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Pacific Northwest Prosthodontics specializes in fixed, removable and implant Prosthodontics as well as being highly trained in fully edentulous immediate implant provisionalization (aka all on 4) options for your patients with failing or missing dentitions.

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Prosthodontics Newsletter™

Focusing on Dental Implants

Implant Impressions for Partially Edentulous Patients

Despite astonishing advances in dental digital processes, virtual reality and artificial intelligence, the fabrication of dental prostheses continues to be driven essentially by indirect methods. Thus, a replica of the intraoral geography generated from traditional or digital impression-making remains necessary. Keeping up with innovations in methods, materials, equipment, clinical techniques and research reports permits the informed practitioner to optimize the impression process, thus improving prosthesis outcomes. This issue of Prosthodontics Newsletter *discusses various factors that have an impact on the quality of intraoral contour capture in the fabrication of implant prostheses for partially edentulous patients.*

Accuracy of Digital Scanning

With advances in computer-aided design and computer-aided manufacturing (CAD/CAM) technology, digital approaches to implant dentistry provide an alternative to conventional impressions. Digital scanning can be cost- and time-effective, allows for electronic archiving, reduces the distortion that may accompany conventional impression materials, and improves patient acceptance and convenience. But digital scanning procedures have required the removal of healing abutments, which disrupts the healing of the adjacent soft tissue and allows for the movement of the junctional epithelium around the implant; this can lead to marginal bone resorption while having a negative impact on the benefits in terms of cost and time, patient comfort and impression accuracy—all advantages of digital scanning.

To address these concerns, manufacturers have developed scannable healing abutments that can remain situated while either a conventional elastomeric impression or an intraoral scan is taken. Jung et al from Korea University Guro Hospital conducted an in vitro study comparing the accuracy of different implant impression techniques in relation to scannable healing abutments.

The authors created 40 maxillary and mandibular models in epoxy resin, replacing the mandibular right second premolar and first molar with 10-mm high, 4.0-mm and 4.5-mm diameter implants. These models were then allocated to 4 experimental groups:

➤ **Group CI (control 1):** conventional impression group (pickup impression plus model scanner)

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Accuracy of Digital Scanning

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➤ **Group DS (control 2):** digital scan group with traditional scan body (digital scan body plus intraoral scanner)

➤ **Group MS:** model scanning group with scannable healing abutment (scannable healing abutment plus dual-arch impression plus model scanner)

➤ **Group IS:** intraoral scanning group with scannable healing abutment (scannable healing abutment plus intraoral scanner)

Each group's accuracy was measured based on the amount of 3-dimensional (3D) deviation: linear intra-arch, linear interarch and implant angle.

In all groups except group MS, mean total linear intra-arch deviation was <100 µm; group MS showed almost twice as much deviation, a significant difference. Group MS also showed significantly greater mean 3D implant angle deviation (Table 1). Linear interarch deviation was <100 µm in all groups.

Comment

Intraoral scanning with scannable healing abutments yielded results comparable to those obtained using conventional pickup impressions and digital scans with traditional scan body; model scans with scannable healing abutments did not. Studies based on measurements taken after placement of implant-supported prostheses are needed to determine which techniques return the most accurate results.

Jung H-T, Kim H-Y, Song S-Y, et al. Accuracy of implant impression techniques with a scannable healing abutment. J Prosthet Dent *2022;128:729-734.*

Patient Preference for Digital Scanners

Digital scanners in restorative dentistry promised a more accurate and cost-effective prosthesis. Eliminating the need for a conventional impression should increase patient comfort (especially in the maxilla) while reducing clinical treatment time and cost. Manicone et al from Università Cattolica del Sacro Cuore, Italy, conducted a systematic review and meta-analysis to determine whether digital scans for implant restorations are more comfortable for the patient and take less time compared with conventional impressions.

