VIRTUAL ARTICULARTORS : REALITY IN VIRTUALITY – A REVIEW

Prosthodontics

Dr. Kalpana.D	Department of Prosthodontics, Dayananda Sagar College of Dental Sciences and Hospital, Kumaraswamy Layout, Bangalore
Dr. Brunda	Department of Prosthodontics, Dayananda Sagar College of Dental Sciences and Hospital, Kumaraswamy Layout, Bangalore
Dr. Sanjana.J.Rao	Department of Prosthodontics, Dayananda Sagar College of Dental Sciences and Hospital, Kumaraswamy Layout, Bangalore
Dr. Pathi Venkatesh*	Department of Prosthodontics, Dayananda Sagar College of Dental Sciences and Hospital, Kumaraswamy Layout, Bangalore *Corresponding Author
Dr. Priyanka Bhat	Department of Prosthodontics, Dayananda Sagar College of Dental Sciences and Hospital, Kumaraswamy Layout, Bangalore

ABSTRACT

The field of dentistry, in particular prosthodontics has seen tremendous and much sophisticated advances. The advent of intra-oral scanners, CAD/CAM and reverse engineering technologies have even further improved the quality and precision of treatment procedures. Virtual articulators are one such tools that enables dentist to overcome the limitations and drawbacks of a traditional mechanical articulator. By input of real patient data it allows the analyses of static and dynamic occlusion. The purpose of this article is to highlight the procedure and benefits of using a virtual articulator over the traditional one.

KEYWORDS

virtual articulator, software articulators, CAD/CAM, recent advances

INTRODUCTION:
The use of computer technology in recent decades has tremendously improved dentistry to emerge as a sophisticated branch in the field of medicine. Virtual reality (VR) implies to the interactive, three-dimensional (3D), multi-sensory, viewer centred computer generated environment. It is the simulation (or) replication of any object onto a 3-D view with better accessibility and improved view.

In the field of prosthetic dentistry, VIRTUAL ARTICULATOR incorporates virtual reality applications to the world of dental practice for analysis of complex, static and dynamic mechanisms[1]. It's chief application is in the simulation of the mechanical articulators.

Acc. to GPT-8, An articulator is defined as " A mechanical instrument that represents the temporomandibular joints and jaws, to which maxillary and mandibular casts may be attached to simulate some or all mandibular movements".

LIMITATIONS OF MECHANICAL ARTICULATORS :
The evolution of an articulator parallels with that of varying concepts of occlusion. Attempts were made to record anatomic relationships (or) reproduce functional movements of the mandible and transfer this to the mechanical devices to simulate the conception of natural movements.

Starting from plaster articulator by Philip Pfaff in 1756, Hanau articulator by Rudolf Hanau in 1921 and so on till the latest TMJ simulator, mechanical articulators have been used extensively in dentistry. But each of these had a few drawbacks and limitations, namely ;

- Articulators are made primarily of metal, although few have plastic parts they are subjected to error in tooling and to error resulting from metal fatigue and wear.
- The problem of making accurate marks in the presence of saliva.
- The inability to know exact location of the condyles.

NEED FOR VIRTUAL ARTICULATOR
The main disadvantage of a mechanical articulator is its limited accuracy of occlusal surfaces since it does not take functional movements into considerations. So the occlusal surface of the prosthesis has to be corrected manually in patients mouth after, this results in loss of valuable patients time and discomfort. But if we do not consider functional mandibular movements and place the restoration as it is, it will cause problems for the patients TMJ. Hence for an accurate occlusal surface construction there is need to include the functional kinematic analysis factor in the designing process aspect which can be achieved by the use of a virtual articulator.

VIRTUAL ARTICULATOR
Virtual articulators are also called as "software articulators" since they exist only as a software programme / tool. Combined with CAD/CAM technology, this tool offers a great potential in accurate planning of various treatment procedures. Its use increases accuracy and precision for the dentist to carry out the treatment and to achieve a better function and comfort for the patient as well.

Advantages of a virtual articulators are as follows ;
- Provides best quality of communication between the dentist and dental technician.
- Simulating real patient specific data.
- Analyses both static and dynamic occlusions.
- Analyses gnathic and joint conditions.
- Designing of occlusal surface in CAD CAM system.

Types of virtual articulators :
Basically there are two types of virtual articulators namely; completely adjustable virtual articulators and mathematically simulated virtual articulators.

A. Completely adjustable virtual articulators
This type of virtual articulators uses an electronic jaw registration system called as jaw motion analyser (JMA) to replicate or record exact movements of the patient's mandible.

Jaw motion analyser (zebris, Germany) is an ultrasonic measurement system used to record and implement various mandibular movements. Procedure for using a basic jaw motion analyser are as follows:-
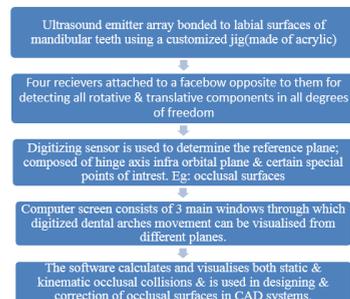
Much recent software versions consists of an orthodontic module allowing the creation of a virtual setup. Condylar trajectories in the sagittal and horizontal planes are also incorporated in these programmes. This tool gives user access to observe inter-relationship between incisal guide and condylar guide and the effects of joint mobility upon occlusion.

