Fixed Implant Rehabilitation for A Mandibular Edentulous Patient Using Innovative Multi-Direct Capturing Intraoral Scanning Technology: A Case Report

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Abstract

The adoption of digital impressions has significantly refined workflows for implant-based restorations, enhancing clinical precision and procedural efficiency. Although intraoral scanning is well-documented for single and multiple implant restorations, evidence regarding its accuracy and reliability in full-arch rehabilitations remains sparse. This case report presents an All-on-6 full-arch rehabilitation utilizing a novel optical scanning technology, the Multi-Direct Capturing (MDC). This technology addresses critical challenges associated with full-arch scanning, while enhancing both operator control and patient experience. The case demonstrates the potential for immediate and precise fit, advancing clinical outcomes in mandibular full arch implant-supported restoration. *Int J Prosthodont 2025. doi: 10.11607/ijp.9379*

Introduction

Tooth loss exerts a profound negative effect on oral function, diminishing the quality of life and increasing the risk of early mortality in edentulous patients.[1] Traditionally, complete dentures have been the standard prosthetic solution for restoring both esthetics and function in cases of edentulism. However, full and partial edentulism often leads to severe atrophy of the residual alveolar ridge and the associated loss of facial support, thereby complicating the prosthetic rehabilitation process. These complex cases necessitate meticulous treatment planning and a prosthetically-driven approach to ensure that both functional and esthetic outcomes align with the expectations of both the patient and the clinician.[2,4]

The introduction of full arch osseointegrated implant rehabilitation has marked a paradigm shift in the treatment of edentulous patients, providing more predictable clinical outcomes and superior long-term success.[2,3] Immediate and delayed loading procedures are well-documented and considered safe methods. A recent systematic review demonstrated that immediate loading protocols have high survival rates for both fixed and removable prostheses.[5] The rise of digital dentistry has further facilitated these rehabilitative treatments. Recent advancements in intraoral digital scanners, computer-aided design and manufacturing (CAD/CAM) technology, and advanced imaging modalities such as cone beam computed tomography (CBCT) have streamlined the workflow for full-arch implant rehabilitation. These innovations have significantly improved clinical efficiency and reduced treatment costs, enabling more accurate and reliable outcomes.[6]

A key determinant of success in implant-supported restorations is the passive fit of the prosthetic framework. Unlike tooth-supported prostheses, which can tolerate around 100 µm of movement, implant-supported restorations are restricted to roughly 10 µm, necessitating a much higher level of precision in prosthesis fabrication.[7–8] Inadequate fit can lead to mechanical and biological complications, jeopardizing the long-term prognosis.[9] Therefore, accuracy—defined as the combination of trueness and precision—is critical in implant prosthodontics.[10–12]

The initial step in achieving this accuracy is through the impression taking process.[13–14] In recent years, the development of digital implant impressions using intraoral scanners (IOS) has advanced significantly. These systems utilize different optical technologies like triangulation, confocal laser scanning, and active wavefront sampling to precisely capture implant positions.[15–16] Compared to conventional impression methods, IOS streamlines the workflow and offers substantial savings in both time and material usage.[17] Additionally, it has the potential to minimize errors associated with traditional processes, such as material mixing, disinfection, storage, transport, and model fabrication, ultimately enhancing the accuracy and reliability of the final restoration.[18–21]

While IOS have demonstrated accuracy comparable to, or even surpassing, that of conventional impression methods in single and multiple implant restorations, capturing full-arch scans presents inherent challenges.[12,22] The necessity to stitch multiple images together over a large scan area can result in cumulative errors, especially with fewer distinct landmarks between scan bodies and long span of mobile mucosa, which may lead to significant discrepancies in the final digital impression. Additionally, varying angles and positions of multiple implants complicate the scanning process, making it challenging to capture the exact orientation and position of each implant.[23] Patient-related factors, including limited mouth opening, implant location, and patient movement during longer scanning durations, further impact accuracy.[24] These limitations underscore the need for advanced technologies to enhance the accuracy and reliability of IOS in comprehensive implant rehabilitations.

