



Oral Health-Related Quality of Life and Satisfaction Following Implant Restoration After Sinus Floor Augmentation: A Prospective Evaluation

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Abstract

Background/Aim: Alveolar ridge resorption and maxillary sinus pneumatization present significant challenges for implant rehabilitation. Although lateral window sinus floor augmentation (LWSFA) is a predictable surgical approach, patient-reported outcomes remain essential for evaluating treatment success beyond osseointegration. This study aimed to evaluate longitudinal oral health-related quality of life (OHRQoL) and satisfaction in patients undergoing implant therapy after LWSFA.

Methods: This prospective longitudinal study included 39 patients with 57 posterior maxillary edentulous sites and residual bone height ≤ 4 mm. All patients underwent LWSFA using a mixture of allograft, synthetic bone substitute and platelet-rich fibrin. After six months of graft maturation, implants were placed, followed by definitive prosthetic restoration after a further six months. OHRQoL was assessed using the Oral Health Impact Profile-14 (OHIP-14) at baseline and at one week, six months and 12 months after functional loading. Patient Satisfaction Score (PSS) was measured using a visual analogue scale.

Results: Mean OHIP-14 scores improved significantly from 24.28 ± 9.77 at baseline to 6.13 ± 2.82 at 12 months ($p < 0.001$). Most domain-specific improvements appeared to stabilise by six months. PSS increased significantly from 8.92 ± 0.81 at one week to 9.44 ± 0.55 at six months ($p < 0.017$), before reaching a plateau. Across all time points, female patients consistently reported significantly higher OHIP-14 scores than males ($p < 0.05$). Satisfaction in single-tooth cases stabilised within one week, whereas multi-unit cases required six months.

Conclusion: LWSFA followed by implant-supported restoration significantly improves OHRQoL and satisfaction. Maximum satisfaction and functional comfort are typically achieved and sustained after six months of functional loading.

Key words: Dental implants; Sinus floor augmentation, lateral window; Quality of life; Patient satisfaction; Treatment outcome.

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Introduction

Oral health-related quality of life (OHRQoL) is a multidimensional concept incorporating functional, psychological and social components and

is increasingly used to evaluate patient-perceived benefits after implant therapy.¹ It reflects the patient's subjective perception of how oral condi-

tions and dental treatment influence daily comfort, self-esteem, masticatory function, speech and social interaction.^{1, 2} In implant dentistry, alveolar ridge resorption after tooth extraction, often aggravated by maxillary sinus pneumatization, presents a major anatomical limitation for posterior maxillary rehabilitation.^{3, 4}

Lateral window sinus floor augmentation (LWSFA) with bone grafting is widely used to increase vertical bone volume and enable implant placement in severely atrophic posterior maxillae, with previous systematic evidence supporting predictable implant survival after sinus floor elevation.^{3, 5, 6} However, surgical predictability and implant survival alone do not fully describe treatment benefit. Patients undergoing LWSFA usually experience a prolonged treatment pathway, including graft maturation, implant placement, prosthetic loading and functional adaptation. During this period, temporary discomfort, delayed chewing recovery, aesthetic concerns and uncertainty about treatment outcome may influence OHRQoL.

Following implant-supported restoration, improvements in OHRQoL are expected through the recovery of masticatory efficiency, comfort, appearance and confidence. Nevertheless, satisfaction may not peak immediately after prosthetic delivery because patients need time to adapt to new occlusal contacts and to the sensory characteristics of implant-supported prostheses, which differ from natural teeth because of the absence of periodontal ligament proprioception. Therefore, longitudinal assessment after loading is important for identifying when patient-perceived benefit stabilises.

The Oral Health Impact Profile-14 (OHIP-14) is a validated short-form instrument widely used to quantify OHRQoL, while visual analogue scales are commonly used to assess patient satisfaction with treatment outcomes.^{1, 7, 8} Despite the increasing use of dental implants and sinus augmentation, longitudinal evidence on OHRQoL and satisfaction specifically after LWSFA remains limited. Therefore, this study aimed to evaluate longitudinal OHRQoL and satisfaction levels in patients undergoing implant-supported rehabilitation after LWSFA and bone grafting.

