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Research on the Application of Digital Intraoral Scanning Impression Technique in Oral Implant Restoration for Periodontitis Patients and Its Impact on VAS Scores

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Abstract: *Objective*: To explore the application effect of digital intraoral scanning impression technique in oral implant restoration for periodontitis patients and analyze its impact on patients' Visual Analogue Scale (VAS) scores. *Methods*: A total of 80 periodontitis patients who received implant restoration in our hospital from May 2023 to May 2025 were selected as research subjects. They were randomly divided into an observation group and a control group using a random number table method, with 40 cases in each group. The observation group used the digital intraoral scanning impression technique to obtain impressions, while the control group used the traditional silicone rubber impression technique. The impression-taking time, the number of prostheses try-ins, implant survival rate, periodontal health indicators (probing depth, gingival index, bleeding index), and VAS scores (pain during treatment and comfort after restoration) were compared between the two groups. *Results:* The observation group was superior to the control group in terms of impression-taking time, the number of prostheses try-ins, and implant survival rate ($p < 0.05$). Six months after restoration, the improvement in periodontal health indicators in the observation group was significantly better than that in the control group ($p < 0.05$). In addition, the pain VAS score of the observation group during treatment was lower than that of the control group, and the comfort VAS score after restoration was higher than that of the control group ($p < 0.05$). *Conclusion:* Digital intraoral scanning impression technology can effectively enhance the efficiency and success rate of implant restoration in periodontitis patients, improve periodontal health, alleviate patients' discomfort during treatment, and increase post-restoration comfort, demonstrating high clinical application value.

Keywords: Digital intraoral scanning impression technology; Periodontitis; Oral implant restoration; Visual analog scale; Implant survival rate

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1. Introduction

Periodontitis is a common chronic oral inflammatory condition that can lead to tooth loss. Oral implant restoration

is the primary treatment method, and impression taking directly influences the restoration outcome [1].

The traditional silicone rubber impression process is cumbersome, and its accuracy is easily affected by the oral environment, increasing the number of restorations try-ins [2]. In recent years, digital technology has been increasingly applied in the field of dentistry, and digital intraoral scanning impression technology has gradually garnered attention due to its advantages of being model-free, highly precise, and efficient [3–5]. This study took 80 periodontitis patients who underwent implant restoration in our hospital from May 2023 to May 2025 as the research subjects. It comparatively analyzed the application effects of digital intraoral scanning impression technology and traditional silicone rubber impression technology and explored their impacts on patients' VAS scores, providing a reference basis for clinical treatment.

2. Materials and methods

2.1. General information

Eighty patients with periodontitis undergoing dental implant restoration in our hospital from May 2023 to May 2025 were selected as the study subjects. They were randomly divided into an observation group and a control group, with 40 cases in each group, according to the random number table method.

2.1.1. Inclusion criteria

(1) All patients met the relevant diagnostic criteria in Periodontology [6]
(2) All had single-tooth loss with good bone conditions
(3) They were able to actively cooperate with the doctors to complete this clinical trial and undergo long-term follow-up examinations
(4) They had no absolute or relative contraindications related to implant surgery
(5) They had signed informed consent forms.

2.1.2. Exclusion criteria

(1) Patients with severe systemic diseases or oral diseases
(2) Patients with a history of head and neck radiation exposure or orthodontic treatment
(3) Patients in special physiological periods such as pregnancy or menstruation
(4) Patients with mental illnesses or those in a state of unconsciousness due to other reasons, making them unable to cooperate with this study.

2.1.3. Study group

Based on the above criteria, stratified sampling was conducted on all eligible subjects, and they were ultimately divided into the observation group and the control group, with 40 subjects in each group participating in this clinical comparative analysis.

In the observation group, there were 22 males and 18 females, with ages ranging from 35 to 68 and an average age of (48.56 ± 7.23). The severity of periodontitis was as follows: 15 mild cases, 18 moderate cases, and 7 severe cases. The control group consisted of 23 males and 17 females, with an age range of 36 to 69 and an average age of (49.12 ± 7.58). The severity of periodontitis in this group was: 14 mild cases, 19 moderate cases, and 7 severe cases. Comparison of general data between the two groups ($p > 0.05$) indicated comparability. This

study was approved by the Medical Ethics Committee of our hospital.