This case report documents the first clinical application of a full-arch implant-based workflow utilizing the innovative Multi-Direct Capture (MDC) technology integrated into the iTero Lumina intraoral scanner, introduced by Align Technology in February 2024.[25] The purpose of this report is to highlight how this advanced imaging system addresses the limitations of conventional intraoral scanning systems, such as restricted fields of view due to reliance on mirrors or reflective elements to redirect light. By integrating six cameras and five structured light projectors directly into the scanner tip, the iTero Lumina eliminates the need for posterior illumination and enabling the direct capture of more data with greater detail. This breakthrough optical design enhances the efficiency of digital impressions, as demonstrated in the presented workflow.

Clinical Case Report

Preoperative information and treatment plan

A 72-year-old male presented at our practice with esthetic and functional issues. His chief concern: “I want to get dentures before Christmas”. He complained of a diminished masticatory capacity and was dissatisfied with his smile. Clinical examination revealed maxillary and mandibular partial edentulism, a significant number of carious lesions with insufficient hygiene, deep periodontal probing depths, generalized gingival recession, lack of keratinized tissue in the posterior sextants and tooth mobility (Grade III mobility according to Miller index). The clinical findings were consistent with a diagnosis of severe chronic periodontitis affecting the remaining hopeless dentition (Fig 1).

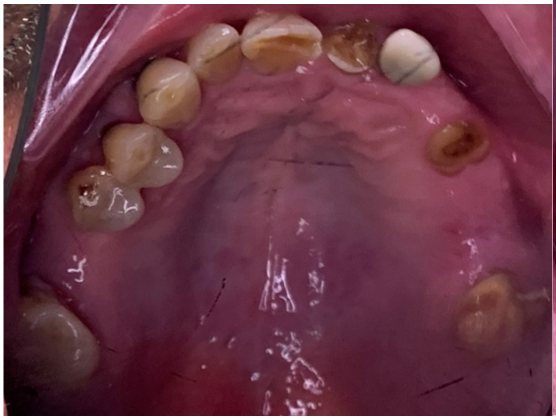


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Fig 1 Intraoral photographs before treatment. Right lateral view; Frontal view; Left lateral view, respectively.

Preoperative periapical and bitewing radiographs reveal advanced periodontal disease, with radiolucencies at teeth (International Dental Federation Numbering System) 43 mesial-cervical and 42 distal-cervical, furcation involvement in teeth 17, 26, and 36, and significant subgingival calculus deposits. Retained root fragments are observed in teeth 11, 24, and 35, along with severe bone loss in the mandibular arch and posterior maxilla. Additionally, periapical radiolucencies are noted in teeth 11, 24, 44 and 35 (Fig 2). A cone beam-computed tomography (CBCT) scan revealed failing mandibular and maxillary dentition (Fig 3).

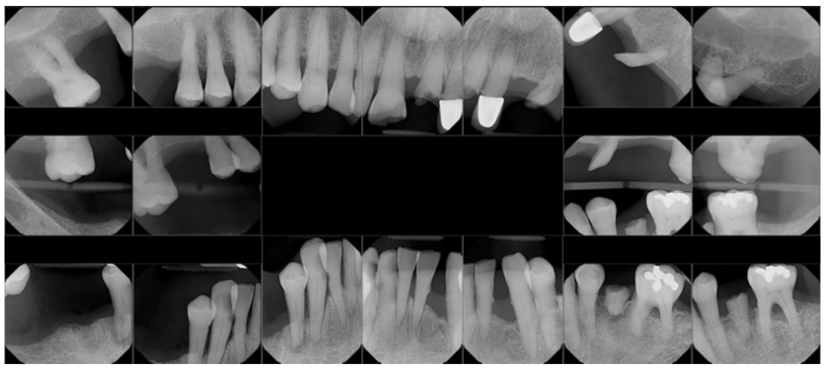

Fig 2 Preoperative periapical and bitewing radiographs.

