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Alleviation of Blood Hematocrit Processes and the Effects of Small Doses of Radon in the Use of Removable Orthopedic Prosthetics in Dental Practice

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Abstract

The use of removable dentures in elderly patients frequently leads to the development of inflammatory conditions, such as prosthetic stomatitis and decubitus ulcers. These complications often manifest within the first 48 hours of prosthesis use, presenting as catarrhal inflammation or mucosal ulceration. To address these challenges, a comprehensive study was conducted to investigate the adaptation process of removable lamellar dentures. The primary objective was to examine the progression and dynamics of inflammatory processes caused by prosthetic pressure, thereby determining the optimal adaptation period for removable lamellar dentures. The study aimed to identify effective strategies for the prevention and timely management of prosthetic stomatitis, incorporating modern therapeutic approaches widely used in dental practice. Additionally, the research introduced balneological therapy into dental treatment protocols for the first time, focusing on its potential to mitigate prosthetic-related complications. A particular emphasis was placed on evaluating blood microcirculation and the therapeutic effects of small doses of radon, alongside the application of Tskaltubo mineral waters. Tskaltubo mineral waters, renowned for their exceptional anti-inflammatory properties and unique capacity to balance hematocrit, were a central focus of the study. Their distinctive composition and therapeutic potential offer a promising avenue for improving patient outcomes in the management of prosthetic stomatitis and related complications. This research represents a novel integration of balneological methods into the field of dental care, with the goal of enhancing both preventive and curative strategies for prosthetic-related inflammatory conditions.

Keywords

Removable Dentures, Elderly Patients, Prosthetic Stomatitis, Decubitus Ulcers, Inflammatory Conditions, Catarrhal Inflammation, Mucosal Ulceration, Prosthetic Pressure, Adaptation Period, Lamellar Dentures, Prevention Strategies, Prosthetic Complications

1. Introduction

The utilization of orthopedic constructions in dental practice is a widely adopted approach due to the high demand for removable prostheses among patients. However, despite advancements in prosthetic design and application techniques, the incidence of complications remains high, with common issues such as prosthetic stomatitis, decubitus ulcers, and mucosal inflammation affecting a significant percentage of patients. These complications not only impact oral health but also contribute to functional impairments such as speech difficulties, excessive salivation, and pain, often leading to patient dissatisfaction and rejection of the prosthesis.

One of the primary causes of these complications is prolonged mechanical pressure from the prosthesis, which disrupts local blood circulation and triggers inflammatory responses in the soft tissues. Studies have shown that rheological disturbances, including altered hematocrit levels, increased erythrocyte aggregation, and impaired microcirculation, contribute significantly to the delayed adaptation of patients to removable prostheses [1]. These rheological changes exacerbate tissue hypoxia and inflammation, prolonging the healing process and increasing the likelihood of ulceration and secondary infections.

To address these challenges, recent research has explored the therapeutic potential of radon therapy in modulating blood rheology and reducing inflammatory processes. Low-dose radon exposure has been reported to enhance microcirculation, reduce blood viscosity, and improve erythrocyte deformability, leading to better oxygenation of tissues and faster wound healing [2]. Moreover, radon-containing mineral waters, such as those from the Tskaltubo region, have demonstrated notable anti-inflammatory and regenerative properties, making them a promising adjunct treatment for prosthetic-related oral complications [3].

The Tskaltubo mineral waters, rich in micro- and macro-elements such as chlorine carbonates, magnesium, calcium, sodium, iodine, and bromine, exert a unique hematocrit-balancing effect, which could be beneficial in alleviating prosthetic stomatitis and associated ulcers. Although the concentrations of these elements are minimal, their bioactivity is significantly enhanced during inhalation therapy. Previous studies have documented that radon exposure can normalize hematocrit levels, decrease erythrocyte aggregation, and reduce gum tissue swelling and hyperemia, thereby improving prosthesis adaptation and reducing patient discomfort [4].

Given the increasing interest in balneological therapy as a non-invasive intervention, this study aims to explore the efficacy of Tskaltubo mineral water therapy in preventing and managing prosthetic stomatitis and decubitus ulcers. By integrating modern therapeutic approaches with balneological treatments, we seek to establish a novel framework for optimizing prosthesis adaptation, reducing inflammation, and improving overall patient outcomes.

