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VIRTUAL ADVANCES IN PROSTHODONTICS - A REVIEW ARTICLE

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ABSTRACT

Virtual reality is becoming an essential part of modern dentistry world. The benefits of virtual reality are been used as a method to improve hand-eye coordination in better analysis of patient outcome & fine motor skills. This article provides an overview of virtual technological advances in the field of dentistry and also provides an inside into the virtual reality techniques used in prosthodontics. This helps in better understanding between doctor and the patient and effective diagnosis & treatment planning for the patient.

KEY WORDS: Virtual reality, Digitalization, Technological advancement.

INTRODUCTION

Virtual reality is used as a tool for various disciplines in dentistry. It has replaced the manual world and it enables broader outlook in the treatment modalities, which are available for the patient.

The virtual reality has improved the precision and accuracy in treatment planning and has also enhanced the quality of treatment for the patient.

Virtualization in prosthodontics have been employed in CAD/CAM, Implant surgeries, maxillofacial prosthesis. It has paved the way for modern technological improvements like CAD/CAM(AUTOCAD), Stereolithography(SLA resin), Rapid Prototyping (Fertigung mit 3D system), Virtual articulators (kordass & gartner), Digital facebows(Whip Mix, Louisville, KY), digital radiographs(Signa MRI from GE), virtual dental softwares, optoelectrometric recording of jaw motion(OKAS-3D), Digital instron machine(Instron 5980 series), Retention testing device(ECT 3000) and Audiovisual aids.[11]

i) CAD/CAM

Computer aided design and computer aided manufacturing is incorporated to modify the design crowns, veneers, inlays and onlays, fixed bridges, implants, dentures and in full-mouth reconstruction cases. The first CEREC chairside treatment took place on sept19,1985, in university of zurisch dental school and the material used was Vita Mark I feldspathic ceramic(Vita Zahnfabrik).[1]

The three main CAD/CAM systems used are 1)In office systems- CEREC system is used in Silicone maxillofacial prosthesis, fixed prosthesis & In RPD, cast partial dentures fabricating using Co-cr alloys or pure titanium.2)CAD/CAM for dental lab models- CEREC- in lab scan models and add esthetic porcelain & characterization of restoration. 3)CAD/CAM for outsourcing-'satellite scanners' in dental lab connected to production center via internet. Data is sent to production center for restoration.

The recent CEREC 3 system has expanded it's uses in fabricating inlays, onlays, veneers, crowns, 3 unit bridges & custom lithium disilicate implant abutments.[14] Currently available system for clinics is the KATANA system, which uses Y-TZP green blocks for milling that provides satisfactory fits within clinically accepted levels.[4]

ii) Virtual Reality Articulators

It is based on virtual reality that will reduce the limitation of mechanical articulators and stimulating real patient data, that allows analysis of digitalized casts regarding to static and dynamic occlusion and jaw relation. It can signify and quantify the effects of resilience of the soft tissue on the time dependent basis during muscular movements of chewing or eating.[17] Completely adjustable(e.g;kordass & gartner) and mathematically adjustable (e.g;stratus 200, szentpetery's)[15] VR articulators are present. Virtual articulators with CAD/CAM offers great potential in treatment planning with dental implants, maxillofacial

prosthesis & fixed prosthesis. It offers greater precision and decreases the duration of implant treatment. virtual articulator improves the design of dental prosthesis by adding kinematic analysis to the design process[7] through CAD & reverse engineering tools.

Completely adjustable virtual articulator records the exact movement paths of mandible using an electronic jaw registration system called "Jaw Motion Analyser" (JMA), which is a ultrasonic motion capture device that consists of an ultrasound emitter array & 4 receivers attached to facebow to detect all rotational and translative components in all degrees of freedom, whereas a special digitizing sensor is used to determine reference plane.

iii) Virtual Facebow Technique
This technique helps transferring the location of digitalized cast from patient to a virtual articulator using virtual facebow transfer,[8] which is effective and accessible digital companion to dental implant diagnosis and treatment planning. The reversal engineering devices necessary to carry out virtual facebow transfer are intraoral scanner, digital camera and specific software. It's current reqirements include any supported tablet device with an android operating system, a back facing camera and a minimum system update of 4.0.3.[16] first version is 2.0 with a simplified approach.

iv) Digital Radiographs
The first digital radiography system called Radio Visio Graphy (RVG) uses a sensor of solid state and information is stored as an image in computer. Experimental digital substraction angiography was first introduced 1977 by kruger et al and introduced into clinical use as first digital imaging system in 1980.[2] The images produced may be direct , indirect or semidirect. It helps in visualizing bone supporting tissues such as pdl, lamina dura, bony trabeculation in high resolution. It is also helpful in post surgical follow-up incase of implants. Recent digital radiographic systems are panoramic, multislide CT, cephalometric projection, sialography & CBCT. Current array of technologies include CR, Photoconductor drum, direct DR, indirect DR and charged coupled device(CCD).[3] Digital radiography requires 90% lesser dose compared to E-speed film.[23]