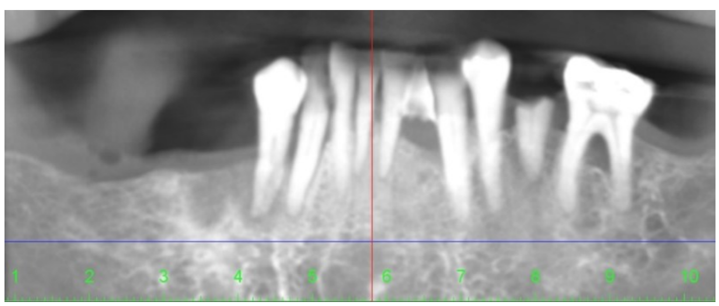

Fig 3 CBCT: Panoramic reconstruction showing failing dentition.

The patient's medical history included liver-related complications, which were stable and regularly monitored by his primary physician. Prosthodontic treatment options were thoroughly evaluated with the patient, who elected to proceed with a treatment plan of full-arch extraction followed by immediate implant placement and immediate loading for the lower arch rehabilitation. For the upper arch, due to financial limitations, the treatment plan involves provisional maxillary complete denture as a temporary solution until the patient secures the necessary funds to proceed with a fixed implant- supported prosthesis for the maxillary arch as well.

Considering the limited amount of bone available in the mandible, the expected bone reabsorption, and the patient's need for an immediate load, the All-on-Six digital guided protocol was chosen for the rehabilitation. Guided surgery was planned as it has demonstrated to be an accurate method to reduce the probability of damage to anatomical structures and to simplify prosthetic treatment.[26–28]

The proposed treatment plan included extracting all remaining lower teeth 44-36 and strategically placing six implants for fixed restoration in the lower arch. The recommended restoration was an FP3 prosthesis—a specialized design that replaces teeth and a segment of the soft tissue, incorporating pink-colored restorative material for highly esthetic results.

The patient accepted the treatment plan and provided informed consent for the publication of their case details, including any accompanying images.

Pre Surgical Planning And Implant Placement

It was decided to keep the patient's vertical dimension of occlusion (VDO) unchanged for at least the provisional prosthesis. The centric relation (CR) was registered with the unchanged VDO. The data was obtained in STL (Standard Tessellation Language) format from the patients' existing records.

The patients' CBCT data in DICOM (Digital Imaging and Communications in Medicine) format and STL files were imported and aligned using surgical planning software by the DSD

(Digital Smile Design) Planning Center. The implants and 4.6mm diameter screw-retained abutments were planned in prosthetically oriented positions. Surgical templates with five lateral fixation pin supports were then designed to facilitate guided implant placement (Fig 4). This 3D guided implant surgery procedure utilized the DSD Clic Guide solution, which enabled virtual planning to enhance preoperative understanding of the proposed treatment before active care commenced. By combining the use of the virtual planning and CAD/CAM technology with 3D-printing, a surgical guide could be produced.

