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COMPARATIVE EVALUATION OF PHOTODYNAMIC THERAPY IN PURULENT INFLAMMATORY DISEASES OF THE MAXILLOFACIAL REGION

Author: Rustambayeva M. M.
Scientific Supervisor: Eshonqulov Sh. B.
Institution: Tashkent State Medical University

Abstract:
This article presents a comparative evaluation of the effectiveness of photodynamic therapy (PDT) versus conventional treatment methods in purulent-inflammatory diseases of the maxillofacial region. The study involved 30 patients divided into two groups: those receiving conventional treatment and those treated with adjunctive photodynamic therapy. The results demonstrated that PDT rapidly and effectively eliminates microbial flora, significantly reduces inflammatory symptoms in a shorter period, and accelerates wound healing. Furthermore, the method proved effective against antibiotic-resistant microorganisms. Photodynamic therapy was assessed as a safe, modern, and promising treatment modality.

Keywords: Photodynamic therapy, maxillofacial region, purulent-inflammatory diseases, phlegmon, laser therapy, microflora, antibiotic resistance, surgical treatment, dentistry

Introduction

Purulent-inflammatory diseases of the maxillofacial region remain one of the most pressing challenges in modern surgical dentistry. Among these conditions, phlegmons occupy a special place due to their rapid progression, severe clinical

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course, and high risk of complications. In particular, the development of mediastinitis, sepsis, and intracranial complications poses a serious threat to patients' lives.

In recent years, the increasing resistance of microorganisms to antibiotics has significantly reduced the effectiveness of conventional treatment methods. The action of antiseptics is often superficial and insufficient for deeply located infectious foci.

Therefore, the search for modern and effective treatment approaches is of great importance. Photodynamic therapy (PDT) is one such promising method, characterized by a strong antimicrobial effect without inducing microbial resistance.

Aim of the Study:

To comparatively evaluate the effectiveness of photodynamic therapy in the treatment of purulent-inflammatory diseases of the maxillofacial region versus conventional treatment.

Materials and Methods:

The study included 30 patients diagnosed with phlegmon of the maxillofacial region. The patients were aged between 18 and 60 years, with a mean age of 35 ± 5 years.

Grouping:

- Group 1 (n=15): Conventional treatment
- Group 2 (n=15): Conventional treatment + photodynamic therapy

Conventional treatment included:

- Surgical intervention (incision and drainage)
- Antibiotic therapy
- Antiseptic treatment
- Symptomatic therapy

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Photodynamic therapy protocol:

- Photosensitizer (Photolon) was used
- A 0.1% solution was applied into the wound
- Irradiation with a 660–670 nm laser for 10–15 minutes

Evaluation criteria:

- Microbial load
- Duration of exudation
- Edema and infiltration
- Granulation tissue formation
- Treatment duration

Microbiological Results:

During the study, wound exudates were collected from all 30 patients and subjected to microbiological analysis. The initial findings demonstrated a high level of microbial contamination in all patients, with an average microbial load of 10^5–10^6 CFU per sample. These results confirm the presence of an active purulent-inflammatory process.

Microbial Composition

The analysis revealed the predominance of the following microorganisms:

- Streptococcus spp. — 40–45%
- Staphylococcus spp. — 25–30%
- Micrococcus spp. — 10–15%
- Enterococcus spp. — 5–10%

In some patients, mixed microbial flora (associations) were identified, typically consisting of 2–3 different species of microorganisms. This condition was considered a contributing factor to the severity of the inflammatory process.

Dynamics of Microbial Changes During Treatment

Conventional Treatment Group (n = 15)

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• Day 3: A slight decrease in microbial load was observed, remaining at approximately 10^4–10^5 CFU
• Day 5: The microbial level decreased to 10^3–10^4 CFU
• Day 7: Microorganisms were still detected in some patients at levels of 10^2–10^3 CFU
• Day 9: Complete sterilization was not achieved in all patients

These results indicate a gradual reduction in microbial load under conventional treatment, with persistence of certain resistant strains.

Photodynamic Therapy Group (n = 15)

• Day 3: A sharp reduction in microbial load was observed, reaching 10^2–10^3 CFU
• Day 5: In most patients, microorganisms decreased to minimal levels
• Day 7: Microflora was almost completely absent in nearly all patients (sterile condition)

The application of photodynamic therapy resulted in rapid and effective elimination of microorganisms.

Clinical Results:

During the study, the effectiveness of treatment in 30 patients was evaluated based on clinical parameters. Particular attention was paid to the reduction of inflammatory signs, improvement of general condition, and the rate of wound healing.

Baseline Clinical Condition:

At the beginning of the study, all patients presented with the following symptoms:
• Severe pain syndrome
• Pronounced swelling of soft tissues
• Infiltration and hyperemia
• Purulent discharge (exudation)

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• Elevated body temperature in some patients (37.5–38.5°C)

These findings indicated that the inflammatory process was in an active phase.

Pain Reduction:

• Conventional treatment:

• Pain persisted for 3–4 days

• Significant reduction was observed by days 5–6

• Photodynamic therapy (PDT):

• Pain significantly decreased within 2–3 days

• Almost completely disappeared by day 4

These findings suggest that PDT also has an analgesic effect.