The researchers looked for randomized controlled trials, cohort studies and cross-sectional studies that enrolled ≥5 partially edentulous or edentulous patients who received ≥1 implants rehabilitated with a conventional workflow using an analog impression or with a digital workflow starting with a digital scan. They found 12 published studies that met the inclusion criteria: 3 randomized controlled trials; 2 randomized crossover trials; 6 observational studies with a digital scan and a conventional impression made for each patient; and 1 observational study with a digital group and a conventional group. Among the studies:

➤ 8 included only single implant crowns

➤ 2 included both single implant crowns and 3-unit fixed partial dentures on 2 implants

➤ 2 included complete-arch rehabilitations on 4 or 6 implants

The meta-analysis' standard mean deviation for the duration of the procedure strongly favored the digital procedure with only 1 study—the oldest included in the systematic review—favoring the conventional procedure; this remained true when the meta-analysis was limited to the studies of single-implant restorations. All patient-reported outcomes (comfort, anxiety, nausea, perceived duration) significantly favored the digital scan.

Comment

Study results found digital scanning faster than conventional impression-making based on the elimination of the impression tray, the ability to correct a defective scan more easily and the more straightforward recording of the occlusion. Patients found digital scanning more convenient, less frightening, less nausea-inducing and more quickly completed.

Manicone PF, De Angelis P, Rella E, et al. Patient preference and clinical working time between digital scanning and conventional impression making for implant-supported prostheses: a systematic review and meta-analysis. J Prosthet Dent *2022;128:589-596.*

Table 1. Mean deviation of implant angle (degrees).

Implant	Group CI	Group DS	Group MS	Group IS
Second premolar	0.96 ± 0.44	1.17 ± 0.52	2.34[a] ± 0.46	1.38 ± 0.35
First molar	0.88 ± 0.43	1.05 ± 0.61	2.49[a] ± 0.53	1.41 ± 0.48

[a]*Statistically significant* ($p < .05$).

Intraoral Scanning Coverage

The intraoral scanner has become widely used for implant impressions; it combines ease of use and fast scanning speed with positive patient experience. Because intraoral scanning is a relatively new technology, ideal parameters for use have not been established for all variables. One standard that needs to be established is the proper intraoral scanning coverage (IOSC). Due to the way intraoral scanning captures data, scanning too great an area results in errors, so full-arch scanning is less accurate than single-quadrant scanning. However, scanning too small an area results in incomplete occlusal alignment and movement of scanning data. Wang et al from Sichuan University, China, reported the results of a study that attempted to identify the appropriate IOSC for multiple scenarios.

They created 5 resin models with different partially edentulous situations: 3 missing a single tooth, 1 missing multiple adjacent anterior teeth and 1 missing multiple adjacent posterior teeth. After the researchers created desktop scans of each model as controls, the models were scanned by an intraoral scanner with the following IOSC:

➤ **single missing tooth:** 2, 4, 6, 8, 10 and 12 teeth, as well as the full arch

➤ **multiple missing anterior teeth:** 2, 4, 6 and 8 teeth, as well as the full arch

➤ **multiple missing posterior teeth:** 2, 4, 6, 8 and 10 teeth, as well as the full arch

Table 2. Intraoral scanning coverage (IOSC) returning the most accurate.

	Model
Missing tooth #8	≥4 teeth
Missing tooth #5	4 and 6 teeth
Missing tooth #3	2, 4, 6 and 8 teeth
Missing teeth #7 through #10	≥4 teeth
Missing teeth #3 through #5	≤8 teeth

The tooth numbers in the original article used the Federation Dentaire Internationale (FDI) system. The numbers were changed to reflect the Universal Tooth Numbering System: https://www.kwcdental.com/blog/what-is-the-tooth-numbering-system.

A convolutional neural network (CNN) was trained to predict the ideal IOSC for each edentulous situation.

IOSC varied for the single-tooth sites (Table 2). CNN determined that the optimal IOSC was 8 teeth for a single missing anterior tooth, 4 teeth for a single missing molar or premolar, 8 teeth for multiple missing anterior teeth, and 6 teeth for multiple missing posterior teeth.

Comment

With the limitations of this study, results suggested that full-arch scanning tends to result in increased deviation. IOSC of 8 teeth was recommended for anterior implants, while IOSC for posterior implants should be restricted to a half arch.

