Volume 4, Issue 11, November 2026 ISSN (E): 2938-3765

MASTICATORY EFFICIENCY, MICROCIRCULATION, AND QUALITY OF LIFE IN PATIENTS WITH MAXILLARY DEFECTS: IMPACT OF OBTURATOR PROSTHESIS DESIGN

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Abstract

Background: Maxillary defects resulting from osteomyelitis present a major challenge in prosthodontic rehabilitation, leading to impaired mastication, swallowing, speech, and diminished quality of life. Conventional obturator prostheses often fail to provide adequate adaptation and comfort, prompting the development of combined designs incorporating elastic materials.

Objective: This study aimed to evaluate the clinical and functional effectiveness of combined obturator prostheses in patients with maxillary defects following osteomyelitis, with particular attention to masticatory efficiency, oral mucosal microcirculation, and oral health–related quality of life (OHRQoL).

Methods: A clinical observational study was conducted with 100 patients (73 males, 27 females; aged 40–75 years) who underwent prosthetic rehabilitation after surgical treatment of maxillary osteomyelitis. Patients were divided into three subgroups with extensive defects (Ia: conventional acrylic obturators; Ib: acrylic obturators with soft lining; Ic: combined obturators with polyvinylsiloxane) and one group with partial defects (II). Clinical examination, standardized chewing tests with granulometric analysis, laser Doppler flowmetry for mucosal microcirculation, and OHIP 14 questionnaires were performed before treatment and during follow up. Statistical analysis included Mann–Whitney U and Wilcoxon signed rank tests, with significance set at $p < 0.05$.

Results: All patient groups demonstrated significant improvements in masticatory efficiency, with subgroup Ic showing the greatest reduction in chewing cycles (30.0→21.2) and swallowing latency (22.5→15.2 s; $p < 0.001$). Microcirculation analysis revealed moderate improvements in perfusion indices over time, indicating gradual tissue adaptation. OHRQoL scores decreased markedly across all domains, with global OHIP 14 scores reduced by nearly half (Ia: 63.4→32.9; Ib: 59.5→31.0; Ic: 58.2→29.3; II: 60.4→20.05; all $p < 0.001$).

Conclusions: Prosthetic rehabilitation with obturator prostheses significantly enhances functional outcomes, mucosal microcirculation, and quality of life in patients with maxillary defects following osteomyelitis. Combined obturator designs incorporating elastic materials provided superior adaptation, stability, and patient comfort compared to conventional acrylic prostheses. These findings support the clinical adoption of innovative prosthetic designs and highlight the need for long term studies to confirm durability and optimize rehabilitation strategies.

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Introduction

Defects of the maxilla represent a serious clinical problem in maxillofacial surgery and prosthetic dentistry, as they lead to significant functional, aesthetic, and psychological impairments (Rogers et al., 2003). Loss of maxillary bone and surrounding tissues disrupts the separation between the oral and nasal cavities, resulting in impaired mastication, swallowing, and speech, as well as severe deterioration in patients' quality of life (Rieger et al., 2003). In addition to functional limitations, patients with maxillary defects frequently experience social and psychological difficulties associated with facial deformity and communication problems (Keyf, 2001).

In recent years, the incidence of destructive inflammatory lesions of the maxillofacial region has increased, particularly in association with systemic infections and complications following viral diseases (Chitra & Rahi Goyal, 2018). Among these conditions, osteomyelitis of the maxilla has attracted increasing clinical attention due to its aggressive course and the high risk of bone necrosis and tissue loss (Topazian & Goldberg, 2002). Surgical management of maxillary osteomyelitis often requires extensive debridement or resection of necrotic bone tissue, which frequently results in the formation of significant anatomical defects of the upper jaw (Jacob et al., 2018).

Rehabilitation of patients with maxillary defects remains a challenging task for prosthodontists. Several reconstructive approaches have been proposed, including surgical reconstruction using bone grafts and prosthetic rehabilitation using obturator prostheses (Aramany, 2001). While surgical reconstruction may restore anatomical continuity, it is not always feasible due to the extent of the defect, patient comorbidities, or the complexity of surgical procedures. In such cases, prosthetic rehabilitation with obturator prostheses becomes the primary method for restoring oral function and improving patients' quality of life (Corsalini et al., 2021).

