

**EFFICACY OF ANTIOXIDANT COMPLEX THERAPY IN RESTORING
PERIODONTAL TISSUES IN WORKERS EXPOSED TO STYRENE**

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Abstract: Occupational exposure to styrene is associated with increased oxidative stress, leading to periodontal tissue damage. This study evaluates the effectiveness of antioxidant complex therapy in restoring periodontal health in workers exposed to styrene. Fifty workers with a history of chronic styrene exposure were divided into two groups: one receiving conventional periodontal therapy and the other receiving an additional antioxidant complex regimen. Clinical parameters, including probing depth, gingival index, and oxidative stress markers, were assessed over a six-month period. Results demonstrated a significant improvement in periodontal parameters and reduction of oxidative stress markers in the group receiving antioxidant therapy compared to the control group. This study suggests that antioxidant complex therapy may serve as a valuable adjunct in managing periodontal diseases in occupationally exposed populations [1], [2].

Keywords: Styrene exposure, oxidative stress, periodontal therapy, antioxidants, occupational health.

Introduction

Styrene is an industrially significant chemical widely used in the production of polymers, resins, and synthetic rubbers. Workers involved in the manufacturing of styrene-based materials are chronically exposed to styrene vapors, which are known to have systemic toxic effects [1], [2]. Occupational exposure to styrene has been associated with neurotoxicity, hepatotoxicity, and immunological alterations, but its impact on oral health, particularly periodontal tissues, has received relatively limited attention [3].

Periodontal tissues, including gingiva, periodontal ligament, and alveolar bone, are highly sensitive to oxidative stress. Oxidative stress occurs when the production of reactive oxygen species (ROS) exceeds the body's antioxidant defense capacity, leading to cellular damage, lipid peroxidation, protein oxidation, and DNA damage [4], [5]. Chronic exposure to toxic chemicals, such as styrene, can increase ROS levels and disturb the redox balance in the oral cavity, thereby exacerbating periodontal tissue destruction [6].

The pathophysiology of periodontal disease in the context of oxidative stress involves a complex interplay of inflammatory mediators, enzymatic tissue degradation, and impaired wound healing. ROS generated during styrene exposure can activate nuclear factor-kappa B (NF- κ B) signaling pathways, upregulate pro-inflammatory cytokines such as interleukin-1 β and tumor necrosis factor-alpha, and accelerate collagen breakdown in periodontal tissues [7], [8]. Consequently,

workers exposed to styrene are at increased risk of gingival recession, alveolar bone loss, and tooth mobility, which can ultimately compromise oral function and quality of life.

Conventional periodontal therapy, including scaling and root planing, primarily targets bacterial biofilm removal and local inflammation control. However, these treatments may not fully address the oxidative stress-induced component of periodontal damage, particularly in populations with occupational chemical exposure [9]. Therefore, adjunctive therapeutic strategies targeting oxidative stress may offer improved clinical outcomes.

Antioxidants, including vitamins C and E, coenzyme Q10, polyphenols, and plant-derived compounds, have been shown to neutralize ROS, enhance collagen synthesis, modulate inflammatory responses, and support tissue regeneration [10], [11]. Several studies suggest that antioxidant supplementation can reduce oxidative stress markers in serum and gingival crevicular fluid, leading to improved periodontal healing and clinical outcomes [12], [13]. However, evidence on the use of antioxidant therapy specifically for workers exposed to styrene remains scarce.

This study aims to investigate the efficacy of a complex antioxidant therapy regimen as an adjunct to conventional periodontal treatment in workers chronically exposed to styrene. By evaluating both clinical periodontal parameters and biochemical markers of oxidative stress, this research seeks to elucidate the potential benefits of antioxidant therapy in mitigating periodontal tissue damage induced by occupational chemical exposure [14], [15].

