

Intraoral Scanners for Complete Dentures: A Review of Literature

Chandani Joshi¹, Preksha Shah¹, Adil Shaikh¹, Sareen Duseja²

¹ PG student, ² Professor and Head, Department of Prosthodontics and Crown & Bridge, Narsinhbhai Patel Dental College and Hospital, Sankalchand Patel University, Visnagar.

Abstract

For many years, complete dentures have stood as a cornerstone of restorative dentistry, offering a vital solution for individuals dealing with edentulism, ultimately enhancing their oral health and overall quality of life. The traditional approach to crafting complete dentures involves a series of labor-intensive steps, including impressions, and often results in time-consuming processes and potential inaccuracies. Intraoral scanners have recently emerged as a groundbreaking technology within the dental field, revolutionizing the entire process of fabricating complete dentures. In this review, we delve into the current landscape of intraoral scanners for complete dentures. The types of intraoral scanners along with the technologies used, methods of scanning the edentulous arches, examining the advantages, and addressing associated challenges are discussed. In the end, we have also shed some light on their future potential to reshape denture treatment.

Keywords: Complete dentures, Intraoral Scanner, Oral Health, Restorative Dentistry, Quality of life

Corresponding Author: Preksha Shah, PG Student, Department of Prosthodontics, Narsinhbhai Patel Dental College and Hospital, Sankalchand Patel University, Visnagar, Gujarat, India. 384315. preksha1474@gmail.com.

Date of submission: 20 January 2025

Date of review: 18 March 2025

Date of Acceptance: 26 May 2025

Introduction

Complete dentures are essential for restoring both oral function and aesthetics in individuals who have lost all their natural teeth. The precision of impressions holds paramount importance, as it directly influences the ability of denture bases to provide both secure retention and stable support within the oral cavity¹. The conventional approach to complete denture fabrication relies on physical impressions, which can be uncomfortable for patients and prone to inaccuracies². In recent years, intraoral scanners have gained momentum as a modern alternative for creating complete dentures. These digital impressions are then used for a wide range

of applications, including implant planning, and complete denture fabrication.³

Discussion

Categories, Principles, and Operating Characteristics of Intraoral Scanners

Presently, the market offers a range of prominent intraoral digital impression systems, with notable options like CEREC, Lava C.O.S. system, iTero, E4D, and TRIOS.³. These systems distinguish themselves based on critical characteristics, including their underlying operational principles, light sources, requirements for

powder coat application, workflow procedures, and the format of output files.

CEREC system- Presently, the predominant CEREC system in use is its fourth-generation offering, recognized as CEREC AC Bluecam. This system utilizes visible blue light, which is radiated from a blue LED, as its illumination source for capturing images. Notably, CEREC AC Bluecam exhibits impressive efficiency, enabling the acquisition of digital impressions for a single quadrant within a mere minute and capturing antagonist impressions in a matter of seconds.

In 2012, the latest addition to the CEREC lineup, CEREC AC Omnicam, entered the market. Omnicam employs a continuous imaging technique, where successive data collection processes result in the creation of a comprehensive 3D model.⁴ In contrast, Bluecam utilizes a single-image acquisition method. Omnicam stands out for its versatility, as it can scan a single tooth, a quadrant, or even an entire arch. Noteworthy features of Omnicam include its powder-free scanning capability and the ability to produce highly precise 3D images with natural color rendition. This powder-free attribute is particularly advantageous when scanning larger areas.⁴

Lava C.O.S. system- The Lava™ C.O.S. (Lava Chairside Oral Scanner), developed by 3M ESPE in Seefeld, Germany, represents an intraoral digital impression technology introduced in 2008, following its invention in 2006. This innovative system operates on the principle of active wavefront sampling, a method that involves capturing three-dimensional data using a single-lens.⁵

The core concept of active wavefront sampling revolves around the simultaneous acquisition of clinical images from various angles by three sensors. These sensors, working in harmony, utilize proprietary image-processing algorithms to create

surface patches that encompass both in-focus and out-of-focus data. Impressively, the Lava C.O.S. can capture a remarkable twenty 3D datasets per second, resulting in over 10,000 data points in each scan.⁶

iTero system- Utilizing laser and optical scanning, the iTero system maps intraoral surfaces and contours based on the principle of parallel confocal imaging. This technology gathers an extensive dataset of roughly 100,000 laser points, with each point encompassing 300 focal depths through the tooth structure.⁷