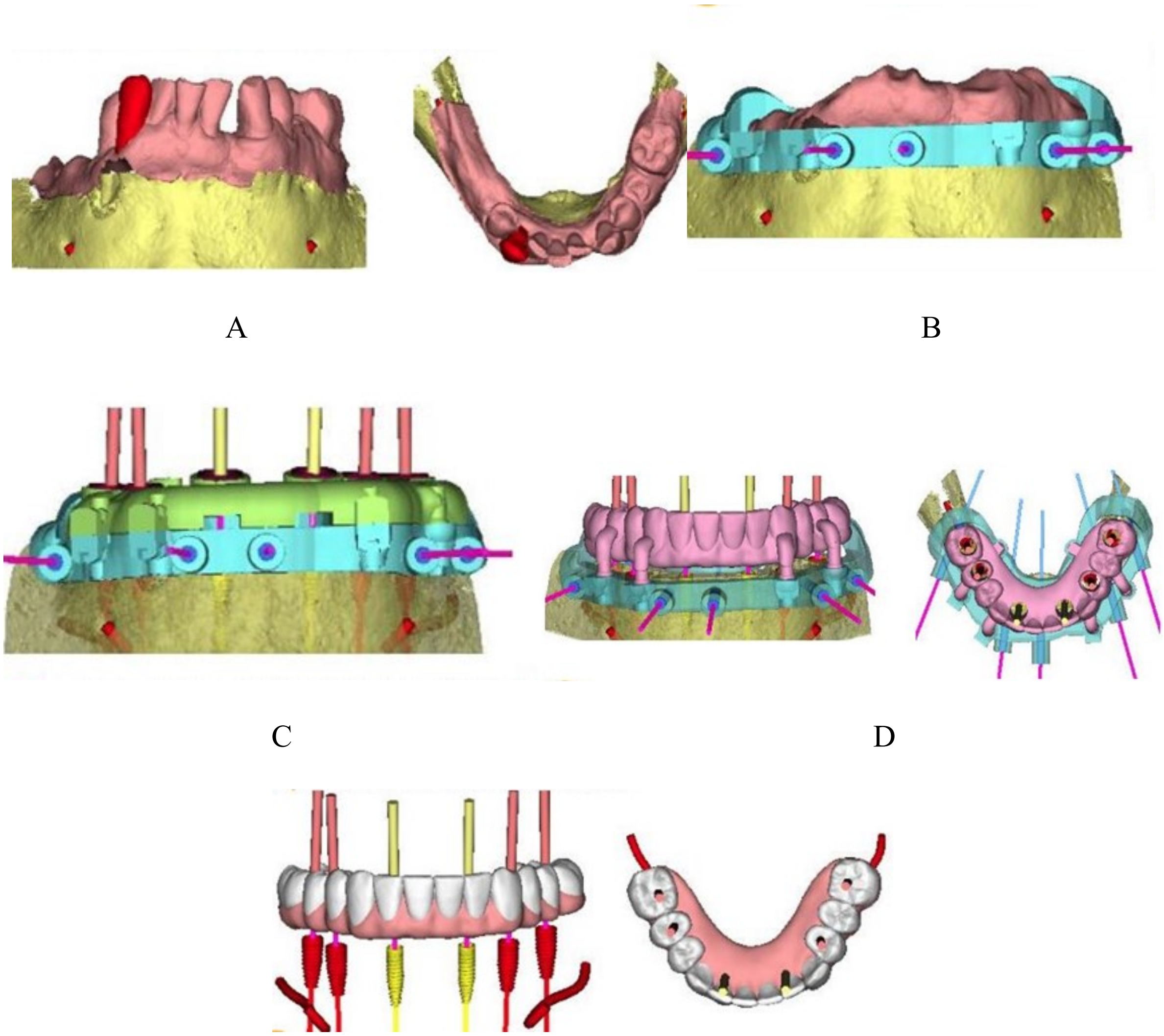

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Fig 4 Integrating DICOM and STL files for prosthetically guided implant surgical planning. (a-c) Computer-aided design of surgical templates for fixating pins, base guide and implant placement, respectively. (d-e) View of the provisional prostheses design in relation with the implants.

The surgical guide was fabricated by 3D-printing (Form3B, FormLabs) using a biocompatible resin (Dental LT, FormLabs), while the Provisional prostheses was 3D-printed using a denture teeth resin (Premium Teeth Resin, FormLabs).

A dose of 2 g of amoxicillin with clavulanic acid was prescribed to be taken one hour before the operation, followed by a seven-day course of 1 g every 12 hours. To ensure the patient's comfort during the procedure, local anesthesia was administered. Extraction of 43 was performed prior to seating the guide.

Once the guide's stability was confirmed, it was temporarily removed to create a full-thickness flap. An incision was made starting on the center of the ridge alongside the entire length of the ridge, from the area of the first molar to the area of the first contralateral molar, with bilateral releasing incisions; a full thickness mucoperiosteal flap was elevated.

The guide was placed and fixated with pins guided with maximum accuracy by the remaining dentition. Hard tissue ensures a more precise fit. Atraumatic extractions and curettage were carried out for teeth 44, 42, 41, 31, 32, 33, 34, 35 and 36. Guided bone remodeling following the base guide which to obtain a uniformly leveled bone crest was performed via ultrasonic bone surgery (VarioSurg, NSK) . The base guide is planned to be at the level of the head of the implant to guide the bone reduction.