Exudation (Purulent Discharge)

• Conventional treatment:

• Continued for 6–7 days

• In some cases, persisted longer

• PDT:

• Resolved within 3–4 days

This indicates that PDT enables faster control of the inflammatory process.

Reduction of Edema and Hyperemia

• Conventional treatment:

• Gradual reduction over 7–9 days

• PDT:

• Significant reduction observed within 4–5 days

This effect can be explained by the anti-inflammatory properties of PDT.

Resolution of Infiltration

• Conventional treatment:

• Required 10–11 days

• PDT:

• Reduced within 5–6 days

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This demonstrates that PDT effectively influences pathological processes within tissues.

Granulation and Epithelialization

Granulation is a key stage in wound healing.

- Conventional treatment:
- Begins on days 8–9
- PDT:
- Appears on days 4–5

Additionally:

- Epithelialization occurred faster in the PDT group
- The wound surface was cleansed more rapidly

General Condition and Body Temperature

- Conventional treatment:
- Elevated body temperature persisted for 3–4 days
- General condition improved gradually
- PDT:
- Body temperature normalized within 2–3 days
- General condition improved rapidly

Duration of Treatment:

- Conventional treatment: 10–12 days
- PDT: 6–7 days

The use of PDT significantly reduced the duration of hospital stay.

Complications and Recurrence:

- Conventional treatment:
- Prolonged persistence of infiltration
- Recurrence of inflammation in some patients
- PDT:

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• Complications were almost absent
• No recurrence was observed

Overall Clinical Conclusion:

• Photodynamic therapy:
• Rapidly reduces pain
• Stops exudation twice as fast
• Quickly eliminates edema and infiltration
• Accelerates wound healing
• Conventional treatment:
• Effective, but produces slower results

Discussion:

The results of the present study demonstrate the high efficacy of photodynamic therapy (PDT) in the treatment of purulent-inflammatory diseases of the maxillofacial region. The findings obtained from 30 patients confirm that the use of PDT leads to rapid and stable improvements in both microbiological and clinical parameters.

First, microbiological analysis revealed that, prior to treatment, all patients exhibited a high microbial load (10^5–10^6 CFU), indicating an active phase of the inflammatory process. Although a gradual reduction in microbial flora was observed under conventional treatment, complete elimination was not achieved even after 7–9 days. This can be explained by the persistence of antibiotic-resistant microorganisms and the presence of microbial associations within the wound.

In contrast, in the PDT group, a significant reduction in microbial load was observed as early as the third day, with near-complete elimination by day 7. This effect is associated with the primary mechanism of photodynamic therapy, which involves the generation of singlet oxygen and reactive oxygen species that rapidly

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destroy bacterial cells. Importantly, this mechanism does not lead to the development of microbial resistance.

The study also highlighted the role of microbial associations. It is well known that bacteria often coexist in the form of biofilms, which provide protection against antibiotic action. In the conventional treatment group, these associations persisted for a longer duration, whereas in the PDT group, they were disrupted at an early stage. This finding indicates the effectiveness of PDT against biofilm-associated infections.

Significant differences were also observed in clinical outcomes. In the conventional treatment group, exudation persisted for 6–7 days, whereas in the PDT group, it resolved within 3–4 days. Similarly, edema and infiltration decreased more rapidly with PDT. These results can be attributed not only to the antimicrobial effect of PDT but also to its anti-inflammatory and regenerative properties.

Early formation of granulation tissue is another important indicator of wound healing. In patients treated with PDT, granulation appeared within 4–5 days, whereas in the conventional treatment group, it was observed only after 8–9 days. This suggests that PDT enhances reparative processes in tissues.

It is important to emphasize that the increasing resistance of microorganisms to antibiotics represents a major challenge in modern medicine. The findings of this study also indicate that many microorganisms exhibit resistance to conventional antibiotic therapy. PDT, however, overcomes this limitation due to its fundamentally different mechanism of action.

Another important advantage of PDT is its localized effect. It acts specifically on the affected area without causing systemic toxicity, thereby minimizing the risk of adverse effects in patients.

In summary, the present study confirms that photodynamic therapy offers several significant advantages, including a rapid and potent antimicrobial effect, the ability to eliminate microbial associations, the absence of resistance development,

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accelerated reduction of inflammatory symptoms, enhanced wound healing, and a high safety profile with minimal side effects.

Although conventional treatment remains the standard approach, its effectiveness may be limited in certain cases. Therefore, combining conventional therapy with photodynamic therapy may provide superior clinical outcomes.

Conclusion:

1. Photodynamic therapy demonstrates high efficacy in the treatment of purulent diseases of the maxillofacial region.
2. It ensures rapid elimination of microbial flora and significantly accelerates wound healing.
3. Clinical outcomes are superior compared to conventional treatment methods.
4. Photodynamic therapy is a safe and modern treatment modality with minimal risk of adverse effects.
5. Its broader implementation in clinical practice is strongly recommended.

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