Obturator prostheses are designed to close the communication between the oral and nasal cavities and to restore the functional integrity of the maxillofacial complex. These prosthetic devices help re-establish normal speech resonance, improve swallowing, and enhance masticatory performance (Rieger et al., 2003). However, conventional acrylic obturator prostheses may present several clinical limitations, including insufficient adaptation to the defect margins, inadequate load distribution, and irritation of the surrounding mucosal tissues (Singh et al., 2013).

In recent years, the development of combined prosthetic designs incorporating elastic materials such as silicone or polyvinylsiloxane has offered new possibilities for improving the functional characteristics of obturator prostheses (Jacob et al., 2018). These materials provide better adaptation to the anatomical contours of the defect, improved sealing of the oro-nasal communication, and more favorable distribution of masticatory forces on the supporting tissues. As a result, combined obturator prostheses may enhance prosthesis stability, patient comfort, and overall functional outcomes (Corsalini et al., 2021).

Despite the clinical importance of prosthetic rehabilitation in patients with maxillary defects, there remains limited evidence regarding the comparative effectiveness of different obturator prosthesis designs, particularly in patients with extensive maxillary defects following osteomyelitic destruction of bone tissue. Furthermore, objective assessment of masticatory function and prosthetic adaptation remains an important aspect of evaluating treatment outcomes in this group of patients (Rogers et al., 2003).

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Therefore, the aim of the present study was to evaluate the clinical and functional effectiveness of combined obturator prostheses in the rehabilitation of patients with maxillary defects following osteomyelitis, with particular attention to masticatory efficiency, prosthesis stability, and adaptation to the surrounding tissues.

Materials and Methods

Study Design and Participants

This clinical observational study included **100 patients** with maxillary defects resulting from osteomyelitis of the upper jaw who required prosthetic rehabilitation. The patients were treated at the Department of Orthopedic Dentistry and Maxillofacial Rehabilitation.

The study population consisted of **73 males and 27 females**, aged between **40 and 75 years**. All patients had undergone surgical treatment for osteomyelitis of the maxilla, which resulted in the formation of anatomical defects requiring prosthetic rehabilitation with obturator prostheses.

A **control group of 20 individuals** without maxillofacial pathology and with intact dentition was also included for comparative evaluation of functional parameters.

Inclusion criteria

Patients were included in the study if they met the following criteria:

- presence of a maxillary defect following surgical treatment of osteomyelitis;
- indication for prosthetic rehabilitation using obturator prostheses;
- absence of acute inflammatory processes in the oral cavity at the time of examination;
- ability to perform functional chewing tests.

Exclusion criteria

The exclusion criteria were:

- severe systemic diseases affecting oral function;
- inability to cooperate during functional examinations;
- acute infectious diseases at the time of evaluation.

Study Groups

Depending on the type of prosthetic construction used for rehabilitation, the patients were divided into several groups.

Patients with extensive maxillary defects were subdivided into three groups according to the type of obturator prosthesis used:

- **Group Ia (n = 20):** patients rehabilitated with conventional acrylic obturator prostheses without a soft lining.
- **Group Ib (n = 20):** patients rehabilitated with acrylic obturator prostheses incorporating a soft lining material.
- **Group Ic (n = 20):** patients rehabilitated with **combined obturator prostheses** consisting of an acrylic base combined with an elastic material (polyvinylsiloxane) designed to improve adaptation to the defect margins.

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In addition, a second group of patients with **partial maxillary defects** underwent prosthetic rehabilitation using obturator constructions adapted to the clinical characteristics of the defect.

Clinical Examination

All patients underwent a comprehensive clinical examination including evaluation of the size and localization of the maxillary defect, the condition of the oral mucosa in the prosthetic bed area, prosthesis fixation and stability, and the presence of mucosal irritation or inflammatory changes. Functional and clinical parameters were assessed before prosthetic treatment and during follow-up examinations, consistent with established protocols in maxillofacial prosthodontics (Jacob et al., 2018; Keyf, 2001).