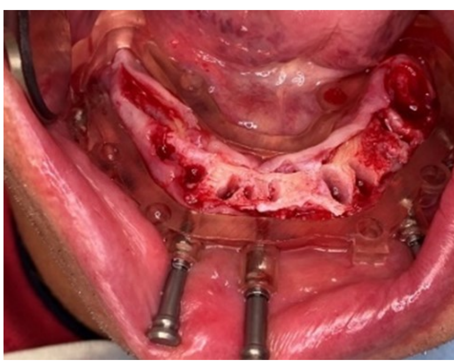
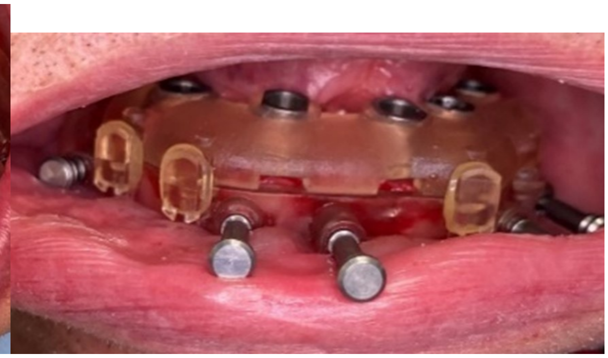
The implant surgery was performed as per protocol with the guided instruments sets in the Straumann Guided Surgery Cassette. The surgical protocol, provided along with the surgical template recommended the sequence of instruments required to prepare each implant site. Six implants (BLT, Straumann) were placed in the in the lateral incisors, premolars and first molars regions of size (in diameter and length) 4.3x10 mm, 4.1x10 mm, 3.3x12 mm, 3.3x12 mm, 4.1x10 mm, 4.3x10 mm in the mandible depending upon the amount of bone present. An insertion torque of more than 35 N/cm was achieved for all implants which indicates good primary stability.

After implant insertion, multi-unit abutments were attached to the implants. The implant guide was removed, and the prosthetic guide was stacked on top of the base guide. This guide allowed for relining the temporary prosthesis in the previously planned position. The base guide was removed and flap was sutured using non-resorbable sutures employing horizontal mattress and simple interrupted suturing techniques. The provisional prosthesis was screwed in the patient’s mouth to obtain immediate loading of the implants. Occlusion required only minor adaptations due to the accurate digital preoperative planning. Patient was recalled after 14 days for evaluation and suture removal. Prosthetic stage was planned after 4 months. According to patient desires, the definitive prosthodontic work consisted of a metal–ceramic prosthesis.

Digital Impressions and Final Prosthesis placement

Nowadays, various IOS have been introduced, primarily utilizing laser imaging technique and visible light imaging technique.[29] Similar to a panoramic image, an intraoral scan consists of multiple images that are stitched together using common overlapping data between one image and the next. That process of data extrapolation introduces slight errors that can add up as the number of images needed for full-arch scanning increases.[30] A latest study aimed to systematically review the studies comparing the accuracy of intraoral scan and conventional implant impressions in completely edentulous patients conclude that digital scans exhibit accuracy within a clinically acceptable range for edentulous arches, showing potential clinical utility for edentulous patients, particularly with unparalleled implants.[22]

In this case, following a 4-month healing period with the provisional lower prosthesis, a digital impression was acquired using the iTero Lumina intraoral scanner, powered by proprietary iTero MDC technology which is a novel scanning technology. This advanced system was selected due to its ability to address the challenges of full-arch implant rehabilitation, particularly in impression taking of the edentulous mandible. The scanner's large field of view (Fig 6), extended depth of field (up to 25mm), and multi-angle data acquisition[25] were pivotal in ensuring accurate impression-taking and facilitating precise prosthesis design.