Methods

Study design and participant selection

The study was approved by the Ethics Committee for Biomedical Research of Can Tho University of Medicine and Pharmacy (Decision No 504/PCT-HĐĐĐ). This prospective, exploratory longitudinal study was conducted between January 2022 and February 2024 and monitored patient-reported outcomes for 12 months after definitive prosthetic loading. From 48 screened individuals, 39 patients with 57 posterior maxillary edentulous sites were enrolled and completed the follow-up assessments (Figure 1). No a priori power analysis was performed; the sample size was determined by the number of eligible patients treated during the study period. The primary objective was to evaluate longitudinal changes in OHIP-14 scores following LWSFA and implant-supported rehabilitation. Given the exploratory design and single-centre recruitment, the findings should be interpreted as preliminary.

Eligible participants were adults aged 18 years or older who required implant-supported rehabilitation in the posterior maxilla after LWSFA. Patients were included when the residual bone height was ≤ 4 mm and the prosthetic space was at least 5 mm. Both unilateral and bilateral LWSFA cases were eligible. Patient inclusion was based on the need for staged LWSFA followed by delayed implant placement and definitive restoration. The cohort comprised 39 patients, including 19 requiring single-tooth implant restoration and 20 requiring multi-unit posterior maxillary rehabilitation. In total, 57 edentulous sites were treated. Patients were excluded if they had acute or chronic maxillary sinusitis, bleeding disorders, uncontrolled diabetes, bone metabolic disease, active periodontal disease, smoking habit, pregnancy, or use of medication affecting bone metabolism or haemostasis, such as aspirin, warfarin, or glucocorticoids.

This study was derived from the same prospective clinical cohort previously reported for histological and histomorphometric outcomes after LWSFA. However, the present analysis addressed a distinct research question, focusing on longitudinal patient-reported outcomes, including OHRQoL and satisfaction after implant-supported prosthetic rehabilitation.¹²

Surgical intervention

The surgical intervention was performed in distinct phases. Initially, LWSFA was conducted following administration of prophylactic antibiotics (amoxicillin/clavulanic acid) and local anaesthesia. A lateral window was created using a piezotome, the Schneiderian membrane was elevated and the sinus cavity was grafted with a 2:1 mixture of allograft (*Corticocancellous*, HC Biologics, USA) and synthetic bone substitute (30 % HA/70 % β -TCP, Osteon II, *Dentium*, Korea) combined with autologous platelet-rich fibrin. After a six-month maturation period, implant osteotomies were prepared and dental implants (*Tekka*, France and *JD*, Italy; diameter: 4.5-5.0 mm; length: 8-13 mm) were placed according to the prosthetic plan. Definitive prosthetic restorations were completed six months after implant placement.

Treatment outcome assessment

Patient outcomes were quantified using two primary tools in the local language by one previously trained interviewer. To evaluate OHRQoL, this study used the OHIP-14, a validated short-form instrument adapted from Slade and Spencer's original 49-item framework (Figure 2).⁹ The questionnaire assesses impact across seven domains: functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability and handicap. Participants responded to 14 items using a five-point Likert scale, with values ranging from zero (never) to four (always). Within this scoring system, lower aggregate totals reflect better OHRQoL, whereas higher scores indicate greater oral health-related impairment.