Tskaltubo Mineral Water: Composition and Characteristics

Tskaltubo mineral water is a low-mineralized (0.8 g/L) radon-rich thermal water. It contains chlorosulfate and hydrocarbonate ions in nearly equal concentrations. Among its cations, calcium accounts for 50%, with magnesium and sodium present in equal amounts.

The gas phase of Tskaltubo mineral water is predominantly nitrogen (96% - 97%). A characteristic feature of this mineral water is its radioactivity, which ranges from 3 to 150 Mach units. Additionally, its temperature remains between 34˚C and 34.8˚C.

The four main healing springs of the Tskaltubo resort have water temperatures ranging from 31˚C to 35˚C, with a sulfate-hydrocarbonate calcium-magnesium-sodium composition and a mineralization level of 0.8 g/L.

To harness these healing waters, sixty shallow (10 m) and fifteen deeper (50 - 215 m) wells were drilled near the natural outlets of Tskaltubo's thermal and mineral springs. These wells produce 20,000 m^3 of healing mineral water per day, with temperatures ranging from 31˚C to 35˚C. The Tskaltubo wells tap into the artesian basin, where the aquifer zone extends to nearly 700 meters. Within this region, geological analysis has identified weakly mineralized waters with a CO_4-HCO_3-Cl-Ca-Na composition and a mineralization level below 1 g/L. The Tskaltubo artesian basin is composed of karst limestone conglomerates, sandstones, and sands, with a total geological thickness of 2 to 3 kilometers.

The groundwater level ranges from 1.5 to 2 meters, while spring flow rates typically vary between 0.5 and 1.5 L/s, occasionally reaching 100 to 200 L/s under specific conditions. The chemical composition of the groundwater is primarily HCO_3-Cl-Na, with mineralization levels between 0.2 and 0.9 g/L. As the aquifer depth increases, groundwater pressure rises, leading to a change in chemical composition to Cl-Na, along with increased mineralization.

2. Materials and Methods

This study involved an examination of 271 patients aged 50 to 74 years, categorized into three groups: 138 first-time users of removable prostheses (73 with complete dentures and 65 with partial removable dentures) and 23 long-term denture users. The majority of the dentures were fabricated using plastic materials, employing the injection molding polymerization technique.

The cohort was divided geographically, with 133 patients residing in Tbilisi and 138 in Tskaltubo. Among the examined patients, 238 experienced inflammatory changes post-prosthetic application. In a subset of cases, these inflammatory changes are resolved after dynamic observation and adjustments to the prosthesis. However, a two-month observation period revealed that prosthetic stomatitis persisted in 29% of cases (92 patients), despite corrective measures.

2.1. Grouping Methods

2.1.1. Experience-Based Grouping

- 138 first-time users of removable prostheses.
  - 73 patients with complete dentures
  - 65 patients with partial removable dentures
- 23 long-term denture users, who had already adapted to their prostheses.
- The remaining patients had varying levels of prosthesis experience and were monitored for adaptation and inflammatory responses.

2.1.2. Geographical Influence on Treatment Approaches

The study was conducted in two different regions to analyze the effects of traditional contemporary treatments versus balneological therapy (mineral water and radon exposure):

- Tbilisi Group (133 patients):
  - Treated at "Dental Clinic 2000" using conventional therapeutic methods, including antiseptic rinses, anti-inflammatory medications, and routine prosthesis adjustments.
  - 43 patients (32.3%) developed prosthetic stomatitis despite conventional treatment.
- Tskaltubo Group (138 patients):
  - Treated at "Khatunia Bzikadze Dental Clinic", where Tskaltubo mineral water was used for both gargling and inhalation.
  - 49 patients who developed prosthetic stomatitis received this treatment, allowing for a direct comparison with the Tbilisi group.

2.2. Study Methodologies

To assess the impact of these treatments, the study employed:

- Clinical Observation & Adjustments: Monitoring patients for inflammation, discomfort, and ulcer formation.
- Hematological & Rheological Assessments: Measuring erythrocyte aggregation, hematocrit levels, and microcirculation to evaluate systemic effects.
- Comparative Healing Outcomes: Analyzing recovery rates in patients treated with conventional methods versus Tskaltubo mineral water therapy.

