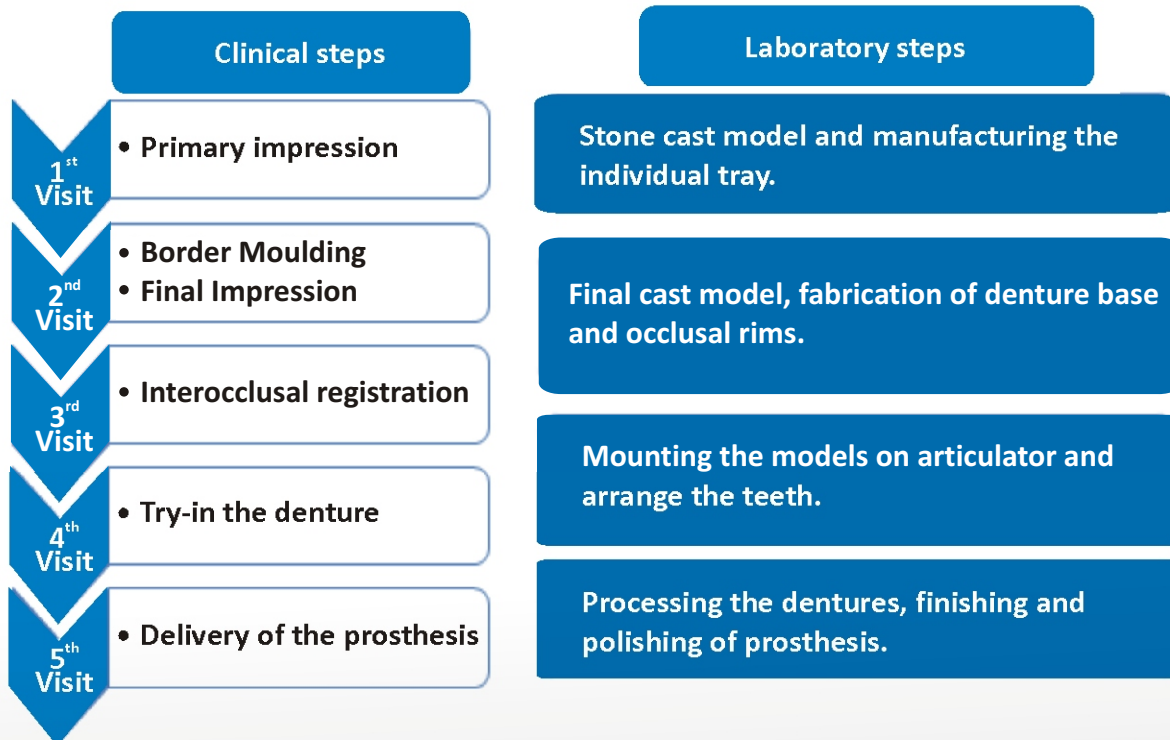


Fig. 2. Workflow of Conventional Complete dentures

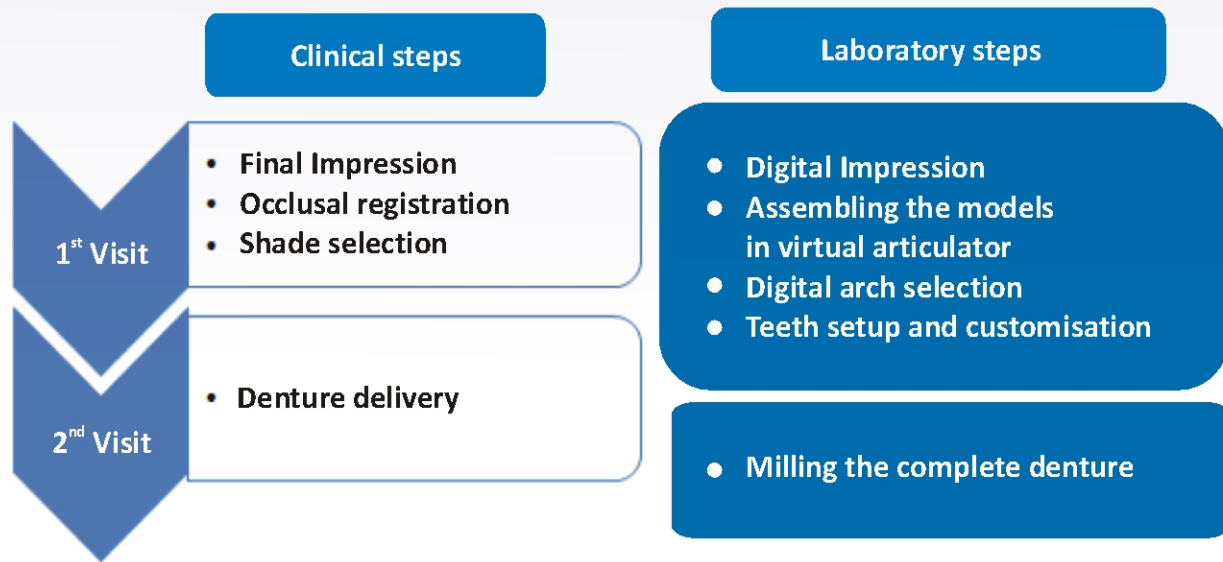


Fig. 3. Workflow of Computer-Engineered Complete dentures

Conclusion

Advancement in digital technology substituted majorly many steps involved before and during fabrication of removable complete denture such as digital imaging, digital impression making and digital manufacturing. It has undoubtedly simplified the clinical procedures along with improved treatment outcomes. Digital technology has remarkable impact on patient motivation. In every aspect digital technology is superior to conventional techniques but have several drawbacks such as high cost of products, trained and skilled working staff. If used properly, this would not only redefine the dentistry but also achieve the utmost for the profession.

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