Examples : Kordass and Gratner virtual articulators and Dentcam virtual articulator developed at university of Griefswald.

A.   Mathematically simulated virtual articulators

It is a fully adjustable 3-dimensional articulator capable of reproducing the movements of a mechanical articulator. It is more versatile than a mechanical dental articulator. Basically it functions as a mechanical average value articulator.

Examples : szentpetery's virtual articulator and stratos 200

### DESIGNING PROCESS
Selection of Virtual Articulator

Selecting an appropriate/ suitable virtual articulator has a significant effect on the success of prosthesis, let it be either fixed or a removable one. Since the mandible is capable of rotating around 3 planes, not only he static but also dynamic component of the prosthesis should be taken into consideration. We all know the harmful or deleterious effects of occlusal interferences and the pathologies associated with it. Hence, a thorough check of any interferences is a mandatory procedure nowadays.

Basic operating mechanism of virtual articulator Stratos 200 is as follows:

The Ivoclar Stratos 200 has been remodelled using a solid edge CAD system. Some parts can be remodelled directly after measuring the actual mechanical dental articulator. Alternatively a Handyscan 3D scanner can be used for scanning the articulator totally.

After the scanning is completed, using the Geoimage point cloud edition software, the useful data is taken from numerous points that had been scanned.

The final step deals with locating/transfer of models onto the articulator. For this the relative position of upper/maxillary model is scanned using the facebow. Afterwards, the location in the virtual articulator is direct and the lower model is mounted using an electronic bite in centric relation. Now the virtual articulator is ready to apply the kinematic simulation using the CATIA CAD system.
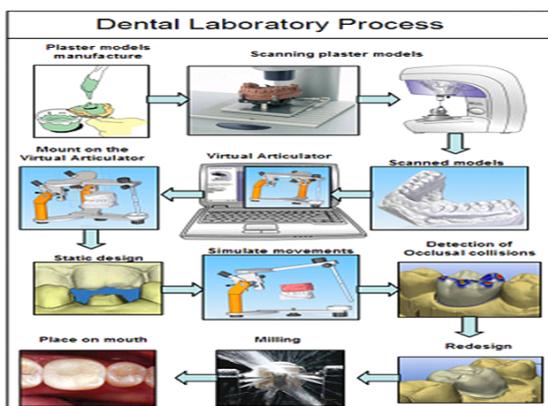
RECENT DEVELOPMENTS IN THE VIRTUAL ARTICULATOR

The development of 3D virtual articulator system (Zebris Company, D-Isny) requires three main unit devices namely:

•   An input device in form of a 3D scanner.
•   3D virtual articulator software for prosthesis modeling with collision detection.
•   An output device in the form of "rapid prototyping system" with stereoscopic inkjet technology.

The advantage with this 3D virtual articulator system is that in addition to analysis of mandibular movements, even masticatory movements can be analysed including force at the points of contact and the frequency of contacts in relation to time.

CONCLUSSION

The use of Virtual technologies in particular virtual articulators dentistry provide better education and training by simulating complex contexts and enhancing procedures that are traditionally limited, such as work with mechanical articulator. As any other newer technique and technology the use of virtual articulator requires a thorough understanding of its principles and working mechanism. The virtual articulator is intended to use as a tool for the analysis of the complex static and dynamic occlusal relations. The main goal of the virtual articulator is to improve the design of dental prosthesis, adding kinematic analysis to the design process. The virtual articulators shows a promising technology of the future, where a more convenient and precise treatment can be achieved with a better patient comfort.

REFERENCES

1. Koralakunte PR, Aljanakh M .The role of virtual articulator in prosthetic and restorative dentistry. J Cli Diag Res. 2014;8(7): ZE25-ZE28.
2. Luthra RP, Gupta R, Kumar N, Mehta S,Sirohi R.Virtual articulators in prosthetic dentistry : A review. J Adv Med Dent Scie Res 2015;3(4):117-121.
3.   Padmaja B.I, Madan B, Himabindu G, Manasa C. Virtual articulators i0n dentistry – A Review. Int J Med and Applied Sci. 2015; 4(2); 109-114.
4. Gugwad RS, Basavakumar M, Abhijeet K, Arvind M, Sudhindra M, Ramesh C. Virtual articulators in prosthodontics. Int J Dent clinics 2011: 3(4); 39-41.
5. Lahori M, Siddharth , Siddharth, Chakraborty DS. Virtual articulators : changing trends in prosthodontics.
6. Maestre-Ferrín.L,Romero-Millán.J,Peñarrocha-Oltra.D,Peñarrocha-Diago.D   Virtual articulator for the analysis of dental occlusion: An update. Med Oral Patol Oral Cir Bucal. 2012 Jan 1;17 (1):e160-3.
7. Amrita Pandita , Antariksha Dod , Ritika Bhat. Virtual Articulators: A Digital Excellence in Prosthetic and Restorative Dentistry. J of Applied Dental and Medical Sciences 2(3);2016.
8. E. Solaberrieta, O. Etxaniz, R. Minguez, J. Muniozguren, A. Arias. Design of a Virtual Articulator for the Simulation and Analysis of Mandibular Movements in Dental CAD/CAM. CIRP Design Conference 2009 march 30-31.
9. E. Solaberrieta, A. Arias, L. Barrenetxea, O. Etxaniz, R. Minguez and J. Muniozguren A virtual dental prostheses design method using a virtual articulator. Int design conference 2010, may 17 – 20.