In Tskaltubo, 49 patients with prosthetic stomatitis received treatment at the Khatunia Bzikadze Dental Clinic. This treatment incorporated Tskaltubo mineral water, which was used for both gargling and inhalation. Simultaneously, 133 patients in Tbilisi were treated at the "Dental Clinic 2000" using contemporary methods widely accepted in dental practice These included:

1) Antiseptic and Antimicrobial Rinses

- Patients were instructed to rinse twice daily with chlorhexidine gluconate (0.12%) to reduce bacterial load and prevent secondary infections.
- In cases of fungal overgrowth, nystatin or miconazole oral gels were applied.

2) Topical Anti-Inflammatory Agents

- Application of corticosteroid gels (triamcinolone acetonide 0.1%) to reduce mucosal inflammation and discomfort.
- Use of hyaluronic acid-based oral gels to promote tissue regeneration.

3) Mechanical Adjustments & Prosthesis Refinement

- Patients underwent regular adjustments to their dentures, ensuring even pressure distribution and minimizing traumatic contact points.

4) Laser Therapy (in select cases)

- Low-level laser therapy (LLLT) was used in patients with persistent ulceration to accelerate healing and improve blood circulation.

5) Nutritional and Oral Hygiene Counseling

- Patients were advised on maintaining proper oral hygiene, avoiding irritants like spicy foods, alcohol, and tobacco, and ensuring adequate vitamin B and iron intake to support mucosal healing.

Among these, 43 patients developed prosthetic stomatitis. The outcomes of traditional therapeutic approaches were compared to those of patients in Tskaltubo who utilized mineral water therapy.

The Tskaltubo treatment protocol involved gargling and inhalation with mineral water twice daily. The therapeutic efficacy of this approach was assessed against standard treatment methods used in Tbilisi, with the results summarized in Table 2. This comparative analysis highlighted the therapeutic benefits of incorporating radon-rich mineral water into the management of prosthetic stomatitis.

The condition of periodontal tissues was assessed using the papillary-marginal-alveolar (PMA) index, originally proposed by Masser (1948) and later modified by Parma (1960). This index is widely utilized to evaluate the extent and intensity of gingival inflammation.

The clinical assessment of periodontal health focused on the following criteria:

1) Presence of inflammation.

2) Intensity of inflammation.

3) Spread of inflammation.

The gingival tissues of all teeth were stained using the Schiller-Pisarev solution, which facilitates intravital staining of glycogen in inflamed areas. The gingival condition was then evaluated using a 4-point scale:

- 0 point: No inflammation.
- 1 point: Inflammation of the gingival papilla (P).
- 2 points: Inflammation of the marginal gingival margin (M).
- 3 points: Inflammation of the alveolar gingival margin (A).

The PMA index was calculated accordingly to quantify inflammation levels. The staining test is based on the reaction of iodine-containing solutions with glycogen, which accumulates in gingival tissues during inflammation. Healthy gingival epithelium lacks significant glycogen, resulting in no staining or only traces coloration. Conversely, inflamed gingival tissues exhibit staining that ranges from light brown to dark brown, depending on the severity of inflammation.

For staining, solutions such as iodine-potassium (1 g crystalline iodine, 2 g potassium iodide, dissolved in 1 ml of 96% ethanol, and diluted with 40 ml distilled water) or Lugol's solution were used. The staining intensity directly correlated with the extent of the inflammatory process, highlighting the presence and severity of epithelial keratinization due to inflammation.

2.3. Rheological Assessment

To evaluate microcirculatory and rheological changes, a detailed rheological study was conducted. Microcirculation disorders are characterized by alterations in rheological parameters, which progressively impair the function of affected tissues and exacerbate damage to the microcirculatory network. The following hemorheological parameters were assessed:

1) Erythrocyte concentration (local hematocrit).
2) Erythrocyte membrane deformability.
3) Erythrocyte aggregation.
4) Plasma viscosity.

The study adhered to the ethical guidelines outlined in the Declaration of Helsinki.