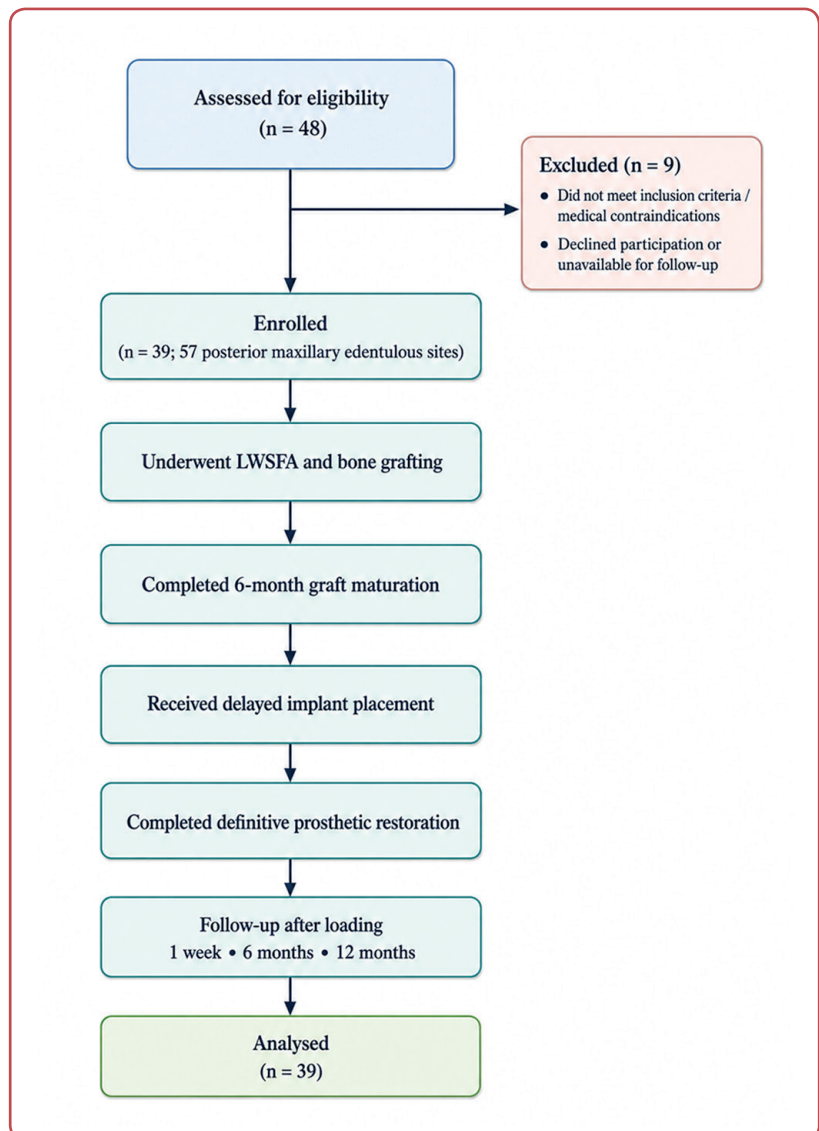


Figure 1: Participant flow and follow-up chart

LWSFA: lateral window sinus floor augmentation;

Functional Limitation

1. Have you had trouble pronouncing any words because of problems with your teeth, mouth or dentures?
2. Have you felt that your sense of taste has worsened because of problems with your teeth, mouth or dentures?

Physical Pain

3. Have you had painful aching in your mouth?
4. Have you found it uncomfortable to eat any foods because of problems with your teeth, mouth or dentures?

Psychological Discomfort

5. Have you been self-conscious because of your teeth, mouth or dentures?
6. Have you felt tense because of problems with your teeth, mouth or dentures?

Physical Disability

7. Has your diet been unsatisfactory because of problems with your teeth, mouth or dentures?
8. Have you had to interrupt meals because of problems with your teeth, mouth or dentures?

Psychological Disability

9. Have you found it difficult to relax because of problems with your teeth, mouth or dentures?
10. Have you been a bit embarrassed because of problems with your teeth, mouth or dentures?

Social Disability

11. Have you been a bit irritable with other people because of problems with your teeth, mouth, or dentures?
12. Have you had difficulty doing your usual jobs because of problems with your teeth, mouth or dentures?

Handicap

13. Have you felt that life in general is less satisfying because of problems with your teeth, mouth or dentures?
14. Have you been totally unable to function because of problems with your teeth, mouth or dentures?

0= never; 1= hardly never; 2= occasionally; 3= fairly often; 4=very often

Figure 2: Oral Health Impact Profile-14 (OHIP-14) questionnaire

General satisfaction with treatment outcome was assessed using a 10-point visual analogue scale (VAS), from 0 (very dissatisfied) to 10 (very satisfied) and recorded as the Patient Satisfaction Score (PSS).^{10, 11} To track longitudinal satisfaction, evaluations were conducted at one week, six months and 12 months after placement of definitive restorations.