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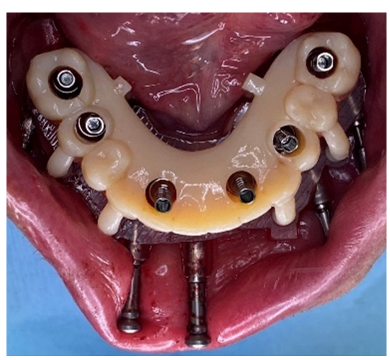

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Fig 5 Open flap fully guided implant surgery sequence. (a) 3D printed base guide stabilized in the mandible by five bone-anchoring pins prior alveolar ridge regularization. (b) Surgical sleeves guided the drilling procedures. Six Straumann BLT implants were placed guided by the surgical guide planned digitally. (c) Occlusal view of immediately loaded interim prosthesis. Provisional polymethyl methacrylate (PMMA) fabricated from the digital design adjusted to patient's needs.

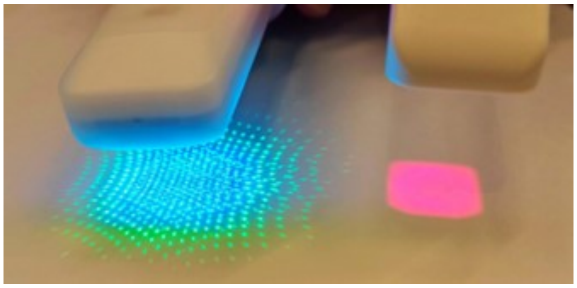
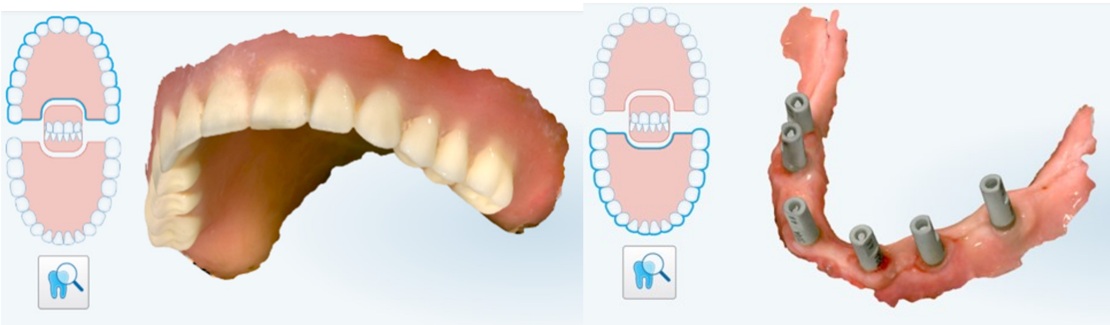


Fig 6 The iTero Lumina (left) demonstrates a wider field of view with multi-directional structured light. In comparison, parallel confocal technology (right) shows a narrower and more focused scanning area.

After ensuring that all six implants achieved successful osseointegration without complications, the procedure began with the placement of six Straumann SRA 4.6 scan bodies onto the implants. Upper provisional denture was scanned first replicating VDO and occlusal position (Fig 7).



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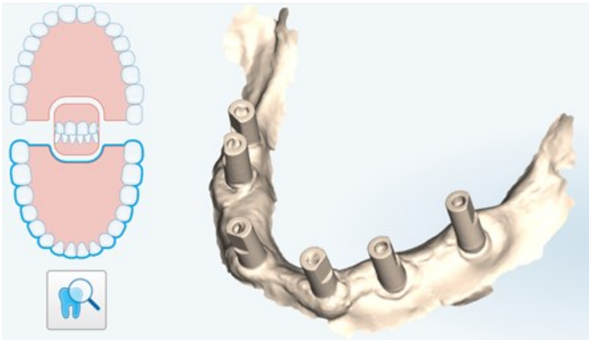