2.2. Methods

2.2.1. Preoperative preparation

Both groups underwent oral examinations and CBCT assessments, completed basic periodontal treatments such as supragingival scaling, and proceeded with surgery after periodontal stability was achieved (negative bleeding on probing and periodontal pocket depth ≤ 3 mm).

2.2.2. Impression taking method

The control group employed the traditional silicone rubber impression technique: An addition-cured silicone rubber impression material was selected, mixed according to the ratio specified in the material instructions, placed into a tray, and then inserted into the patient's mouth. It was accurately positioned and secured, and after the material had fully cured, it was removed. The integrity of the impression was checked, and once confirmed to be error-free, it was sent to the dental laboratory for fabrication of a plaster model, which was used for the production of the prosthesis.

The observation group utilized digital intraoral scanning impression technology: A TRIOS intraoral scanner was selected, which is based on ultra-fast optical sectioning technology and confocal microscopy, capable of capturing over 3,000 two-dimensional images per second and synthesizing them into a three-dimensional digital impression. Before scanning, the patient's mouth was cleaned with a mouthwash to remove food debris and dental plaque. The operator held the scanning head and slowly scanned the edentulous area and adjacent teeth in the patient's mouth, observing the completeness of the three-dimensional image on the screen in real time. Areas with unclear scans were rescanned to ensure complete data of the dentition and soft and hard tissues were obtained. After scanning was completed, the data was transmitted in STL format to a CAD/CAM system for direct design and production of the prosthesis.

2.2.3. Implant restoration procedure

The same group of doctors implanted Straumann implants, administered postoperative anti-infection treatment, and provided nursing guidance. After 3 to 6 months of stable osseointegration, the prosthesis was installed, and follow-up records were kept.

2.3. Observation indicators

(1) Indicators related to implant restoration

Impression-making time, number of attempts to fit the prosthesis, and implant retention rate. Among them, impression-making time refers to the duration from surgery to obtaining the impression; the number of attempts to fit the prosthesis indicates how many times it takes to fully secure the denture onto the abutment; the implant retention rate is calculated as the number of implants remaining 6 months postoperatively divided by the total number of implants placed during surgery, multiplied by 100%.

(2) Periodontal health indicators

These are assessed 6 months after restoration completion and include probing depth around the implant (measured as the distance from the implant neck to the deepest point of probing using a periodontal probe), gingival index (using the Loe-Silness gingival index criteria, where 0 indicates normal gingiva, 1 indicates mild gingival inflammation, 2 indicates moderate gingival inflammation, and 3 indicates severe

gingival inflammation), and bleeding index (using the Mazza bleeding index criteria, where 0 indicates no bleeding upon probing, 1 indicates punctate bleeding after probing, 2 indicates linear bleeding after probing, and 3 indicates significant bleeding after probing).

(3) VAS scoring indicators

These include the pain VAS score during treatment and the comfort VAS score after restoration [7]. Among them, the VAS score for pain during treatment refers to the pain experienced during the impression-taking process (VAS visual analog scale, ranging from 0 to 10, with 0 indicating no pain and 10 indicating the most severe pain); the VAS score for comfort after restoration was assessed one month after the completion of the restoration, with patients evaluating the usage of their intraoral dentures based on their own sensations (VAS visual analog scale, ranging from 0 to 10, with 0 indicating extreme discomfort and 10 indicating great comfort).

2.4. Statistical methods

Data were analyzed using SPSS 26.0. Continuous data ($\overline{x} \pm s$) were subjected to *t*-tests, while categorical data [n (%)] were analyzed using χ^2 tests. A *p*-value less than 0.05 was considered statistically significant.

3. Results

3.1. Comparison of implant restoration-related indicators between the two groups

The impression-taking time in the observation group was shorter than that in the control group, the number of prostheses try-ins was fewer in the observation group than in the control group, and the implant survival rate was higher in the observation group than in the control group ($p < 0.05$). See **Table 1**.

Table 1. Comparison of implant restoration-related indicators between the two groups ($\overline{x} \pm s$)

Group	Impression time (min)	Prosthesis try-in times (times)	Implant survival rate (%)
Observation group (n = 40)	5.23 ± 1.05	1.08 ± 0.27	39 (97.50%)
Control group (n = 40)	12.67 ± 2.18	1.89 ± 0.43	33 (82.50%)
Statistical value (t/χ^2)	19.447	10.090	5.000
p-value	0.000	0.000	0.025

3.2. Comparison of periodontal health indicators between the two groups

Six months after restoration completion, the probing depth around implants, gingival index, and bleeding index in the observation group were all lower than those in the control group ($P<0.05$). See **Table 2**.