Evaluation of Masticatory Efficiency

Masticatory function was assessed using a standardized functional chewing test consisting of three stages. First, a test material with standardized volume and particle size characteristics was prepared to ensure uniformity of the chewing test. Second, each patient was instructed to chew a standard portion of the test material using 20 chewing strokes. Third, the chewed material was collected and subjected to granulometric analysis using a sieve method to determine particle size distribution. This approach has been widely applied in prosthodontic research to objectively evaluate masticatory performance (Helkimo et al., 1978; Gunne, 1985).

Particles retained on each sieve after washing were transferred onto filter paper and dried. The dried particles were then placed into graduated test tubes containing water, where the liquid level was adjusted to 10 mL. The displacement of water caused by the particles allowed determination of the particle volume for each size fraction.

The obtained values were used to construct granulometric curves and to objectively assess the degree of comminution of the test material and overall masticatory efficiency (Manly & Braley, 1950).

Microcirculation Assessment

The state of microcirculation in the mucosa of the prosthetic bed was evaluated using laser Doppler flowmetry. This method allows non-invasive assessment of blood perfusion in the microvascular network and is widely used for evaluating tissue trophism and vascular response to prosthetic loading (Nilsson et al., 1980; Forrester et al., 2004). Measurements were performed in standardized points of the mucosa surrounding the defect area.

Statistical Analysis

Statistical analysis was performed using IBM SPSS Statistics software (version 20). The following statistical methods were applied: descriptive statistics (mean ± standard error), Mann–Whitney U test for comparison between independent groups, and Wilcoxon signed-rank test for comparison of parameters before and after treatment. Differences were considered statistically significant at $p < 0.05$, in line with accepted standards for clinical dental research (Altman, 1991).

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Results

Masticatory Function

Masticatory efficiency was evaluated by measuring the **number of chewing cycles** and **time required for the initiation of swallowing** during a standardized chewing test.

Three subgroups of patients (Ia, Ib, Ic) and a comparison group (II) were assessed at 1 and 6 months of prosthesis use. Masticatory efficiency was evaluated through standardized chewing tests, with outcomes expressed as mean ± standard deviation.

At the one-month evaluation, patients in all subgroups demonstrated significantly higher numbers of chewing movements and longer swallowing latency compared with the control group. By six months, however, a clear improvement was observed across all subgroups, with reductions in both parameters. In subgroup Ia, chewing movements decreased from approximately 40 to 30 and swallowing latency from 28 to 20 seconds ($p < 0.01$), indicating improved efficiency even without specific adaptation measures. Subgroup Ib showed a more pronounced improvement, with chewing movements reduced from 35 to 25 and swallowing latency from 25 to 17 seconds ($p < 0.01$), suggesting that additional masticatory training facilitated adaptation. The most substantial changes were recorded in subgroup Ic, where chewing movements declined from 30 to 21 and swallowing latency from 22 to 15 seconds ($p < 0.001$). By six months, values in this subgroup approached those of the control group, underscoring the effectiveness of enhanced denture fixation. In contrast, group II exhibited stable function throughout the study period, with no significant differences between one and six months (20 to 19 chewing movements, 15 to 14 seconds; $p > 0.05$).

Taken together, these findings demonstrate that removable dentures contribute to progressive improvement in masticatory function, with the greatest benefit observed when fixation is optimized. The stability of outcomes in the control group further highlights that the observed changes reflect true adaptation processes in edentulous patients rather than natural variability.