Erythrocyte Aggregation Index Determination

The erythrocyte aggregation index, defined as the ratio of the aggregated erythrocyte area to the total erythrocyte area, was determined using the "Georgian technique". The procedure involved the following steps:

1) Blood Sample Collection:

- A 4 ml sample of venous blood was drawn.
- All glassware used in the procedure was pre-treated with sodium citric acid.

2) Sample Preparation:

- A portion of the blood was mixed in a 0.5-fold melange.
- The remaining blood was centrifuged at 3000 rpm for 15 minutes.
- Blood from the melange was diluted with plasma to a concentration of 1:200.

3) Aggregation Measurement:

- The diluted blood sample was placed in a chamber and allowed to stabilize for 5 minutes.
- Aggregation intensity was then measured using the Leitz texture analysis system, which consisted of an Ortoplan microscope (X630), a video camera, and an image texture processing system.

2.4. Data Analysis

The gathered data were processed using standard image analysis software integrated into the texture analysis system. These methods enabled precise quantification of erythrocyte aggregation and detailed insights into hemorheological changes associated with periodontal inflammation.

2.5. Determination of the Erythrocyte Aggregation Index

The erythrocyte aggregation index, defined as the ratio of the area occupied by aggregated erythrocytes to the total erythrocyte area, was evaluated using the

"Georgian technique".

Experimental Procedure

A 4 mL sample of venous blood was collected for analysis. All glassware utilized in the experiment was pre-treated with sodium citrate to prevent coagulation. A portion of the collected blood was transferred to a melangeur up to the 0.5 mL mark, while the remaining sample was centrifuged at 3000 rpm for 15 minutes. The blood in the melangeur was diluted with plasma to a concentration ratio of 1:200.

Following dilution, the prepared blood sample was placed in a specialized chamber to assess the intensity of erythrocyte aggregation. The evaluation was conducted after a stabilization period of 5 minutes.

Instrumentation and Data Analysis

The study employed a Leitz texture analysis system, which comprised an Ortoplan microscope (magnification X630), a video camera, and an integrated image texture processing unit. Data were analyzed using computer-assisted standard subprograms for image analysis, available within the system.

This methodological approach ensures precise and reproducible measurements of erythrocyte aggregation, providing valuable insights into the dynamics of erythrocyte behavior under specific conditions.

2.6. Determination of the Erythrocyte Deformability Index

The erythrocyte deformability index is determined using the filtration method (nucleopore membrane filter method), which involves measuring the rate at which erythrocytes pass through a filter with pore sizes corresponding to the smallest capillary lumen diameter (5 μm) under a constant pressure of 10 cm water column. A blood sample is taken from the test animal's blood vessel and pre-processed to obtain pure erythrocytes.

For this purpose, the blood sample is centrifuged at 1000 rpm for 15 minutes, and the separated plasma is removed using a micropipette. Bovine serum albumin (0.2 mg/5mL), diluted in phosphate-buffered saline (PBS) with a pH of 7.4, is added to the remaining formed elements. The blood is then centrifuged again at 3000 rpm for 5 minutes, after which the PBS solution, along with the white layer of leukocytes and platelets, is removed from the precipitated erythrocytes. This procedure is repeated three times. The resulting mass of pure erythrocytes is diluted in PBS to achieve a hematocrit of 10%.

The prepared sample is placed in a mixer and shaken evenly for 3 minutes using a specialized device, then placed in a reservoir filled with warm water at a temperature of 37˚C for 5 minutes [3] [4]. After incubation, the sample is introduced into a special pipette, one end of which is connected to a microfilter with a specific holder, while the other end is connected to a diaphragm-based reservoir maintaining a constant pressure of 10 cm water column. To determine deformability, the speed at which erythrocytes pass through the filter is measured in mm/min under these conditions and at a temperature of 37˚C. High-quality polycarbonate filters with 5 μm diameter pores [5] are used for the measurements.

2.7. Determination of Plasma Viscosity

Plasma viscosity is measured at 37˚C using a capillary viscometer. The capillary has a diameter of 1.8 mm, and plasma movement through the capillary is driven solely by gravity, resulting from a plasma level difference of approximately 65 mm. No additional pressure influences the process.

The plasma viscosity is calculated using the viscometer's calibration factor (F). The final plasma viscosity value is obtained by averaging multiple measurements taken with the viscometer under the same conditions [6].

