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Original Article

The role of professional oral hygiene in enhancing outcomes of maxillofacial trauma surgery

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ABSTRACT

Background: The oral cavity poses challenges in surgical interventions due to its microbial flora. Maxillofacial trauma surgeries are vulnerable to infections, complicating recovery. Traditional methods, including antibiotic prophylaxis, have limitations, highlighting the need for complementary strategies.
Objective: This study evaluated the impact of professional oral hygiene protocol on infection rates, mucosal health, and pain levels in maxillofacial trauma patients.
Material and methods: A retrospective study analyzed 529 patients treated for maxillofacial trauma at the Maxillo-Facial Surgery Unit of "Azienda Ospedaliera Ospedali Riuniti" in Ancona, Italy, from 2018 to 2023. Patients were divided into two groups: Period 1 (2018–2020, no protocol) and Period 2 (2021–2023, protocol implemented). All patients were in good general health, with no systemic diseases compromising immunity or influencing surgical outcomes. The protocol included supragingival scaling 48 h preoperatively, chlorhexidine 0.20 % three times daily postoperatively, and standardized antibiotic and analgesic regimens. Data included infection rates, modified Beck Oral Assessment Scores and Numerical Rating Scale pain scores. Statistical analyses included independent *t*-tests and Chi-square tests, with significance set at $p < 0.05$.
Results: Period 2 showed significantly lower infection rates (13.44 % vs. 19.48 %, $p = 0.023$), reduced pain scores (mean NRS: 4.6 vs. 5.4, $p < 0.01$) and improved mucosal health (mean BOAS: 2.91 vs. 3.75, $p < 0.001$).
Discussion: The professional oral hygiene protocol reduced postoperative complications, improved oral health, and enhanced patient comfort. These findings support the integration of structured oral hygiene measures into standard maxillofacial surgical care to optimize outcomes and quality of life.

1. Introduction

The oral cavity hosts a vast and diverse microbial flora that represents a significant challenge in surgical interventions. As a "clean-contaminated" site, it is continuously exposed to bacteria, making intraoral wounds particularly susceptible to infections. This susceptibility increases in maxillofacial trauma surgeries due to extensive surgical incisions and the use of titanium hardware, which provide favorable conditions for biofilm formation [1]. Biofilms act as reservoirs for persistent infections, complicating the healing process and leading to increased risks of delayed healing, chronic inflammation, and secondary complications such as osteomyelitis. Such infections delay recovery, prolong hospital stays, escalate healthcare costs, and diminish patient quality of life. [2,3]

Traditional surgical approaches, considering the sterile techniques and antibiotic prophylaxis, have shown limitations in fully mitigating infection risks [4]. While antibiotics play an important role, over-reliance on them has led to concerns about antimicrobial resistance, underscoring the need for complementary strategies. Effective oral hygiene, though often overlooked, is emerging as a cornerstone in reducing microbial burdens and enhancing surgical outcomes. By targeting bacterial loads both pre- and postoperatively, professional oral hygiene protocols can effectively reduce infection risks, facilitate wound healing, and enhance patient comfort [5].

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Emerging evidence highlights the strict connection between oral health and systemic conditions [6]. Poor oral hygiene has been implicated in exacerbating systemic inflammatory responses, which may adversely affect surgical outcomes. For maxillofacial trauma patients, ensuring an optimal environment is critical to mitigating these risks [7]. Maxillofacial fractures, particularly those involving the mandible and maxilla, present unique challenges due to their proximity to the oral cavity, necessitating tailored interventions [1].

In recent years, several studies have explored the epidemiology and management of maxillofacial fractures, emphasizing the role of effective post-surgical care in reducing complications. Studies have highlighted the high prevalence of infections in maxillofacial trauma, particularly in open fractures involving the mandible and maxilla. These fractures, often associated with significant functional and aesthetic impairments, require meticulous management to minimize complications such as infections, malocclusions, and delayed bone healing; furthermore, the use of professional oral hygiene has been correlated with improved outcomes, including reduced infection rates and enhanced patient satisfaction [5,8,9].