In a single scan, the iTero system captures focal depth images, which are distinctly spaced at intervals of approximately 50 μ .⁸ This precision enables the camera to gather accurate data regarding tooth surfaces. Notably, the parallel confocal scanning technology utilized by the iTero system allows for the comprehensive capture of all oral structures and materials, eliminating the need for applying scanning powders.^{9,10}

E4D system- Developed by D4D Technologies in Richardson, Texas, the E4D system utilizes the principles of optical coherence tomography and confocal microscopy.¹¹ It uses a crimson laser for illumination and incorporates micro-mirrors that oscillate at an impressive rate of 20,000 rotations per second.

The E4D system employs a high-speed laser to produce digital impressions of prepared and adjacent teeth, creating an interactive 3D image.¹² This technology captures views from multiple angles, enabling the creation of a detailed image database that can be rapidly integrated into an accurate virtual model within seconds. Additionally, the E4D operates as a powder-free intraoral scanner.

TRIOS system- In 2010, a company based in Copenhagen, Denmark, known as 3Shape, unveiled an innovative digital intraoral impression system named TRIOS.

This system was launched in the market in 2011. The functioning of TRIOS is based on the concepts of ultrafast optical sectioning and confocal microscopy. This advanced technology involves the recognition of focus plane variations within a specific range while having a constant spatial relation between the scanner and the scanned object.¹²

The system boasts exceptional scanning speed, acquiring up to 3,000 images per second, which minimizes the impact of movement between the scanning probe and the teeth.¹² By processing this large volume of images, TRIOS rapidly produces a final 3D digital model that accurately reflects the teeth's structure and gingival color. Like the iTero and E4D systems, TRIOS is powder-free, enhancing both user convenience and efficiency

Scanning Strategy for Complete Dentures

Various scanning techniques are utilized for capturing impressions of the oral ridge, each with its distinctive approach:¹³

- a. **B-O-P (Buccal-Occlusal-Palatal):** The process starts in the posterior area, continues along the buccal side of the ridge, moves to the opposite side, then returns along the occlusal surface, and finally scans the palatal or lingual side.¹⁴
- b. **P-O-B (Palatal-Occlusal-Buccal):** This technique starts at the back, and proceeds by scanning the ridge's palatal or lingual side, moves back along the biting surface, and finishes with a scan of the buccal side.
- c. **O-B-P (Occlusal-Buccal-Palatal):**^{15,16} The procedure initiates at the posterior segment, scanning the occlusal facet of the ridge towards the other side, retracing along the buccal aspect, and ultimately scanning the palatal or lingual aspect.
- d. **O-P-B (Occlusal-Palatal-Buccal):**¹⁷ The scan starts in the posterior region, proceeds along the occlusal surface to the opposite side, returns via the palatal or lingual surface, and finishes with the buccal aspect
- e. **ZZ-P (Zig-Zag-Palatal):**¹⁸ Starting from the posterior on the occlusal surface, this approach alternates between occlusal and buccal scans in a zigzag path along the ridge, ending with the surface adjacent to the palate or tongue.
- f. **ZZ (Zig-Zag):**¹⁸ For the mandible, the zig-zag technique initiates posteriorly on the buccal side, alternating between buccal, occlusal, and lingual aspects while progressing along the ridge. In the maxillary arch, the process starts at the posterior buccal side, traverses the palate to the opposite side, follows a zigzag path to scan the full arch, and finishes at the anterior region

These distinct approaches offer flexibility in capturing comprehensive impressions of the oral ridge, catering to various clinical scenarios and patient needs.