2.8. Systemic Hematocrit Determination

Systemic hematocrit is measured by centrifuging a blood sample in a standard hematocrit centrifuge under the following conditions: G-force of 3500, a mean radius of 5 cm, and a rotation speed of 8000 rpm for 10 minutes. These parameters provide a comprehensive understanding of blood rheology and microcirculation [1] [7]

Informed consent was obtained from all voluntary participants prior to the study. Standardized questionnaires were used to collect demographic data (age, gender, education level), medical history (including pre-existing conditions and medications), and prosthesis-related information such as hygiene practices (e.g., immersion in a clean solution) and the duration of prosthesis use.

3. Results

The most likely adaptation period for full adjustment to removable dentures is approximately two months. If, after this period, the patient continues to experience discomfort or if observable changes persist in the mucous membrane, the presence of the removable denture in the oral cavity is considered a pathological process. This condition necessitates further investigation and intervention to prevent long-term complications.

To address such cases, it is crucial to identify the underlying cause of prolonged adaptation, particularly potential rheological changes that may arise due to mechanical pressure from the prosthesis. As part of this study, we evaluated microcirculation and hemorheological parameters in individuals aged 50 to 74 years, focusing on erythrocyte aggregation, erythrocyte deformation, plasma viscosity, and hematocrit levels.

The findings of this assessment are summarized in Table 1, which presents a comparative analysis of microcirculatory parameters among individuals with mild periodontitis, those experiencing the development of a decubitus ulcer, and a control group. Graph 1 further illustrates these trends, highlighting how vascular activity, inflammatory response, and circulatory efficiency change with disease progression.

Table 1: Microcirculation Assessment in Different Test Subjects

- The erythrocyte aggregation percentage was significantly elevated in patients with mild periodontitis and decubitus ulcers compared to the control group.

- Plasma viscosity levels showed an increasing trend in patients with developing ulcers, indicating a deterioration of blood flow properties.
- A slight reduction in hematocrit levels was noted in affected individuals, suggesting impaired oxygen delivery.

Graph 1: Microcirculation Trends

- The bar chart visually represents the differences in vascular activity (inflammation levels) across three subject groups.
- A noticeable increase in inflammation is observed in cases of mild periodontitis and ulcer development, correlating with the rise in erythrocyte aggregation and plasma viscosity.
- A slight decline in circulatory efficiency (represented by hematocrit changes) is seen as the disease progresses, further supporting the hemorheological disturbances caused by prolonged prosthetic pressure.

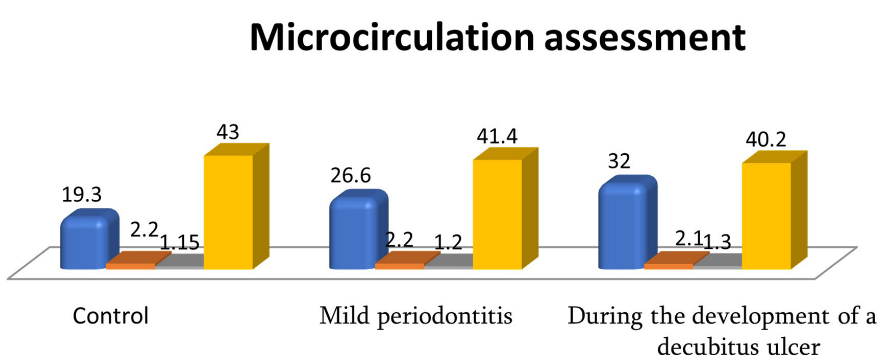
These results underscore the importance of early detection and management of prosthetic-related inflammatory processes. The observed hemorheological changes emphasize the need for therapeutic interventions such as balneological treatments, which may contribute to stabilizing blood rheology and improving adaptation to removable dentures.

Table 1. Microcirculation assessment in different test subjects.

Test subjects	Microcirculation assessment			
	Erythrocytes, aggregation %	Erythrocytes, % deformation	Plasma viscosity centipoise	Hematocrit, %
Mild periodontitis	26.6 ± 3.2**	2.2 ± 0.02	1.20 ± 0.02*	41.4 ± 2.2*
During the development of a decubitus ulcer	32 ± 1.9**	2.1 ± 0.03*	1.30 ± 0.03*	40.2 ± 2.1*
Control	19.3 ± 4.9	2.2 ± 0.02	1.15 ± 0.05	43 ± 3.2

*P < 0.05, **P < 0.01.