Notably, irrigation with antiseptic solutions like chlorhexidine has been identified as a key intervention to reduce postoperative complications. Randomized controlled trials have shown that postoperative irrigation significantly reduces the incidence of alveolar osteitis and infections in oral surgeries [10]. These findings underline the importance of incorporating evidence-based oral hygiene practices into surgical protocols; additionally, studies on patients with panfacial fractures suggest that structured oral care, combined with interdisciplinary approaches, can increase healing and reduce systemic inflammatory responses [5,6].

Recognizing these challenges, a professional oral hygiene protocol was introduced in January 2021, specifically tailored for patients who underwent surgical treatment for maxillofacial trauma. This protocol integrated evidence-based practices aiming to optimize patient outcomes that included: preoperative counseling, professional plaque removal, and postoperative antiseptic. Previous studies have highlighted the role of structured oral care in reducing surgical site infections in other domains of surgery; however, its application in maxillofacial trauma remains understudied.

This study aimed to evaluate whether implementing a professional oral hygiene protocol improves surgical outcomes, specifically infection rates, mucosal health, and patient-reported pain levels. By comparing outcomes in patients treated before and after the protocol's implementation, this research provides critical insights into the transformative potential of structured oral hygiene in maxillofacial trauma care. The findings aim to inform best practices and advocate for the integration of similar protocols into standard surgical guidelines.

2. Materials and methods

This retrospective study enrolled a total of 529 patients who underwent surgical treatment for maxillofacial fractures in the Maxillo-Facial Surgery Unit of "Azienda Ospedaliera Ospedali Riuniti" in Ancona (Marche,Italy) from January 2018 to December 2023.

The Authors collected the patients' information (age, sex, type of fracture and reduction) from the hospital's medical records and operating room activity recording software (Ormaweb®, Dedalus Italia Spa). All data were retrieved and tabulated using Microsoft Excel (Version 16.63.1; Microsoft Corporation).

No personal identifiers, such as names or surnames, were recorded at any stage of this study.

All patients included in this study were of both sexes over the age over 18 years, treated for maxillofacial fracture, in good general health, with no systemic diseases that could compromise immunity or influence surgical outcomes. Specifically, none of the patients had conditions such as diabetes mellitus, autoimmune disorders, or chronic diseases affecting wound healing and immune response. Furthermore, all patients presented with a full set of natural dentition, without prosthetic reconstructions or significant dental pathology, ensuring a homogenous sample regarding oral health status. All patients were treated with intraoral surgical access and all zygomatic complex fractures included in the study were also treated with an intraoral access to reduce visible scarring and complications, aligning with established surgical practices [11–13]

The criteria of exclusion were applied as follows: patients with maxillofacial fractures without intraoral surgical access, patients that refused surgical treatment or chose conservative treatment, patients with anamnesis of previous other facial fractures surgically treated, patients that did not give consent to inclusion in the study or patients with incomplete data charts, patients who did not follow the postoperative advice, patients with allergies to cefazolin, metronidazole and paracetamol, those classified as ASA 3 by anesthesiologists to ensure sample homogeneity.