Current Applications of Intraoral Scanners in Complete Dentures

Duplication of Complete dentures- The intraoral scanner can be employed to scan both the cameo and intaglio surfaces of the denture, while simultaneously superimposing the area representing the denture margin from the inter-occlusal imaging. After making slight adjustments such as connecting and smoothing the scanned data using CAD software, the process of duplicating the denture can be accomplished. This innovative technique streamlines the duplication of dentures, significantly reducing the time required compared to traditional methods and introducing a fresh approach to denture fabrication.¹⁹

Digital record-keeping: In conventional techniques, the impressions of any patient cannot be stored after the fabrication of complete dentures. Using the intra-oral scanners, it is possible to keep the digital impression records of the patients, so that whenever in the near term, the patients lose their dentures or have their dentures damaged, it is fairly easy to simply refabricate those dentures.²⁰

Combination with conventional technique for compromised ridges- For edentulous patients with mobile tissues in the anterior maxilla, a two-step approach can be employed to create definitive complete dentures. First, an intraoral scanner can be used to capture an anatomic impression of the maxilla without applying any pressure. Then, a traditional closed-mouth impression method can be utilized to obtain a functional impression. The final complete dentures can be meticulously crafted by combining the data from both impressions, resulting in an effective solution for this specific clinical scenario.²¹

Advantages of Intraoral Scanners for Complete Dentures

- a. Patient Comfort: Intraoral scanners eliminate the need for traditional impression materials, making the process more comfortable for patients, especially those with a persistent gag reflex.
- b. Precision: Digital impressions are highly accurate and reduce the risk of errors, resulting in better-fitting complete dentures. As more advanced intraoral scanning devices have been introduced, the level of accuracy in direct digital data acquisition has significantly improved, with reported minor deviations as small as 125 μ .²²
- c. Time Efficiency: Intraoral scanning significantly reduces chairside time, as it eliminates the need for material setting and removal, impression tray adjustments, and shipping impressions to laboratories. The digital impression

of the maxillary arch can be completed in around 2 minutes, whereas the mandibular arch can require a little longer period, around 5 minutes.²³

- d. Improved Communication: The ability to promptly share digital impressions with dental laboratories facilitates improved interaction and collaboration between dentists and technicians.
- e. Enhanced Aesthetics: Intraoral scanners provide a unique opportunity for the customization of denture aesthetics, offering a digital platform for precisely tailoring the visual aspects of teeth and gums. This technology allows dental professionals to meticulously design and fine-tune the appearance of the dentures, ensuring that they align seamlessly with the patient's preferences and natural oral characteristics. This level of customization not only enhances the esthetic outcome of the dentures but also contributes to improved patient satisfaction and a more natural-looking smile.²⁴

Challenges and Limitations

- a. Cost: The acquisition and maintenance costs associated with intraoral scanners can be substantial, and these financial considerations may pose significant challenges for smaller dental practices. Consequently, the potential limitations in terms of financial accessibility can deter such practices from readily incorporating this technology into their operations.²⁵
- b. Learning Curve: The successful utilization of intraoral scanners by dentists and dental technicians necessitates comprehensive training, a factor that can potentially impede the pace of their widespread adoption in the field of dentistry.^{26,27}
- c. Scanning Limitations: Intraoral scanners may face challenges when scanning edentulous arches with irregular anatomy, leading to potential inaccuracies. Scanning of the

mandibular denture did face challenges, as it could not accurately replicate ideal border extensions.^{28,29}

- d. **Data Security:** Ensuring the security of patient data is crucial when using digital impressions, as they are susceptible to cyber threats. The privacy of the patient data is also in question, as the companies that store the data are susceptible to data leaks. Hence, strong privacy protection policies should be adopted by the companies so both the practitioner as well as the patient can perform scans with peace of mind.^{30,31}
- e. **Equipment Reliability:** The reliability of intraoral scanning devices, including their resistance to moisture and wear, can impact the success of complete denture fabrication.

Future Prospects

- a. **Democratization:** With the progression of technology it is anticipated that the prices of intraoral scanners will fall, thereby making them more affordable and accessible to dental practitioners.
- b. **Integration with CAD/CAM:** Combining intraoral scanners with computer-aided design and manufacturing (CAD/CAM) systems can greatly enhance and streamline the complete denture fabrication process. This technological integration enables a smooth digital workflow, beginning with the accurate capture of intraoral data via the scanner.³² Once the digital impressions are obtained, they can be directly transferred to CAD software, where dental professionals can design the dentures with meticulous precision. This digital design phase not only enables fine-tuning of the denture's fit, aesthetics, and functionality but also allows for swift and efficient modifications if needed.³³
- c. **Improved Predictability and Accuracy:** AI-driven software may further improve, and computational

algorithms will get even better at predicting compromised ridges, or mandibular ridges.