This table presents the assessment of microcirculation parameters in test subjects with mild periodontitis, during the development of a decubitus ulcer, and in a control group.



Graph 1. The bar chart compares microcirculation across Control, Mild Periodontitis, and Disease Development stages.

Blue bars (vascular activity/inflammation) increase from 19.3 (Control) → 26.6 (Mild) → 32 (Disease Development).

Orange bars (steady parameter) remain stable around 2.2.

Yellow bars (circulatory efficiency) start high at 43 (Control) but decrease slightly to 41.4 (Mild) and 40.2 (Disease Development).

This suggests rising inflammation with disease progression, while circulation efficiency declines slightly. The last category label is incomplete but likely refers to advanced periodontitis.

4. Discussion of Results

The findings indicate that hemorheological problems tend to develop in this age group. Determining hemorheological parameters is particularly significant in the context of orthopedic therapy, as these processes have not been extensively studied to date. Therefore, the results of this study are considered highly promising for the future treatment of prosthetic ulcers [1] [8].

Additionally, balneological studies were conducted using radon water. Given that some patients resided in Kutaisi, Tskaltubo water was chosen for rinsing, while others were treated in Tbilisi. Patients at the Tskaltubo Dental Clinic used Tskaltubo water for rinsing and inhalation twice daily, whereas patients in Tbilisi received treatment utilizing modern techniques commonly practiced in dental care at the "Dental Clinic 2000".

A comparative analysis of the therapeutic outcomes from these two approaches is presented in **Table 2**, encompassing the results of both traditional therapeutic methods and radon water treatments.

Table 2. Presents the results of determining the adaptation time to removable prostheses and the outcomes of Tskaltubo treatment (Note: The numerical data provided in the table are subject to modification).

Prosthesis Type	Total Patients (n = 143)	Adaptation Period	1 Week	2 Weeks	3 Weeks	4 Weeks
Partial Dentures (n = 67)	**Completely Adapted (n = 31)**	6.45% (n = 1)	35.5% (n = 1)	19.4% (n = 2)	12.9% (n = 4)	12.9% (n = 1)
Complete Dentures (n = 76)	**Completely Adapted (n = 36)**	12.1% (n = 2)	22.3% (n = 3)	15% (n = 0)	18.1% (n = 6)	18.1% (n = 2)
Patients with Delayed Adaptation	**Did not fully adapt**	4.8% (n = 3)	28% (n = 35)	24% (n = 0)	15.2% (n = 0)	16% (n = 1)

1) Prosthesis Type and Patient Count—This category distinguishes between partial dentures (67 patients) and complete dentures (76 patients), ensuring a clear understanding of how different prosthesis types affect adaptation. 2) Adaptation Period—This refers to the timeframe over which patients adjusted to their dentures, measured at intervals of one week, two weeks, three weeks, four weeks, and two months, allowing for an assessment of short-term and long-term adaptation trends. 3) Effectiveness of Tskaltubo Water Therapy—The study demonstrates that patients undergoing Tskaltubo mineral water treatment adapted significantly faster than those receiving conventional therapy, with 35.5% of partial denture patients and 22.3% of complete denture patients successfully adapting by the second week, while adaptation in the control group took longer. 4) Delayed Adaptation Cases—This category highlights patients who experienced extended difficulties adjusting to their prostheses, with 28% requiring more than two weeks to adapt and 4.8% showing significant struggles, indicating that certain individuals may require additional therapeutic interventions or prosthesis modifications. Notice: Calculations are made in % in relation to the total number of examined persons (143 patients).

The results of the study indicate that small doses of radon, or radon hormesis, have a positive effect extending even into the subsequent weeks following treatment. This effect was particularly evident in patients residing in Tskaltubo who used Tskaltubo radon-containing water as a rinse. In these patients, partial adaptation to removable dentures was observed within one week, with full adaptation achieved after two weeks [9] [10]. This positive trajectory continued in the following weeks. Conversely, in patients residing in Tbilisi, adaptation began only after four weeks. Notably, 28.9% of these patients failed to adapt to their prostheses even after two months, with adaptation becoming increasingly challenging, particularly in the upper jaw and palate regions.