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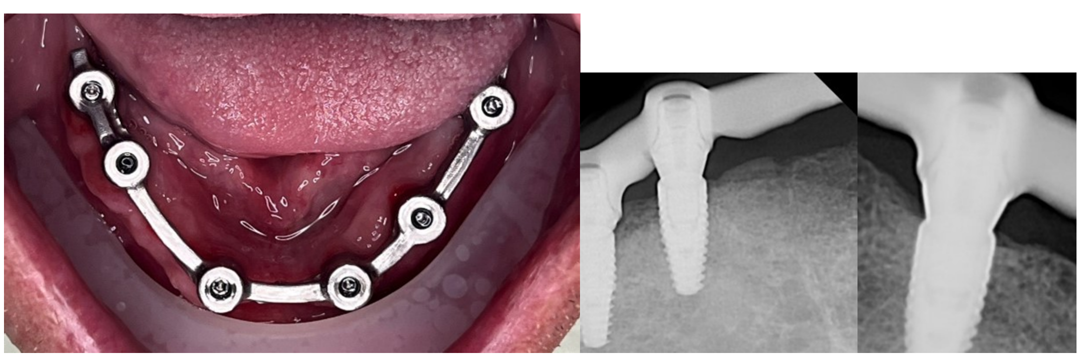
Fig 7 (a-c) View of intra oral scan of the upper provisional denture, view of intraoral scan of the lower arch with six Straumann SRA 4.6 scan bodies in color and monochrome modes, respectively.

The Lumina scanner's optical system, comprising six cameras and five structured light projectors, was utilized to capture detailed imaging of the scan bodies and surrounding anatomical structures. The multi-structured light system generates a hexagonal laser spot pattern in contrast to the changing line patterns employed by most other structured light scanners.

The scanning path followed a systematic approach, beginning at the distobuccal region on one side of the mandibular arch and progressing along the crest of the jaw to the opposite side, hovering over the occlusal surfaces. The scanner's wide-angle cameras facilitated simultaneous capture of the buccal, lingual, and interproximal aspects of the scan bodies. Subsequently, the wand was rolled lingually to capture any missing anatomy and then positioned slightly buccally to ensure completeness of the scan. Although the iTero Lumina, supported by its advanced algorithm, allows for flexible scanning without adhering to a specific strategy—stitching and aligning images seamlessly—this case followed a defined scanning protocol.

The simultaneous capture eliminated the need for sequential imaging, reducing reliance on post-processing algorithms and minimizing errors in stitching and alignment. Additionally, the extended depth of field enabled precise imaging of soft tissue contours and scan bodies geometries, ensuring accurate reconstruction of the intraoral environment.

The digital impression was exported as an STL file and integrated to CAD software (NemoStudio, Nemotec) for the design a full-arch FP3 prosthesis in the dental laboratory. The framework was digitally modeled to ensure a passive fit on the implant platform, adhering to the biomechanical requirements necessary to prevent mechanical and biological complications. Occlusal relationships were carefully analyzed and incorporated into the final design to optimize functional and esthetic outcomes. The passive fit of the metal bar was confirmed on the master model, demonstrating stability without any rocking. Intraoral verification further validated that the bar seated securely onto the multi-unit abutments (RC/NC, Straumann) without movement (Fig 8). Achieving a passive fit is essential for full-arch implant-supported prostheses, as any lack of passivity can introduce unwanted stresses on the implants, potentially leading to mechanical issues, implant failure, or bone loss around the implants.



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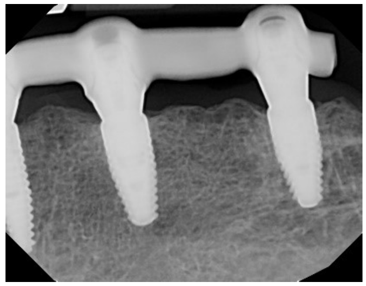

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Fig 8 (a-d) The metal bar try-in was performed intraorally and seated passively, demonstrating excellent stability without any rocking or movement. Intraoral radiographs confirmed proper alignment, showing no discrepancies or misfits.

The delivery of the final mandibular prosthesis successfully met the primary objectives of restoring comfort, function, and esthetics. The patient was highly satisfied with the tooth shape, size, color, and the definition of the smile arc (Fig 9). During follow-up visits, the patient reported no discomfort or functional issues with the prosthesis. Furthermore, no prosthetic or implant-related complications were observed at re-evaluation appointments following implant placement and the delivery of the definitive prosthesis.