- d. **Teledentistry:** Intraoral scanners have the potential to play a pivotal role in the realm of teledentistry by facilitating remote consultations and treatment planning, particularly in fabrication of complete dentures. Detailed intraoral images and impressions can be captured at their location, transmitted to dental professionals for analysis and assessment. This capability not only bridges geographical barriers but also allows for timely and informed decision-making regarding. Dental practitioners can remotely evaluate the scans, collaborate with patients, and devise comprehensive treatment plans, which contribute to more accessible and efficient complete denture care, even from a distance.^{34,35}

Conclusion

The introduction of intraoral scanners represents a transformative phase in the realm of complete denture fabrication, presenting a multitude of benefits including heightened precision, enhanced patient comfort, and efficient time utilization. Despite persisting challenges and limitations, the ongoing evolution of technology and wider acceptance of this technology are poised to stimulate further breakthroughs within the domain. It is foreseeable that intraoral scanners will evolve into an indispensable instrument in the development of complete dentures, ultimately serving as a boon for dental practitioners and their patients.

References

1. Rao S, Chowdhary R, Mahoorkar S. A systematic review of impression technique for conventional complete denture. The Journal of Indian Prosthodontic Society. 2010;10(2):105-11.

2. Nedelcu R, Olsson P, Nyström I, Rydén J, Thor A. Accuracy and precision of 3 intraoral scanners and accuracy of conventional impressions: A novel in vivo analysis method. *Journal of dentistry*. 2018;69:110-8.
3. Ting-shu S, Jian S. Intraoral digital impression technique: a review. *Journal of Prosthodontics*. 2015;24(4):313-21.
4. Birnbaum NS, Aaronson HB, Stevens C, Cohen B. 3D digital scanners: a high-tech approach to more accurate dental impressions. *Inside Dentistry*. 2009;5(4):70-4.
5. Rohaly J, Hart DP, Brukilacchio TJ, inventors; 3M Innovative Properties Co, assignee. Three-channel camera systems with non-collinear apertures. United States patent US 7,372,642. 2008.
6. COS LC. 3M ESPE Technical Datasheet, St. Paul, MN. 2009.
7. Att W, Witkowski S, Strub JR, editors. *Digital workflow in reconstructive dentistry*. Quintessenz Verlag; 2021.
8. Garg AK. Cadent iTero's digital system for dental impressions: the end of trays and putty?. *Dental implantology update*. 2008;19(1):1-4.
9. Kachalia PR, Geissberger MJ. Dentistry a la carte: in-office CAD/CAM technology. *Journal of the California Dental Association*. 2010;38(5):323-30.
10. Kim SY, Kim MJ, Han JS, Yeo IS, Lim YJ, Kwon HB. Accuracy of dies captured by an intraoral digital impression system using parallel confocal imaging. *International Journal of Prosthodontics*. 2013;26(2).
11. Galhano GÁ, Pellizzer EP, Mazaro JV. Optical impression systems for CAD-CAM restorations. *Journal of Craniofacial Surgery*. 2012;23(6):e575-9.
12. Logozzo S, Franceschini G, Kilpelä A, Caponi M, Governi L, Blois L. A comparative analysis of intraoral 3D digital scanners for restorative dentistry. *Internet J Med Technol*. 2011;5(1):1-2.
13. Jamjoom FZ, Aldghim A, Aldibasi O, Yilmaz B. Impact of intraoral scanner, scanning strategy, and scanned arch on the scan accuracy of edentulous arches: An in vitro study. *The journal of prosthetic dentistry*. 2023.
14. Chang TA, Zhao YJ, Yu Chun SU, Di Heng M, Qiu Fei XI, Pan SX. Accuracy of Intraoral Scanning of Edentulous Jaws with and without Resin Markers. *Chinese Journal of Dental Research*. 2020;23(4).
15. Jung S, Park C, Yang HS, Lim HP, Yun KD, Ying Z, Park SW. Comparison of different impression techniques for edentulous jaws using three-dimensional analysis. *The Journal of Advanced Prosthodontics*. 2019;11(3):179-86.
16. Zarone F, Ruggiero G, Ferrari M, Mangano F, Joda T, Sorrentino R. Comparison of different intraoral scanning techniques on the completely edentulous maxilla: An in vitro 3-dimensional comparative analysis. *The Journal of Prosthetic Dentistry*. 2020;124(6):762-e1.
17. 3Shape. TRIOS® Module User Manual. TRIOS-1.18.5-S-EN. Available at: https://3shape.widen.net/view/pdf/vda_f6vgd5g/TRIOS-Module-UserManual-1.18.5-C-EN.pdf?t.download=true&u=6xmdhr. Accessed September 04, 2023.
18. Fang JH, An X, Jeong SM, Choi BH. Development of complete dentures based on digital intraoral impressions—case report. *journal of prosthodontic research*. 2018;62(1):116-20.
19. Oyamada Y, Yonezawa Y, Kondo H. Simple duplication technique of complete denture using an intraoral scanner. *Journal of Prosthodontics*. 2021;30(5):458-61.
20. Goodacre BJ, Goodacre CJ. Using Intraoral Scanning to Fabricate