Table 2. Comparison of periodontal health indicators between the two groups ($\overline{x} \pm s$)

Group	Probing depth (mm)	Gingival index (score)	Bleeding index (score)
Observation group (n = 40)	2.15 ± 0.32	0.52 ± 0.16	0.48 ± 0.15
Control group (n = 40)	3.26 ± 0.45	1.23 ± 0.28	1.15 ± 0.26
t-value	12.714	13.924	14.117
p-value	0.000	0.000	0.000

3.3. Comparison of VAS scores between the two groups

The pain VAS score during treatment in the observation group was lower than that in the control group, while the comfort VAS score after restoration was higher in the observation group than in the control group ($p < 0.05$). See **Table 3**.

Table 3. Comparison of VAS scores between the two groups ($\overline{x} \pm s$, points)

Group	Intraoperative pain VAS score	Postoperative comfort VAS score
Observation group (n = 40)	2.13 ± 0.65	8.67 ± 0.72
Control group (n = 40)	4.89 ± 1.02	6.23 ± 0.89
t-value	14.432	13.480
p-value	0.000	0.000

4. Discussion

Digital intraoral scanning generates high-precision impressions by collecting three-dimensional oral data through optical technology. The TRIOS scanner used in this study has an accuracy of 50 μm and does not require reflective powder. Compared with traditional techniques, its mold-free process shortens the cycle, its high precision fits complex anatomical structures, and its compact scanning head enhances the patient experience.

The results of this study showed that the impression-taking time in the observation group was significantly shorter than that in the control group, and the core reason for this data difference lies in the procedural differences between the two techniques. Traditional silicone rubber impressions require multiple steps, including material preparation, seating, curing, and removal, with the material curing time alone taking 3 to 5 minutes. In contrast, digital scanning can complete data acquisition in real time without waiting for material curing, thus significantly reducing operation time. The number of prostheses try-ins in the observation group was less than that in the control group (1.89 ± 0.43 times), and the implant survival rate was higher than that in the control group, which was directly related to the high precision of digital impressions. Regarding conventional impression-taking methods, factors such as the limited fluidity of the materials themselves or improper operation can easily lead to defects like air bubbles, thereby affecting the quality of the models. This undoubtedly has an adverse impact on the subsequent denture fabrication. In contrast, digital scanning can precisely capture these subtle structures, significantly improving the fit between the prosthesis and adjacent teeth as well as the implant, thereby reducing the number of try-ins, lowering the risk of peri-implant infection, and increasing the survival rate [8].

In terms of periodontal health indicators, the probing depth around implants, gingival index, and bleeding index in the observation group were all significantly lower than those in the control group. This result reflects the indirect protective effect of digital technology on periodontal health [9]. Accurate prosthesis fabrication can effectively prevent food impaction and reduce the likelihood of plaque accumulation around implants, as bacterial plaque attachment is a major cause of peri-implantitis. Traditional impression-making techniques cannot accurately record the patient's anatomical morphology and interproximal conditions, resulting in prostheses with edges that are not tightly fitted, creating plaque retention areas and triggering gingival inflammation and probing bleeding. However, the high-precision edge design of digital prostheses can effectively circumvent this issue, thereby improving periodontal health status [10].

The results of the VAS scores revealed that the observation group experienced lower pain scores during

treatment and higher comfort levels after restoration, which was closely related to the operational characteristics of digital technology. Traditional silicone rubber impression trays are large and cumbersome, and their insertion into a patient's mouth can easily compress the periodontal tissues and mucosa, causing discomfort. In contrast, digital scanning heads are smaller and more agile, allowing for accurate three-dimensional data acquisition by simply placing them gently in the mouth and sliding them slowly along the teeth, significantly reducing damage to the oral soft and hard tissues. Furthermore, precise prosthesis design ensures harmonious occlusal relationships, preventing occlusal trauma and thereby enhancing oral comfort after restoration.

5. Conclusion

In conclusion, the application of digital intraoral scanning impression technology in oral implant restoration for periodontitis patients can significantly shorten impression-taking time, reduce the number of prostheses try-ins, and improve implant survival rates. Simultaneously, it can enhance periodontal health, alleviate pain and discomfort during treatment, and improve post-restoration comfort, making it worthy of clinical promotion and application.

Disclosure statement

The authors declare no conflict of interest.

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