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Fig 9 (a-c) Intra-oral occlusal view evidencing the mandibular final prosthesis, anterior view of the prosthesis and patient smiling after completion of the full-arch mandibular rehabilitation using All-on-6 concept, respectively.

Discussion

Intraoral scanning systems offer varying performance levels depending on their capabilities and limitations. While some scanners are adept at capturing precise details in small areas, they may fall short when it comes to full arch impressions. The precision and reliability of digital impressions are influenced by multiple factors, including IOS-related variables such as the type of scanning technology and the algorithms utilized within the device.[11,31]

In this case report we used the iTero Lumina intraoral scanner which incorporates the Multi-Direct Capturing technology, an innovative approach which aims to optimize data acquisition by capturing multiple angles simultaneously within a single scan.[25] Coupled with its wide field of view, this technology enabled us in this case the seamless capture of extensive intraoral areas, including complex geometries, without requiring adjunct procedures. The wide field of view is particularly significant in full-arch cases, where it ensures comprehensive imaging of both horizontal and vertical surfaces, including the intricate morphology of implant scan bodies, in fewer passes. This combination reduces reliance on stitching algorithms, thereby decreasing the likelihood of cumulative inaccuracies.[31–32]

The accuracy of intraoral scans can be also influenced by the arch being scanned, as the maxilla and mandible differ in their anatomical characteristics.[33–35] Unlike the maxilla, the mandible lacks features like rugae, has a larger proportion of movable mucosa, and is affected by the presence of the tongue and mandibular movement. The absence of topographical features such as rugae in the mandible increases the complexity of scanning. Additionally, mandibular deformation during jaw opening—a patient-specific factor—can impact the scanning process.[35] The widest jaw opening typically occurs when scanning posterior implants or teeth, potentially compromising scanning precision. As a result, intraoral scanning in mandibular full-arch multiple-implant cases is particularly complex, and the available research on its accuracy is limited.[30,36]

In this case, the iTero Lumina facilitated the efficient and complete digital acquisition of the mandibular arch, including the vertical surfaces of the scan bodies. A systematic scanning path was followed, starting at the posterior region and progressing along the occlusal, buccal, and lingual surfaces. The resulting digital impression was used to design and fabricate the full-arch prosthesis, which achieved a passive fit on the first attempt during the clinical try-in.

The patient in this case reported a comfortable and stress-free experience during the scanning process despite having a strong gag reflex. The ergonomic design of the iTero Lumina’s lightweight handpiece enabled improved access enables to capture the scan bodies and, reducing discomfort often associated with impression-taking, especially in the analog workflow. Additionally, the clear and immediate visualization of the 3D model provided reassurance and enhanced the patient’s understanding of the treatment process. These findings align with recent research comparing intraoral scanners, which highlighted the benefits of the iTero Lumina in terms of patient comfort, reduced scanning duration, and improved visualization of the digital impression. Specifically, patients expressed higher satisfaction levels with the iTero Lumina, citing the painless procedure and smooth workflow facilitated by the scanner's advanced technology.[37] The limitations of this case report include its single-patient focus, which restricts the generalizability of the findings to broader clinical scenarios. Although the immediate outcomes were favorable, there is a lack of long-term follow-up to assess the durability and performance of the final prosthesis over time.

Conclusions

This case highlights the successful application of the iTero Lumina intraoral scanner, incorporating MDC technology, in addressing the challenges of full-arch implant rehabilitation. By ensuring precise data acquisition, minimizing errors, and achieving a passive prosthetic fit on the first attempt, this advanced technology has demonstrated its potential to overcome key limitations of intraoral scanning for mandibular edentulism.

Furthermore, MDC technology enhances operator control and patient experience, making it a valuable tool in modern restorative workflows. While this case adds to the growing evidence supporting the clinical utility of digital workflows in implant-supported restorations, further research is needed to validate its broader application and long-term outcomes in full-arch rehabilitation. These findings emphasize the ongoing evolution of intraoral scanning technologies and their essential role in advancing the standards of care in digital dentistry.

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