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Editorial

Digital occlusion technologies in Prosthodontics

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The diagnosis and execution of a prosthodontic treatment plan, whether by conventional or digital methods, rely primarily on dental occlusion, which is defined as the static relationship between the incising or masticating surfaces of the maxillary or mandibular teeth or tooth analogues. Since the beginning of the nineteenth century, the patient's mandibular motion has been observed and analysed. These recordings are intended to be used for the design and fabrication of interim and definitive prostheses, as well as to incorporate the patient's mandibular motion into diagnostic and treatment planning procedures. Additional tools like photometric sensors, artificial intelligence (AI) algorithms, and ultrasonic systems have been mentioned as a part of the dental field's arsenal for tracking and recording mandibular motion. Furthermore, a few of these systems allow the recorded mandibular motion to be integrated into the computer-aided design (CAD) software used to create dental prosthesis.[1,2]

Intra oral Scanning systems enable recording of the maxillomandibular relationship through the integration of virtual occlusal records to align previously acquired diagnostic casts. Moreover, iOS systems have the ability to offer information regarding contacts in both static and dynamic occlusion. IOS scanning accuracy can be influenced by factors related to the operator and the patient. The accuracy of IOSs depends on the operator's skills and decision-making, including the technology and system used, scanning head size, calibration, distance and angulation, exposure to temperature changes, humidity, lighting conditions, operator experience, scanning pattern, scan extension, and use of cutting off, rescanning, and overlapping procedures. The intraoral conditions of the patient being scanned that interfere with the IOSs' scanning accuracy have been referred to as patient factors. Patient factors include tooth type, interdental spaces, arch width, palate characteristics, wetness, existing restorations, surface characteristics, edentulous areas, inter implant distance, implant position, angulation, depth, and implant scan body design. Regardless of scanning technology or system, IOSs offer a viable digital impression option for obtaining virtual diagnostic casts with comparable accuracy to traditional procedures. Clinical investigations have revealed that IOSs are accurate for capturing complete-arch intraoral digital scans, with trueness values ranging from 73 to 433 μm and precision values ranging from 80 to 199 μm.[2,3,4,5]

Digital jaw tracking technologies include ultrasonic, infrared optical camera, photometric, and algorithms.

Jaw trackers are classified based on their functional capabilities: diagnostic (data collecting and analysis) or diagnostic and design. Diagnostic jaw tracking systems can record and track a patient's mandibular movements. The software program of the device can perform a posterior analysis, but the recording cannot be exported. Diagnostic jaw tracking systems, or CAD integrable systems, enable the exportation of the patient's mandibular movements for integration into CAD software applications.[2,6]

- Ultrasonic systems utilise collectors in the head coordinate frame and transmitters in the tracker attached to the mandibular dentition. The device calculates mandibular relative position by measuring the time it takes ultrasonic pulses from emitters to reach collectors. To simulate 3D mandibular motion, a triangle plane is aligned between condyle points and the system's base position. The triangle plane determines the target position of the mandible. Environmental noise and temperature can impact the positional accuracy of ultrasound-based devices by up to 0.1 mm even after calibration.[2,7]
- Infrared optical camera systems have two components: the face-bow (receiver and control unit) and the lower jaw sensor (transmitter unit). The lower jaw sensor runs on a battery button cell. The face-bow sends an infrared signal that activates 12 LEDs during measurement. Cameras embedded within the face-bow record movement of the sensor attached to the mandibular teeth during measurements. The two cameras in the face-bow determine the position of the LED luminous points and then send it to the computer via USB. This information is analysed by the computer to determine the position of the lower jaw sensor in relation to the face bow. The measurement data is stored and analysed using the application software.[2,8]
- Photometric devices use cameras to track markers on the patient's mandible and face, with or without additional markers. Video-based mandibular motion tracking relies heavily on marker size and frame rate, with smaller markers performing poorly compared to high-frame-per second devices. While some IOSs can capture the patient's mandibular motion, their accuracy remains unknown.
- AI algorithms have been designed for restorative and prosthodontic procedures. AI models, such as smart stitching or AI cleaning, have been employed in IOS software programs to enhance scanning, but their effectiveness remains unknown. IOS manufacturers' exclusive knowledge of software stitching, maxillomandibular alignments, and occlusal collision adjustments makes it difficult to compare and understand different IOS systems.[2,9]

Jaw tracking device accuracy varied from 50 to 330 μm among digital systems, with low interoperator reliability while tracking motion from photographs. Confounding variables that influenced jaw movement trajectories included mandibular and condylar growth, kinematic dysfunction of the neuromuscular system, shortened dental arches, previous orthodontic treatment, variations in habitual head posture, temporomandibular joint disorders, fricative phonetics, parafunctional habits, and unbalanced occlusal contact. However, age, gender, and diet did not have a significant impact.

Conventional occlusal contact indicators' sensitivity and reliability are affected by material thickness, strength, and elasticity, along with saliva absorption and clinician interpretation. While computerised occlusal analysis systems are reliable for measuring occlusal contact at maximum bite force, traditional occlusal registration methods appear to be more trustworthy and valid.[10]

Digital occlusion technology such as IOSs, jaw tracking systems, and computerised occlusal analysis devices offer effective diagnostic and design tools for prosthodontic care. Further analysis is needed to determine the accuracy of digital technologies employed to gather and analyse static and dynamic occlusions. Although digital technologies can enhance clinical efficiency and diagnostic capabilities, dental professionals nevertheless face ambiguity.

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