Anamnestic, cephalometric data, measurements of the distances between certain landmarks for the evaluation of facial edema [14], patient-referred pain, and accurate intraoral and extraoral physical examination both pre and postoperative were collected for each patient. A search was made among all possible plaque removal interventions in patients previously undergoing post-traumatic surgery and the possible causes that led to the second intervention were analyzed. We also used evaluation parameters, the modified Beck Oral Assessment Score (BOAS) [15] and the Numerical Rating Scale (NRS) [16], at the pre- and postoperative levels. The modified BOAS was assessed using predefined parameters, including color, moisture, the presence of lesions, and bleeding tendency; healthcare professionals were trained on the scoring system prior to data collection to ensure interobserver reliability. The scoring was performed at predefined intervals—preoperatively, weekly during the first postoperative month, and at 3, 6, 12, and 24 months postoperatively. Furthermore, any significant deviations from the expected healing trajectory were cross-referenced with clinical records to confirm the accuracy of the BOAS scores [15]. The scoring scale ranged from 1 (optimal condition) to 5 (severe condition). Assessments were conducted by trained healthcare professionals to ensure interobserver consistency. Data collection occurred at predefined intervals: preoperatively, weekly during the first postoperative month, and at 3, 6, 12, and 24 months postoperatively. Pain levels were measured using the Numerical Rating Scale (NRS), where patients were asked to rate their pain on a scale from 0 to 10, with 0 indicating no pain and 10 representing the worst imaginable pain. NRS scores were recorded during the first postoperative week for all patients and at subsequent follow-ups as deemed necessary by the clinical team. The professional oral hygiene protocol included a full supragingival scaling performed 48 h preoperatively [17] and the use of chlorhexidine 0.20 % three times daily 1 min each time for seven days postoperatively [5,18]. Antibiotics (cefazolin 1 g three times daily and metronidazole 500 mg three times daily) and analgesics (paracetamol 1 g three times daily) were uniformly administered postoperatively in all patients [19,20].

Out of a total of 1150 surgical procedures analyzed 744 patients met the inclusion criteria for this study.

In this study, the data collected for patients surgically treated in the years 2018, 2019 and 2020 were compared with similar interventions carried out in the years 2021, 2022, and 2023. The patients were divided into 2 groups: patients belonging to period 1, undergoing treatment in the 3-year period, 2018 to 2020, and patients of period 2 in the 3-year period, 2021 to 2023.

Numerical Rating Scale (NRS) was chosen to evaluate the patient's pain suffered in the first postoperative week. Patients undergoing professional oral hygiene reported an average of 4.6/10 instead of the 5.4/10 referred by patients in period 1.