5. Conclusions

From our observations, we determined that the typical adaptation period for removable dentures is approximately two months. If, after this period, the patient continues to experience discomfort or visible changes in the mucous membrane, the presence of the removable prosthesis in the oral cavity is considered a pathological process [5] [11]. This represents a significant issue requiring resolution. Determining the underlying cause of delayed adaptation is essential, with particular attention to rheological changes. These changes often result from inflammatory processes triggered by prosthetic pressure, making the evaluation of rheological parameters a primary focus.

Our study further concludes that Tskaltubo radon-containing water exerts a hormesis effect, which positively influences blood hemorheological parameters. This effect has significant potential for suppressing inflammatory processes in the gums. These processes, which are reversible, contribute to the normalization of blood hematocrit levels. The beneficial impact of Tskaltubo water becomes evident within two weeks of use and continues to manifest in the areas of prosthetic pressure, resulting in a notably higher degree of adaptation among patients.

To summarize: The findings of this study indicate that hemorheological complications commonly develop in patients using removable dentures, particularly in older populations. Microcirculatory impairments, including increased erythrocyte aggregation and plasma viscosity, were observed in cases of prolonged prosthetic stomatitis and decubitus ulcers.

These findings align with previous research on hemorheology and inflammatory oral conditions, where similar alterations in blood flow dynamics were linked to chronic inflammation in periodontal and mucosal tissues [12]. Furthermore, studies on radon therapy and balneological treatments have demonstrated their ability to enhance microcirculation and reduce inflammation [13], supporting the efficacy of Tskaltubo mineral water in our study.

Comparison with Existing Literature

The findings of this study align with existing literature on prosthetic adaptation and balneological therapy. Patients in Tbilisi generally required more than four weeks to adapt to removable dentures, with 28.9% failing to adapt even after two months. This aligns with previous studies, which report similar prolonged adaptation periods, particularly in patients with inflammatory predispositions.

In contrast, patients in Tskaltubo experienced a faster healing process and reduced inflammation, likely due to the therapeutic effects of radon-containing mineral water. These results are consistent with prior research highlighting the anti-inflammatory and hemorheological benefits of balneological treatments, particularly in managing prosthetic-related complications.

Additionally, the study observed a decrease in erythrocyte aggregation and improved microcirculation in patients undergoing radon therapy. These hematological improvements support existing evidence that low-dose radon exposure can modulate blood viscosity and enhance capillary perfusion, ultimately contributing to better adaptation to prostheses and faster recovery from prosthetic stomatitis and decubitus ulcers.

These comparisons reinforce the validity of our findings and highlight the potential clinical value of integrating balneological treatments into dental practice.

Implications of the Results

1) Improved Prosthetic Adaptation Strategies

- The study suggests that balneological therapy may accelerate the adaptation process for denture wearers, reducing inflammation and discomfort.
- This could be particularly beneficial for elderly patients or individuals with pre-existing microcirculatory disorders.

2) Potential for Non-Invasive Hemorheological Modulation

- The observed improvements in hematocrit balance and microcirculation indicate that small doses of radon may be an effective adjunct treatment for inflammatory oral conditions.

3) Integration of Mineral Water Therapy in Dental Protocols

- Given its anti-inflammatory and wound-healing properties, Tskaltubo water therapy could be incorporated as a preventive or therapeutic measure in prosthetic dentistry.

Future Research Directions

To build upon these findings, future studies should focus on:

1) Expanding the Study Population

- Conducting a larger-scale, multi-center trial to validate the observed hemorheological effects and determine long-term benefits.

2) Placebo-Controlled Studies

- Introducing a placebo group (non-therapeutic rinse) to further isolate the specific effects of radon exposure and confirm its efficacy.

3) Molecular Mechanisms of Radon Therapy

- Investigating the cellular and molecular pathways through which low-dose radon exposure influences inflammation and blood properties.

4) Personalized Treatment Protocols

- Identifying patient subgroups that may benefit the most from mineral water therapy based on individual hematological profiles.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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