Materials and Methods

Study Design and Participants:

This prospective, controlled study included 50 workers from a styrene polymer manufacturing facility with a minimum of five years of exposure. Participants were randomly assigned to either the control group (n=25), receiving standard periodontal therapy, or the experimental group (n=25), receiving standard therapy plus a six-month antioxidant complex regimen. Exclusion criteria included systemic diseases affecting periodontal health, smoking, and recent use of antibiotics or antioxidants [11].

Therapeutic Intervention:

The antioxidant complex comprised vitamin C (500 mg/day), vitamin E (400 IU/day), coenzyme Q10 (100 mg/day), and green tea extract (200 mg/day). Conventional periodontal therapy included scaling, root planing, and oral hygiene instruction.

Clinical Assessment:

Periodontal status was evaluated at baseline, 3 months, and 6 months, including probing depth (PD), clinical attachment level (CAL), gingival index (GI), and bleeding on probing (BOP). Oxidative stress was assessed by measuring serum malondialdehyde (MDA) levels and total antioxidant capacity (TAC) [12].

Statistical Analysis:

Data were analyzed using SPSS v.26. Paired t-tests and ANOVA were applied to compare intra-group and inter-group differences. Statistical significance was set at $p < 0.05$.

Results

Clinical Outcomes:

The experimental group showed significant reductions in PD and GI compared to baseline and the control group. Mean probing depth decreased from 4.2 ± 0.5 mm to 2.9 ± 0.4 mm, while gingival index improved from 2.1 ± 0.3 to 0.9 ± 0.2 after six months ($p < 0.01$). The control group showed smaller improvements (Table 1).

Oxidative Stress Markers:

Serum MDA levels significantly decreased in the experimental group (from 5.6 ± 0.8 $\mu\text{mol/L}$ to 3.1 ± 0.6 $\mu\text{mol/L}$), while TAC increased from 1.2 ± 0.3 to 1.9 ± 0.4 mmol/L ($p < 0.01$). Changes in the control group were less pronounced (Figure 1) [13].

Table 1. Clinical and Biochemical Parameters in Styrene-Exposed Workers

Parameter	Control Group (n=25)	Experimental Group (n=25)	p-value
Probing Depth (mm)	$4.1 \pm 0.4 \rightarrow 3.5 \pm 0.5$	$4.2 \pm 0.5 \rightarrow 2.9 \pm 0.4$	<0.01
Gingival Index	$2.0 \pm 0.3 \rightarrow 1.5 \pm 0.3$	$2.1 \pm 0.3 \rightarrow 0.9 \pm 0.2$	<0.01
MDA ($\mu\text{mol/L}$)	$5.5 \pm 0.7 \rightarrow 4.9 \pm 0.6$	$5.6 \pm 0.8 \rightarrow 3.1 \pm 0.6$	<0.01
TAC (mmol/L)	$1.2 \pm 0.2 \rightarrow 1.4 \pm 0.3$	$1.2 \pm 0.3 \rightarrow 1.9 \pm 0.4$	<0.01

Discussion

Our findings indicate that antioxidant complex therapy significantly improves periodontal health in workers exposed to styrene by mitigating oxidative stress. The reduction of MDA and increase in TAC suggest effective neutralization of ROS, leading to enhanced tissue repair and inflammation control [14].

These results align with prior studies demonstrating that antioxidants can serve as adjunctive therapy in periodontal diseases, particularly in populations with environmental or occupational exposure to toxins [15]. The combination of vitamins C, E, coenzyme Q10, and polyphenols synergistically reduces oxidative stress and promotes collagen synthesis, improving periodontal regeneration [8], [9].

Limitations of this study include the relatively small sample size and the short duration of follow-up. Future studies with larger cohorts and longer observation periods are warranted to confirm the long-term benefits of antioxidant therapy in occupationally exposed populations.

Conclusion

Antioxidant complex therapy is an effective adjunct to conventional periodontal treatment in workers chronically exposed to styrene. It reduces oxidative stress, enhances periodontal tissue healing, and improves clinical outcomes. Implementing antioxidant therapy in occupational

health programs may contribute to better oral health and overall well-being of workers in chemical industries [1], [2], [13].

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