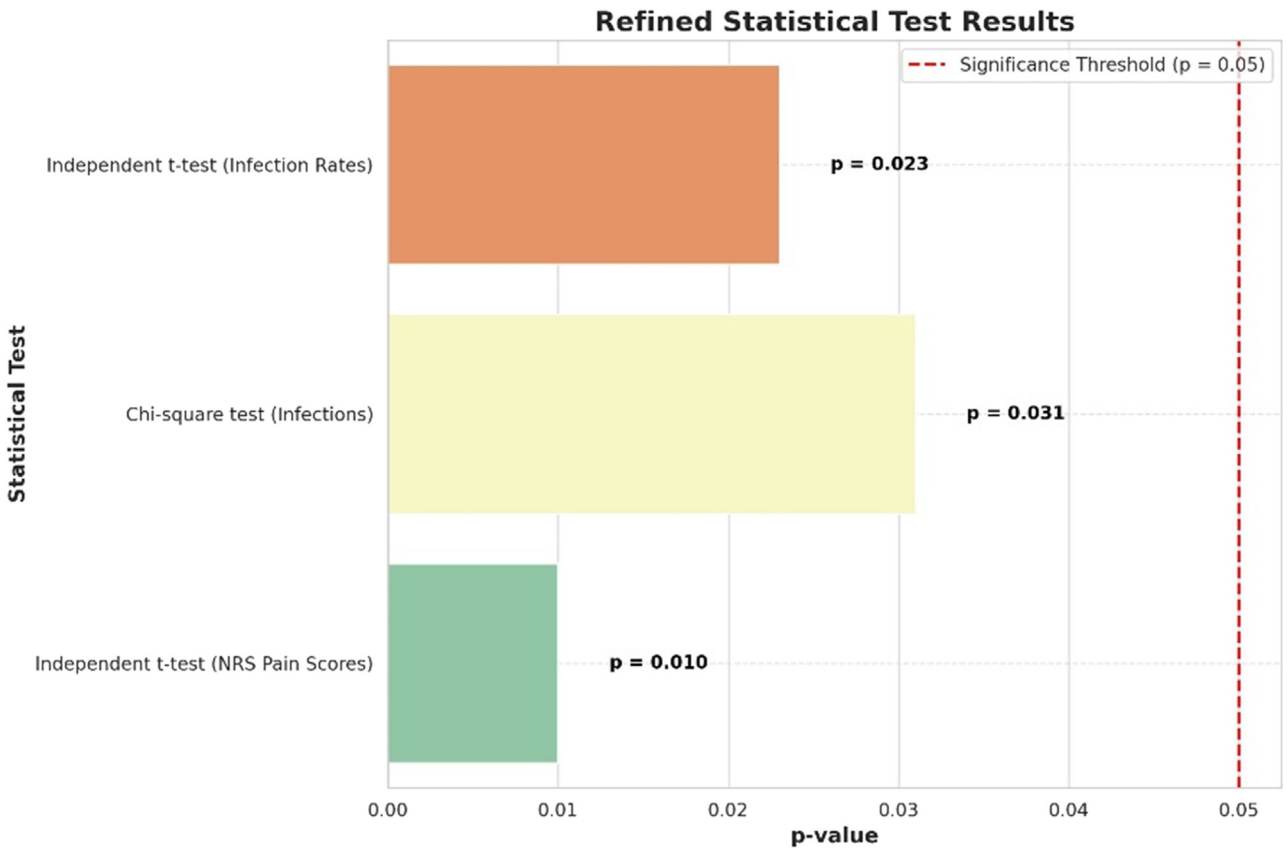

Fig. 1. Detailed Statistical Test Results: This horizontal bar chart illustrates the p-values obtained from three statistical tests conducted in the study. The red dashed line represents the significance threshold (p = 0.05). All tests demonstrated statistically significant results, emphasizing the effectiveness of the professional oral hygiene protocol in improving patient outcomes. Created with BioRender.com.

2.1. Statistical analysis

Statistical analyses were performed using Jamovi Statistics version 29.0.1.0 (IBM, ARMONK, New York, USA). Descriptive statistics were calculated to summarize the demographic and clinical characteristics of the patients, including the average infection rates, mean pain scores, and fracture distribution. The primary analyses included independent *t*-tests used to compare the infection rates between Period 1 (2018−2020) and Period 2 (2021−2023); chi-square test used to evaluate the association between infection occurrence (infections vs. non-infections) and the two time periods and independent *t*-tests were used to compare mean Numerical Rating Scale (NRS) pain scores in the first postoperative week across the two periods.

Detailed Statistical Test Results: This horizontal bar chart illustrates the p-values obtained from the three statistical tests conducted in the study. The red dashed line represents the significance threshold (p = 0.05). The analyses confirmed statistically significant differences between the time periods, supporting the effectiveness of the professional oral hygiene protocol in reducing postoperative complications and improving patient outcomes (Fig. 1).

3. Results

3.1. Demographic and clinical characteristics

A total of 745 patients underwent post-traumatic maxillofacial surgery between 2018 and 2023, with an annual average of 124.16 patients. The male-to-female ratio was 3:1, and the mean age of the patients was 46.2 years.

Fractures were distributed as follows:

- Mandibular fractures: 387 (52.43 %)
- Maxillary fractures: 134 (18.32 %)
- Zygomatic fractures: 223 (29.25 %)

3.2. Infection rates

A significant reduction in infection rates was observed between the two periods. Infection rates are detailed in Table 1, showing a reduction from 19.48 % in Period 1 to 13.44 % in Period 2. This reduction was statistically significant (t = 3.58, p = 0.023).

3.3. Pain scores

Pain levels, as measured by the Numerical Rating Scale (NRS), were also significantly lower in Period 2. Patients in Period 1 reported

Table 1
Infection rate reported each year after surgical reduction of maxillofacial fracture.