- Complete Dentures: First Experiences. International Journal of Prosthodontics. 2018;31(2).
21. Park SY, Yun Y, Park C, Yun K. Integration of an intraoral scan and a conventional impression for fabricating complete dentures for a patient with flabby tissues. The Journal of Prosthetic Dentistry. 2023.
 22. Goodacre BJ, Goodacre CJ, Baba NZ. Using Intraoral Scanning to Capture Complete Denture Impressions, Tooth Positions, and Centric Relation Records. International Journal of Prosthodontics. 2018;31(4).
 23. Patzelt SB, Vonau S, Stampf S, Att W. Assessing the feasibility and accuracy of digitizing edentulous jaws. The Journal of the American Dental Association. 2013;144(8):914-20.
 24. Monaco C, Ragazzini N, Sceda L, Evangelisti E. A fully digital approach to replicate functional and aesthetic parameters in implant-supported full-arch rehabilitation. journal of prosthodontic research. 2018;62(3):383-5.
 25. Resnick CM, Doyle M, Calabrese CE, Sanchez K, Padwa BL. Is it cost effective to add an intraoral scanner to an oral and maxillofacial surgery practice?. Journal of Oral and Maxillofacial Surgery. 2019;77(8):1687-94.
 26. Róth I, Czigola A, Joós-Kovács GL, Dalos M, Hermann P, Borbély J. Learning curve of digital intraoral scanning—an in vivo study. BMC oral health. 2020;20(1):1-7.
 27. Al Hamad KQ. Learning curve of intraoral scanning by prosthodontic residents. The Journal of prosthetic dentistry. 2020;123(2):277-83.
 28. Unkovskiy A, Wahl E, Zander AT, Huettig F, Spintzyk S. Intraoral scanning to fabricate complete dentures with functional borders: a proof-of-concept case report. BMC oral health. 2019;19(1):1-7
 29. Zimmermann M, Mehl A, Mörmann WH, Reich S. Intraoral scanning systems-a current overview. International journal of computerized dentistry. 2015;18(2):101-29.
 30. Verizon Data Breach Investigations Report. [verizon.com/business/resources/T794/reports/2023-data-breach-investigations-report-dbir.pdf](https://www.verizon.com/business/resources/T794/reports/2023-data-breach-investigations-report-dbir.pdf). Accessed September 04, 2023
 31. van Kessel R, Haig M, Mossialos E. Strengthening Cybersecurity for Patient Data Protection in Europe. Journal of Medical Internet Research. 2023;25:e48824.
 32. Stanley M, Paz AG, Miguel I, Coachman C. Fully digital workflow, integrating dental scan, smile design and CAD-CAM: case report. BMC oral health. 2018;18(1):1-8.
 33. Conejo J, Dayo AF, Syed AZ, Mupparapu M. The digital clone: intraoral scanning, face scans and cone beam computed tomography integration for diagnosis and treatment planning. Dental Clinics. 2021;65(3):529-53.
 34. Jampani ND, Nutalapati R, Dontula BS, Boyapati R. Applications of teledentistry: A literature review and update. Journal of International Society of Preventive & Community Dentistry. 2011;1(2):37.
 35. Ghai S. Teledentistry during COVID-19 pandemic. Diabetes & Metabolic Syndrome: Clinical Research & Reviews. 2020;14(5):933-5.

How to cite the article:

Joshi C, Shah P, Shaikh A, Duseja S. Intraoral Scanners for Complete Dentures: A Review of Literature. JIHR 2025;2(1):28-34.