Wang Z-Y, Gong Y, Liu F, et al. Influence of intraoral scanning coverage on the accuracy of digital implant impressions—an in vitro *study.* J Dent *2024;doi:10.1016/j.jdent.2024.104929.*

3D Printed Impression Trays

For implant-supported restorations, an accurate representation of the intraoral implant position is critical. While the accuracy of implant impressions has improved greatly, clinically relevant deviation remains a common problem when using either conventional custom implant impression trays or customized self-perforating foil impression trays. Digital implant impressions using intraoral scanners have limitations on accuracy when taking full-arch impressions. A recently introduced option involves using 3-dimensional (3D) printing to manufacture patient-specific individual impression trays. Schmidt et al from Justus Liebig University, Germany, conducted an in vitro study to investigate whether chairside 3D printed impression trays increased the accuracy of implant impressions.

Their study used a master model of a partially edentulous maxilla with 4 implants in the posterior region at #14, #16, #24 and #26. Four different impression techniques were compared:

➤ conventional custom impression tray (CIT)

➤ customized foil tray (CFT)

➤ chairside 3D printed impression tray using the SHERA system (3DS)

➤ chairside 3D printed impression tray using the Primeprint system (3DP)

Ten implant impressions were obtained from each group. Trays were replaced after 5 impressions for the CIT, 3DS and 3DP groups; a new customized tray was used for each impression in the CFT group. Plaster models based on each impression tray were measured for mean deviation from the master model.

Both 3D groups had significantly better results than the CFT group at all implant positions. The 3DS and 3DP groups showed significantly better results than the CIT group at #14 and #26, while the 3DP group also showed significantly better results at #24. The results for the 3DS group were slightly better than those for the 3DP group, but the differences were not significant.

Comment

This was the first study to show that significantly higher accuracy in implant impressions could be obtained with 3D printed impression trays. The authors recommended that if a 3D printer is available, it should be the choice for manufacturing patient-specific impression trays.

Schmidt A, Berschin C, Wöstmann B, Schlenz MA. Chairside 3-D printed impression trays: a new approach to increase the accuracy of conventional implant impression taking? An in vitro *study.* Int J Implant Dent *2023;doi:10.1186/s40729-023-00516-9.*

Materials for Obtaining Accurate Impressions

Obtaining an accurate implant impression is critical early in planning a prosthetic restoration. Several variables may influence the accuracy of implant impressions, including impression material, impression technique and tray type. The most frequently employed impression materials are polyether and polyvinyl siloxane (PVS), while impressions are obtained using either the open or closed tray technique. Tray types include stock trays (made of metal or plastic) and custom trays, which are typically manufactured in laboratories or printed using 3-dimensional (3D) printers employing either a liquid crystal display (LCD) system or a fused deposition modeling (FDM) system.

Unsal et al from Ankara Yıldırım Bayazıt University, Türkiye, conducted an in vitro study to measure the dimensional accuracy of impressions using various combinations of these options. They created a model of a maxillary dentate arch with 3 implants replacing the right first premolar and first and second molars. Thirty examples of 5 different types of trays were prepared:

- metal stock trays
- plastic stock trays
- custom trays produced using a 3D LCD printer with liquid polymer
- custom trays produced using a 3D FDM printer with a thermoplastic filament
- custom trays manufactured using conventional methods with urethane dimethacrylate (UDMA) resin

Impressions were obtained using closed and open tray techniques; all impressions used PVS impression material and the 1-step impression technique. Scans of the impressions were superimposed on the reference model, and deviations in position and angle were measured; results for all 5 groups were compared.

Angular deviation of the second molar implant was greater for plastic and UDMA trays; it was also greater for closed plastic trays than for open plastic trays. The greatest positional deviation was seen with an open plastic tray at the first molar implant. However, the researchers found no statistically significant differences among the groups for positional or angular deviation.

Comment

Previous studies had indicated that tray type or impression technique could have an impact on the accuracy of the impression when ≥4 implants were being used. The results of this study suggested that when treating maxillary partial edentulism with 3 implants, any combination of impression technique and tray type will result in reasonable accuracy.

Unsal G, Caglar A, Tural M, et al. Evaluation of implant impression accuracy using different trays and techniques with a 3D superimposition method. Int J Oral Maxillofac Implants *2024;39:595-602.*

In the Next Issue

Edentulous dental implant impressions

Our next report features a discussion of this issue and the studies that analyze them, as well as other articles exploring topics of vital interest to you as a practitioner.

Do you or your staff have any questions or comments about **Prosthodontics Newsletter**? Please write or call our office. We would be happy to hear from you.