Year	Patients	Infections	Infection Rate (%)
2018	131	25	19.08
2019	125	28	22.4
2020	112	19	16.96
2021	137	19	13.86
2022	120	17	14.16
2023	122	15	12.29

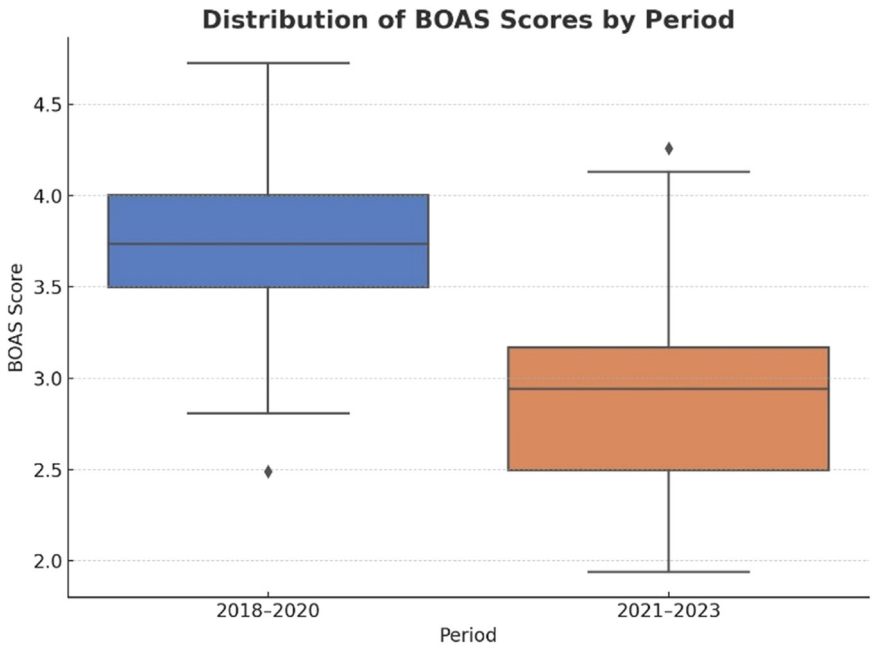

Fig. 2. Distribution of BOAS Scores by Period: This boxplot illustrates the distribution of modified Beck Oral Assessment Scale (BOAS) scores in two periods: 2018–2020 (pre-protocol) and 2021–2023 (post-protocol). The lower median and interquartile range in the 2021–2023 period indicate significant improvements in mucosal health following the introduction of the professional oral hygiene protocol. Outliers highlight individual variations in postoperative recovery. Created with BioRender.com

an average pain score of 5.4 in the first postoperative week, compared to 4.6 in Period 2 ($t = 4.21$, $p < 0.01$).

3.4. BOAS scores

The mucosal health, as assessed by the modified Beck Oral Assessment Score (BOAS), demonstrated statistically significant improvements between the two periods. In Period 1 (2018–2020), the mean BOAS score was 3.75 (SD = 0.45), reflecting poorer mucosal conditions. In contrast, in Period 2 (2021–2023), the mean BOAS score decreased to 2.91 (SD = 0.48), indicating improved oral health. The difference in mean BOAS scores between the two periods was statistically significant ($t = 12.71$, $p < 0.001$). These findings underscore the positive impact of the professional oral hygiene protocol on postoperative mucosal health. (Fig 2)

Among the patients belonging to period 1 in the first postoperative week, the conditions of the mucosa and gums were classified with a score equal to 4 in 17 % and equal to 3 in 26 %; score relating to the hygiene of the dental elements with a score of 4 in 7 % and 3 in 20 %. In contrast, analyzing the subjects subjected to professional hygiene, that is part of period 2, in the first postoperative week, the conditions of the mucosa and gums could be classified with a score of 4 in 6 % and 3 in 14 %; whereas with a score relating to the hygiene of the dental elements equal to 4 in 1 % and equal to 3 in 15 %. We know that early and late infections of the surgical site are among the most frequent and above all the most relevant complications of orthognathic surgery. The numbers of infections per year are reported in Table 1.

3.5. Complication analysis

Early and late postoperative infections were among the most frequent complications. Data revealed a steady decline in infection rates after the introduction of the professional oral hygiene protocol, aligning with the observed improvements in mucosal health and pain management.