Statistical analysis

Data analysis was performed using IBM SPSS version 20 (IBM Inc, USA). All statistical analyses for OHIP-14 and PSS indices were conducted at the patient level, meaning each patient was treated as a single statistical unit regardless of the total number of implants received or the specific positions of the edentulous sites.

Because the data followed a non-normal distribution, non-parametric statistics, specifically the Wilcoxon signed-rank test, were employed to evaluate longitudinal changes. To maintain statistical stringency and account for multiple comparisons across the longitudinal assessment intervals, a Bonferroni correction was applied. For OHIP-14, evaluations were conducted at four distinct time points: baseline, one week, six months and 12 months post-loading. This required six possible pairwise comparisons, for which the significance threshold was established at $p < 0.008$ (0.05/6).

PSS was assessed at three post-loading intervals, involving three possible pairwise comparisons; consequently, the adjusted significance threshold for PSS was set at $p < 0.017$ (0.05/3). Subgroup comparisons, such as those based on gender or

the number of teeth replaced, were analysed using the Mann-Whitney U-test with a significance level of $p < 0.05$.

A total of 48 individuals were assessed for eligibility. Nine were excluded because they did not meet the inclusion criteria, had medical contraindications, declined participation, or were unavailable for follow-up. Finally, 39 patients with

57 posterior maxillary edentulous sites were enrolled, underwent LWSFA and bone grafting, completed the 6-month graft maturation period, received delayed implant placement and definitive prosthetic restoration and were followed up at 1 week, 6 months and 12 months after loading. All 39 patients were included in the final analysis (Figure 1).

Results

A total of 39 patients (57 edentulous posterior maxillary sites) were included, with a mean age of 53.13 ± 13.00 years (range: 23-72). Females accounted for 61.5 % ($n = 24$) and males for 38.5 % ($n = 15$). Single-tooth restorations were performed in 48.7 % of patients ($n = 19$), while 51.3 % received multi-unit prostheses ($n = 20$).

Wilcoxon signed-rank test, Bonferroni-adjusted. Selected pairwise comparisons are shown. OHIP-14 scores decreased significantly from baseline to all post-loading time points ($p < 0.008$), while no significant difference was observed between 6 and 12 months.

Longitudinal changes in OHIP-14

As shown in Table 1, the mean OHIP-14 score decreased significantly from 24.28 ± 9.77 at baseline to 10.00 ± 3.96 at one-week post-loading, further declining to 6.64 ± 3.00 at six months and 6.13 ± 2.82 at 12 months. Pairwise comparisons using the Wilcoxon signed-rank test revealed statistically significant differences between base-

Table 1: Longitudinal changes in Oral Health Impact Profile-14 (OHIP-14) questionnaire ($N = 39$)

Stage	OHIP-14 (Mean \pm SD)	p-value
Baseline (pre-treatment) (a)	24.28 ± 9.77	$p^{ab} < 0.001$
One-week post-loading (b)	10.00 ± 3.96	$p^{bc} < 0.001$
Six months post-loading (c)	6.64 ± 3.00	$p^{cd} < 0.001$
12 months post-loading (d)	6.13 ± 2.82	$p^{cd} = 0.182$

line and all post-loading time points ($p < 0.008$, Bonferroni-adjusted). No significant difference was observed between six and 12 months ($p = 0.182$), indicating stabilisation after six months.

Domain-specific OHIP-14 changes

As detailed in Table 2, all seven OHIP-14 domains demonstrated a reduction in mean scores over time. Given the repeated-measures structure, comparisons across time were evaluated using the Wilcoxon signed-rank test; however, domain-level results are presented descriptively to minimise the risk of type I error due to multiple testing.