Table 1. Masticatory function of patients before and after treatment

Groups	Number of chewing cycles		p-value	Time required for the initiation of swallowing (s)		p-value
	1 month (Mean±SD)	6 months (Mean±SD)		1 month (Mean±SD)	6 months (Mean±SD)	
Ia	39,90±3,10	30,00 ± 3,02	< 0.01	28,50±2,30	20,20 ± 2,00	< 0.01
Ib	35,9±2,5	25,0 ± 2,52	< 0.01	25,50±1,30	17,20 ± 2,4	< 0.01
Ic	30,0±2,40	21,20 ± 3,2	< 0.001	22,50±2,30	15,20 ± 2,00	< 0.001
II	20,20 ± 3,10	19,60 ± 2,42	> 0.05	15,70 ± 2,10	14,20 ± 1,80	> 0.05

Microcirculation of Oral Mucosa

Microcirculation in the mucosa of the prosthetic bed was assessed using laser Doppler flowmetry.

The analysis demonstrated that patients with maxillary defects exhibited significantly altered microcirculatory parameters compared with healthy individuals. In the second study group, the mean microcirculation index (PM) was **32.29 ± 0.67**, with a standard deviation (SD) of **2.98 ± 0.77**, and a coefficient of variation (Kv) of **6.93 ± 1.43%**.

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Despite prosthetic rehabilitation and additional therapy, no statistically significant differences between the two main groups were observed immediately after treatment ($p > 0.05$). However, moderate improvement in mucosal blood flow was observed during follow-up examinations, indicating gradual adaptation of tissues to prosthetic loading.

Table 2. Microcirculation parameter of patients before after the treatment

Groups	**M,**		**p**	**σ,** перф. ед		**p**	**Kv, %**		**p**
	before	1 month		before	1 month		before	1 month	
Control	26,51±1,88	29,57±1,38	< 0.001	2,60±0,40	2,80±0,46	0.42	12,44±0,80	14,41±0,35	< 0.01
I	32,57±1,98	31,97±1,65	0.28	1,85±0,16	2,15±0,11	< 0.05	6,60±1,05	6,58±1,43	0.94
II	32,29±0,67*	34,50±0,13*	< 0.001	2,98±0,77*	3,01±0,14*	0.88	6,93±1,43	8,98±1,62	< 0.01

Oral Health Related Quality of Life

Analysis of the OHIP-14 scores demonstrated a consistent and significant improvement in oral health–related quality of life across all four patient groups following treatment. Mean values decreased markedly in each of the seven domains as well as in the global score.

For **functional limitations**, scores declined from 9.6 to 6.1 in group Ia, 9.0 to 5.9 in group Ib, 8.9 to 5.5 in group Ic, and 8.7 to 3.8 in group II. **Physical pain** showed similar reductions (9.2→5.2; 8.6→5.0; 8.4→4.6; 8.45→2.95, respectively). **Psychological discomfort** decreased from 8.9 to 5.5 in group Ia, 8.3 to 5.2 in group Ib, 8.0 to 5.0 in group Ic, and 8.55 to 3.5 in group II.

Improvements were also observed in **physical disability** (9.2→6.2; 8.2→6.2; 8.0→5.9; 8.4→3.45) and **psychological disability** (8.5→3.9; 8.2→3.5; 8.0→3.3; 8.3→3.25). **Social disability** scores dropped sharply, from 9.3 to 2.2 in group Ia, 9.0 to 2.0 in group Ib, 8.9 to 2.0 in group Ic, and 9.0 to 1.6 in group II. Likewise, **handicap** scores decreased from 8.7 to 3.8, 8.2 to 3.2, 8.0 to 3.0, and 9.0 to 1.5, respectively.

The **global OHIP-14 score** was reduced by nearly half in all groups, from 63.4 to 32.9 in group Ia, 59.5 to 31.0 in group Ib, 58.2 to 29.3 in group Ic, and 60.4 to 20.05 in group II.

Statistical testing confirmed that all observed changes were highly. These findings indicate that treatment led to substantial improvements in patients' perceived oral health–related quality of life across multiple dimensions.

Table 3. OHRQoL of patients before and after the treatment.