3.6. Average duration

The average duration of the surgeries was approximately 1 h and 30 min, with minimal variations attributable to fracture complexity. All patients were treated by senior surgeons with at least 15 years of experience, ensuring consistency in surgical outcomes and reducing potential variability associated with less experienced operators.

4. Discussion

The findings of this study underscored the role of structured professional oral hygiene protocols that significantly improved surgical outcomes, including reduced infection rates, better mucosal health, and lower pain scores [21]. The implementation of this protocol resulted in significant reductions in postoperative complications, including infection rates, pain levels, and poor mucosal health, as evidenced by BOAS scores. Existing evidence highlighted the benefits of oral hygiene interventions in surgical settings [5,9].

One of the most important outcomes of this study was the significant decrease in infection rates observed in Period 2, dropping from an average of 19.48 % in Period 1 to 13.44 % in Period 2. This improvement can be attributed to preoperative plaque removal and the use of postoperative antiseptic solutions like chlorhexidine, which have been shown to effectively reduce bacterial loads and prevent biofilm formation on titanium hardware [22]. These results underscored the importance of addressing microbial burdens both before and after surgery, particularly in high-risk settings such as maxillofacial trauma.

Pain management is another critical aspect of postoperative care, and the observed reduction in NRS scores in Period 2 reflected the protocol's impact on patient comfort. The decrease in pain levels, from an average of 5.4 in Period 1 to 4.6 in Period 2, suggests that targeted oral hygiene measures may have contributed to reduce inflammation and improve wound healing. These findings are consistent with prior studies demonstrating the role of oral health in modulating systemic inflammatory responses [23–27]

The significant reduction in BOAS scores in Period 2 highlighted the efficacy of the professional oral hygiene protocol in improving

postoperative mucosal health. Lower BOAS scores indicated better oral conditions, including reduced inflammation and healthier mucosa. These results aligned with existing evidence that systematic oral care protocols contribute to enhanced surgical outcomes by minimizing microbial burden and promoting tissue regeneration. The statistical significance of these findings reinforced the clinical relevance of incorporating structured oral hygiene measures into maxillofacial surgical care.

Despite these positive outcomes, challenges remain in ensuring patient compliance with oral hygiene protocols, particularly in the postoperative period. Educational initiatives and interdisciplinary collaboration between surgeons, dental hygienists, and nursing staff are essential to address these barriers [28,29]..

This study is limited by its retrospective design and reliance on patient-reported outcomes, which may introduce recall bias.

The professional oral hygiene protocol implemented, has demonstrated substantial benefits in reducing postoperative complications and enhancing patient outcomes. These findings support the integration of structured oral hygiene measures into standard surgical protocols, highlighting the critical role of oral health in advancing surgical care.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

CRediT authorship contribution statement

Giuseppe Consorti: Writing – review & editing, Supervision, Formal analysis, Data curation, Conceptualization. **Giulio Cirignaco:** Writing – original draft, Investigation, Formal analysis, Data curation. **Gabriele Monarchi:** Investigation, Data curation, Conceptualization. **Lisa Catarzi:** Investigation, Data curation, Investigation, Data curation. **Mariagrazia Paglianiti:** Data curation, Conceptualization. **Enrico Betti:** Supervision, Conceptualization. **Umberto Committeri:** Supervision, Data curation, Supervision, Data curation. **Lucrezia Togni:** Data curation, Conceptualization. **Marco Mascitti:** Writing – review & editing, Supervision. **Paolo Balercia:** Validation, Supervision, Validation, Supervision. **Andrea Santarelli:** Writing – review & editing, Validation, Supervision.

Ethics statement/confirmation of patient permission

The study was conducted in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. To ensure patient confidentiality, all personal identifiers were removed or coded during data collection, and access to sensitive information was restricted to authorized personnel only. All the procedures followed the ethical standard of our IRB – CET Marche.

Consent to participate

Informed consent was obtained from all individual participants included in the study.

Patients signed informed consent regarding publishing their data and photographs.

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