Table 2: Longitudinal changes in total and domain-specific Oral Health Impact Profile-14 (OHIP-14) scores across assessment intervals

Measure	Reference scores	Pre-treatment	1-week post-restoration	6-month post-restoration	12-month post-restoration
n		39	39	39	39
Mean score	0-56	24.28 ± 9.77	10.00 ± 3.96	6.64 ± 3.00	6.13 ± 2.82
Functional limitations	0-8	2.97 ± 1.98	1.54 ± 1.05	0.97 ± 0.84	0.90 ± 0.82
Physical pain	0-8	4.03 ± 1.39	2.05 ± 0.92	1.51 ± 0.82	1.41 ± 0.85
Psychological discomfort	0-8	4.59 ± 2.19	1.62 ± 0.99	0.87 ± 0.73	0.85 ± 0.84
Physical disability	0-8	3.51 ± 1.59	1.18 ± 0.85	0.92 ± 0.77	0.90 ± 0.64
Psychological disability	0-8	3.90 ± 1.81	1.44 ± 0.99	0.79 ± 0.89	0.82 ± 0.82
Social disability	0-8	2.87 ± 1.24	1.13 ± 0.66	1.03 ± 0.67	0.87 ± 0.61
Handicap	0-8	2.41 ± 1.27	1.05 ± 0.72	0.54 ± 0.50	0.38 ± 0.49

Changes in PSS

As presented in Table 3, mean PSS increased from 8.92 ± 0.81 at one week to 9.44 ± 0.55 at six months. The Wilcoxon signed-rank test demonstrated a statistically significant difference between one week and six months ($p = 0.001$; adjusted threshold $p < 0.017$). No significant difference was observed between six and 12 months ($p = 0.467$), while the comparison between one week and 12 months remained statistically significant ($p < 0.001$).

Table 3: Longitudinal changes in Patient Satisfaction Score (PSS) ($N = 39$)

Stage	PSS (Mean \pm SD)	p-value
One-week post-loading (a)	8.92 ± 0.81	$p^{ab} = 0.001$
Six months post-loading (b)	9.44 ± 0.55	$p^{bc} = 0.467$
12 months post-loading (c)	9.51 ± 0.56	$p^{ac} < 0.001$

Wilcoxon signed-rank test, Bonferroni-adjusted.

Stratified analysis

Between-group comparisons were performed using the Mann-Whitney U test. Females consistently exhibited higher OHIP-14 scores than males at all time points, with statistically significant differences. Multi-unit cases showed higher OHIP-14 scores than single-tooth cases at one week and six months. For PSS, male patients demonstrated significantly higher satisfaction than females at one week and six months, with no difference at 12 months. Single-tooth restorations showed higher satisfaction than multi-unit restorations at one week, while no statistically significant differences were observed at six and 12 months (Table 4 and 5).

Table 4: Stratified analysis of Oral Health Impact Profile-14 (OHIP-14) questionnaire scores ($N = 39$)

Variable	Group	Baseline	1-week post-restoration	6-month post-restoration	12-month post-restoration
Gender	Male	19.67 ± 8.21	7.13 ± 3.18	5.20 ± 2.62	4.27 ± 2.43
	Female	27.17 ± 9.71	11.79 ± 3.32	7.54 ± 2.92	7.29 ± 2.42
	p-value	0.036	< 0.001	0.017	0.001
Tooth count	Single tooth ($n = 19$)	20.74 ± 10.37	7.84 ± 3.64	5.53 ± 3.13	5.26 ± 2.83
	Multi-unit restorations ($n = 20$)	27.65 ± 8.05	12.05 ± 3.12	7.70 ± 2.52	6.95 ± 2.63
	p-value	0.050	0.001	0.028	0.051

Mann-Whitney U test.

Table 5: Stratified analysis of Patient Satisfaction Scores (PSS) ($N = 39$)

Variable	Group	1-week post-restoration	6-month post-restoration	12-month post-restoration
Gender	Male	9.33 ± 0.62	9.67 ± 0.49	9.60 ± 0.51
	Female	8.67 ± 0.82	9.29 ± 0.55	9.46 ± 0.59
	p-value	0.011	0.039	0.487
Tooth count	Single tooth ($n = 19$)	9.42 ± 0.51	9.58 ± 0.51	9.68 ± 0.48
	Multi-unit restorations ($n = 20$)	8.45 ± 0.76	9.30 ± 0.57	9.35 ± 0.59
	p-value	< 0.001	0.128	0.066

Mann-Whitney U test.