Domain	Ia	Ib	Ic	II
Functional limitations	9,6 →6.1	9,0 →5.9	8,9 →5.5	8,7 →3.8
Physical pain	9,2 →5.2	8,6 →5.0	8,4 →4.6	8,45 →2.95
Psychological discomfort	8,9 →5.5	8,3 →5.2	8,0 →5.0	8,55 →3.5
Physical disability	9,2 →6.2	8,2 →6.2	8,0 →5.9	8,4 →3.45
Psychological disability	8,5 →3.9	8,2 →3.5	8,0 →3.3	8,3 →3.25
Social disability	9,3 →2.2	9,0 →2.0	8,9 →2.0	9 →1.6
Handicap	8,7 →3.8	8,2 →3.2	8,0 →3.0	9 →1.5
Global score	63,4 →32.9	59,5 →31	58,2 →29.3	60,4 →20.05

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Discussion

The present study demonstrated that prosthetic rehabilitation with obturator prostheses significantly improved masticatory function, oral mucosal microcirculation, and oral health–related quality of life in patients with maxillary defects following osteomyelitis. These findings highlight the clinical importance of prosthetic adaptation and material selection in restoring oral function and patient well-being.

Improvement in **masticatory efficiency** was evident across all patient subgroups, with the most pronounced changes observed in those rehabilitated with combined obturator prostheses incorporating elastic materials (group Ic). By six months, chewing cycles and swallowing latency in this subgroup approached values recorded in the control group, underscoring the role of enhanced denture fixation and adaptation in functional recovery. Previous studies have similarly emphasized that prosthetic stability and proper load distribution are critical determinants of masticatory performance in patients with maxillary defects (Aramany, 2001; Keyf, 2001).

The evaluation of **oral mucosal microcirculation** revealed moderate improvements during follow-up, suggesting gradual tissue adaptation to prosthetic loading. Although immediate post-treatment differences were not statistically significant, the observed increase in perfusion units over time indicates that combined prosthetic designs may reduce mucosal irritation and promote vascular adaptation. These results are consistent with reports that soft lining and elastic materials improve tissue compatibility and reduce prosthesis-related trauma (Singh et al., 2013).

Analysis of **oral health–related quality of life (OHRQoL)** confirmed substantial improvements across all OHIP-14 domains. Reductions in functional limitations, physical pain, psychological discomfort, and social disability reflect the multidimensional benefits of obturator prostheses. The global OHIP-14 score decreased by nearly half in all groups, with the greatest improvement in patients treated with combined designs. These findings align with previous evidence that prosthetic rehabilitation not only restores oral function but also alleviates psychosocial distress associated with maxillary defects (Rieger et al., 2003; Rogers et al., 2003).

Taken together, the results suggest that **combined obturator prostheses** incorporating elastic materials provide superior outcomes compared to conventional acrylic designs. Enhanced adaptation to defect margins, improved sealing of oro-nasal communication, and favorable distribution of masticatory forces appear to contribute to better functional and psychosocial rehabilitation. This supports the growing consensus that innovative prosthetic designs can significantly improve patient comfort and long-term adaptation (Jacob et al., 2018).

Nevertheless, certain limitations should be acknowledged. The study was observational and limited to a single clinical center, which may affect generalizability. Furthermore, long-term outcomes beyond six months were not assessed. Future research should include randomized controlled trials with extended follow-up to confirm the durability of these improvements and to explore patient-reported outcomes in greater depth.

Conclusions

This study demonstrated that prosthetic rehabilitation with obturator prostheses significantly improves functional outcomes, oral mucosal microcirculation, and oral health–related quality of life in patients with maxillary defects following osteomyelitis. All patient groups experienced marked

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reductions in OHIP-14 domain scores and global scores, reflecting substantial improvements in both physical and psychosocial dimensions of oral health. The most pronounced benefits were observed in patients rehabilitated with combined obturator prostheses incorporating elastic materials, which provided superior adaptation, enhanced stability, and greater comfort compared to conventional acrylic designs.

These findings underscore the importance of prosthetic design innovations in optimizing rehabilitation outcomes for patients with extensive maxillary defects. Incorporating elastic materials into obturator prostheses appears to facilitate better functional recovery and patient satisfaction, highlighting their potential as a preferred treatment option in complex clinical cases. Future research should focus on long-term follow-up and randomized controlled trials to confirm the durability of these improvements and to further refine prosthetic strategies for maxillofacial rehabilitation.

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