In recent years 3D image of CBCT has grown rapidly in the field of implant, orthodontic & endodontic treatments.

v) Dental Softwares
Dental Software helps user control and freedom, consistency and standards, error prevention, recognition rather than remembrance, flexibility and efficiency of use, aesthetic and minimalist design, help tool recognizable by the user, diagnose and correct errors, help and documentation.[12] Schleyer & kirshner categorized as administration, clinical & for internet. Zimmerman et al categorized as for administration &

management of patient's documents, telecommunication, computerizing instruments etc. assisting with clinical decision making. DEMS(Dental Meassurement System of UIAM) is the system that has been developed to calibrate & measure tooth decay.this system is been used by dentists to teach dentistry students.[9] Different dental softwares are eaglesoft 20,open dental, Cs softdent, EZ 2000 dental software, easy dental, exact v12 & virtual assessment software, which is used as an assessment strategy in fixed preclinical prosthodontics.[28]

Implant 3D software allows 3D implant simulation directly on our personal computer, which simulates the position of implants in 2D & 3D that helps in better treatment planning which is safe, efficient & quick. Exocad Dental CAD 2.2 Valletta, a dynamic and innovative CAD/CAM software which helps in implant planning, production, scanning & communication that is very easy & reliable to use by the dentist & lab technician.

vi) Audiovisual Aids
It provides effective communication and interaction between students & teacher, which keeps individual learner focused or attentive, retains interest till end of session and avoids students being distracted. It provides more versatility and accessibility through a virtual environment, that maximizes realism of the actual patient care at low level of risk.[24]

vii) Stereolithography
Sterolithography apparatus was invented by Charlie Hull of 3D systems Inc.[19] It is a laser lithography that consists of container with liquid photo sensitive resin, model building platform & curing uv laser. The model is designed through a CAD software. The 3D stereolithographic modeling is a valuable tool in designing a surgical or rehabilitation treatment such as prosthetic implantology & craniofacial surgery such as reconstruction & orthognathic surgery. This method includes a photosensitive liquid resin bath, a model-building platform, and an ultraviolet (UV) laser for curing the resin.[20]

viii) Rapid Prototyping
The term rapid prototyping refers to a class of techniques that can automatically construct physical models from CAD data. Time and money saving varies from 50-90% than conventional system.[6] There are three phases of development which can lead to rapid prototyping. They are manual prototyping, soft or virtual prototyping and finally leads to rapid prototyping.[10] It is commonly used in wax pattern fabrication, direct dental metal fabrication prosthesis, mold for complete dentures, maxillofacial prosthodontics.[25] Rapid prototyping method is employed to plan, produce and develop dental prosthesis such as crown, fixed and removable partial dentures and copings.[21]

ix) Digital Instron Machine

Digitalization has become part of contemporary procedures and most of the procedures based on digital techniques in prosthodontics. Digital procedures like impression making, recording jaw movements and fabricating prosthesis[13]. CAD/CAM is involved not only in ceramic technology but also used for CAD/CAM implant surgeries, maxillofacial prosthesis and diagnostic splints. Testing of dental materials has become more efficient with advanced digitized testing instruments such as the Digital Instron Machine. It is used for testing material tensile strength, cpmpression fatigue and structure. Similarly, there has been development in impact testing machines.[26]

x) Optoelectrometric Recording of Jaw Motion

This method is one of the further development of single floating circuit target tracker. The jaw movements can be recorded with high spatial and temporal resolution.[27] The jaw motion was recorded by digital video camera and processed as spatial co-ordination. It is used in locating the TMJ point during opening and closing of jaw in mandible retarded position.[29]

xi) Retention Testing Device

Retention testing device is used for implant over dentures. The mandibular denture was positioned correctly on the tissues and the patient is asked to rest his tongue passively in the floor of the mouth with its tip adjacent to the anterior denture teeth.[30] The device is attached with digital force measurement guage secured to a vertical wheel stand associated with customized support to held and support the denture in adjustable angulations.[22] The retention measurement test is performed for each set of dentures at the time of insertion. During the retention test, the patient was asked to keep his chin firmly on a chin support and to wear upper denture to prevent palatal injury while talking off the denture. The test begins after the patient is allowed to bite on his dentures to release the air trapped beneath denture base.[5]

CONCLUSION

These virtual advances has brought up a better understanding between the dentist and patient & has made the cost and duration less. The main drawback of these virtual advances is it's high financial cost & it is not easily available for all patients. If it is implemented in near future, it would bring up a friendly approach for patients and better processing of prosthesis, which will eventually make this boring manual world a better place to live.

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