Discussion

Implant rehabilitation after LWSFA substantially improved OHRQoL and patient satisfaction in this prospective cohort. The progressive reduction in OHIP-14 scores observed in the present study is consistent with previous reports showing that implant-supported rehabilitation improves patient-perceived oral function, comfort and psychosocial well-being.^{13,14} This improvement likely reflects restoration of the functional and biopsychosocial pillars affected by posterior maxillary edentulism, including masticatory comfort, self-confidence and social interaction.^{14,15}

The six-month plateau in PSS suggests that patient satisfaction continues to evolve after prosthetic delivery and requires a functional adaptation period. This finding is consistent with longitudinal observations showing improvement in satisfaction during the early months after implant rehabilitation.¹³ During this phase, patients adapt to new occlusal contacts, prosthesis contours and the tactile characteristics of implant-supported restorations, which lack periodontal ligament-mediated proprioception.¹⁶

The faster stabilisation observed in single-tooth restorations compared with multi-unit restorations is clinically plausible. Single-tooth replacement usually involves fewer changes in occlusal pattern and oral sensorimotor adaptation, whereas multi-unit posterior rehabilitation often requires broader changes in mastication, hygiene access and patient expectations. These findings are supported by studies indicating that more extensive maxillary implant rehabilitation can have a stronger psychosocial impact and may require a longer adaptation period.¹⁷⁻¹⁹

The importance of monitoring patient-reported outcomes after implant therapy is supported by Mauland et al, who reported that peri-implant diseases and complications may negatively affect OHRQoL in patients treated with dental implants.²⁰ This reinforces that implant success should be evaluated not only by survival or prosthetic stability, but also by patient-perceived comfort, function, aesthetics and psychosocial well-being. In the present study, the significant reduction in OHIP-14 scores and high PSS values suggest favourable patient-perceived outcomes after LWSFA and implant-supported restoration during the 12-month follow-up. Previous im-

plant-related studies also showed that OHRQoL and satisfaction are influenced by prosthetic design and functional adaptation. Brennan et al reported favourable patient-reported outcomes in implant overdentures and fixed complete dentures,²¹ while Oh et al found differences in satisfaction and OHRQoL among fixed implant-supported prostheses, removable implant-supported prostheses and conventional dentures.²² Similarly, Reissmann et al concluded that implant-supported prostheses are generally associated with improved OHRQoL.²³ Therefore, the higher OHIP-14 scores observed in female patients in this study may reflect greater perceived concerns regarding mastication, aesthetics and social comfort, although this exploratory finding should be interpreted cautiously because the study was not primarily powered to assess gender-related differences.

Several limitations must be considered. The exclusion of smokers and patients with uncontrolled systemic conditions limits generalisability, as these factors may influence peri-implant complications and OHRQoL.¹³ The single-centre design, convenience sampling and absence of an a priori power calculation also limit external validity. Although the 12-month follow-up demonstrated stable outcomes, longer-term evaluations are required because OHRQoL may change beyond the first year, particularly if biological or prosthetic complications occur.²⁰ Future research should use multi-centre designs, larger samples and longer observation periods to explore the relationship between patient-reported outcomes and objective clinical or radiographic parameters.

Conclusion

LWSFA followed by implant-supported restoration provides a significant positive impact on OHRQoL and satisfaction levels. Maximum satisfaction is typically achieved and sustained after six months of functional loading. Future research should use multi-centre designs and longer observation periods to explore correlations between OHRQoL and objective clinical and radiographic outcomes over the long term.

Ethics

Ethical approval was granted by the Biomedical Research Ethics Board of Can Tho University of Medicine and Pharmacy. The study was conducted under Decision No 504/PCT-HĐĐĐ, dated 5 November 2021. A written informed consent for anonymised patient information to be published in this article was obtained from the patient.

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Conflicts of interest

The authors declare that there is no conflict of interest.

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Data access

The data that support the findings of this study are available from the corresponding author upon reasonable individual request.

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