

Prevention of Post-Surgical Complications Following Odontectomy in Patients with Underlying Diabetes Mellitus

Zapobieganie pooperacyjnym powikłaniom po odontektomii u pacjentów ze współistniejącą cukrzycą

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SUMMARY

Aim: Purpose of the study. The study was dedicated to assessment of the effect of photon physiotherapeutic therapy combined with the use of PRF clot on the course of regeneration processes in a socket of extracted tooth in DM patients.

Materials and Methods: Thirty patients with confirmed diabetes mellitus aged 40 - 60 referred to the Pirogov Memorial Clinical Hospital (Vinnytsia) that required tooth extraction were engaged in the study. Patients were assigned into two groups: Group I patients with spontaneously healed post-extraction wounds, and Group II patients subjected to physiotherapy in combination with the PRF. The physiotherapeutic effect was achieved by using a multispectral photon physiological system. Platelet-rich fibrin (PRF) was produced immediately before tooth extraction from the patients' venous blood. The efficacy of the photon physiotherapeutic therapy combined with the use of PRF clot was studied by the morphological methods.

Results: The study of pathomorphological features of the post-extraction wound regeneration revealed differences in patients of Groups I and II. In Group II patients, the treatment was characterized by an anti-inflammatory effect (less abundant inflammatory infiltrate with fewer polymorphonuclear leukocytes in bioptic samples), accelerated regeneration process, as evidenced by a larger number of fibroblasts on Day 3 and Day 7 of follow-up, and faster development of fibrous structures in the granular tissue. Group II patients demonstrated earlier post-extraction wound epithelialization and more active angiogenesis.

Conclusions: The study of pathomorphological features of post-extraction wound regeneration proved the therapeutic efficacy of the photon effect combined with the transport of PRF to the extracted tooth socket in two DM patient groups (Group I patients with spontaneously-healed post-extraction wounds, and Group II patients subjected to physiotherapy in combination with PRF).

Key words: photon effect, growth factors, regeneration, diabetes mellitus

Słowa kluczowe: efekt fotonowy, czynniki wzrostu, regeneracja, cukrzyca

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INTRODUCTION

According to WHO, the number of patients with diabetes mellitus in the world has been increasing exponentially year by year. Diabetic complications, including the most common ones, such as angiopathy and polyneuropathy, pose a significant medical problem. Changes in the microcirculatory vasculature that develop in the course of the disease are considered one of the main pathogenetic factors of poor tissue regeneration in wounds. DM patients also develop slow and unregulated formation of new capillaries (angiogenesis) in damaged tissues. Angiogenesis is one of the physiological processes that play a key role in the response of tissues to damage. Restoration of damaged tissues produces the growing demand in nutrient metabolism. Various cells, biologically active substances, matrix structures, and microelements need to be quickly delivered to all points of the wound. Blood flow

in the newly developed blood vessels contributes greatly to this kind of metabolism. Therefore, the disturbance of the angiogenic response has a negative effect on the course of wound healing.

That's why, simple surgery in DM patients (e.g. tooth extraction) may lead to disproportionately severe consequences.

The topical issue of today is a search for non-invasive techniques that exert positive effect on the processes of tissue regeneration in wounds of DM patients.

AIM

The objective of the study was to assess the photon physiotherapeutic effect in combination with the use of PRF clot on the course of regeneration process in the extracted tooth socket of DM patients.

MATERIALS AND METHODS

Thirty patients with confirmed diabetes mellitus aged 40-60 referred to the Department of Maxillofacial Surgery of the Pirogov Memorial Clinical Hospital (Vinnytsia) that required tooth extraction were engaged in the study. All patients voluntarily gave written consent for surgery. Patients were assigned into two groups: Group I patients with spontaneously-healed post-extraction wounds, and Group II patients subjected to physiotherapy in combination with the use of PRF. Females and males accounted for 57% and 43% of the population, accordingly. The physiotherapeutic effect was achieved by using a multispectral photon physiological system [1] (Figure 1). The post-extraction wounds were irradiated with a 50 mW red light for 5 min; the course consisted of 3 sessions (once a day).

Platelet-enriched fibrin was produced immediately before tooth extraction. To do this, 10 ml of venous blood was taken from the patients' ulnar vein. Venepuncture was performed using a butterfly needle connected by a catheter to a vacuum tube with walls covered with a coagulation activator. The resulting blood was centrifuged for 12 minutes at 3000 rpm. The efficacy of the photon physiotherapeutic effect combined with PRF was assessed by morphological methods. All morphological changes were assessed 5 hours following tooth extraction, then on 3, 7 and 14 post-operation days in the control (without model diabetes) and in the experimental (with model diabetes) patient groups. Mucotome or curettage spoon were used for sampling tissues from a socket of the extracted teeth.

RESULTS

Healing of the post-extraction wound is an important issue for recovery of patients to the normal quality of life, which in case of such concomitant pathology as diabetes mellitus, is a precondition for compensated course of the disease.

The regenerative processes in the alveolar process tissues following tooth extraction can be analyzed by evaluating the results of the morphological examination.

The study of slides revealed a large number of segmental leukocytes, including dead, in samples of the first group of patients



Figure 1. Multispectral photon system

on Day 1 of the follow-up. The damaged area was abnormally large, had no clear boundaries, and contained isolated fibrin threads (Figure 2A). A similar pathomorphological pattern was observed in Group II, but the amount of fibrin in the slides was much higher (Figure 2B).

Three days following tooth extraction, patients of experimental Group I manifested a large number of polymorphonuclear leukocytes between the remaining fibrin threads while studying the histological samples. The damaged zone was abnormally large, yet had clearer boundaries (Figure 3A). On Day 3, patients of the experimental Group II presented a significant amount of fibrin in tested samples, while the inflammatory infiltrate was less pronounced compared to the morphological data of the experimental Group I. In addition, in contrast to the experimental Group I, the inflammatory infiltrate was found containing macrophages, which are stimulators of tissue regeneration (Figure 3B).

The differences of the morphological pattern between Groups I and II were even more significant on Day 7 of the follow-up.

Slides taken in Group I had the inflammatory infiltrate still pronounced, consisting mainly of polymorphonuclear leukocytes, including, among others, mononuclear cells such as blood monocytes, predecessors of young fibroblasts, and tissue macrophages. Immature fibroblasts had a sharply basophilic cytoplasm and swollen, loose nuclei. No signs of epithelialization

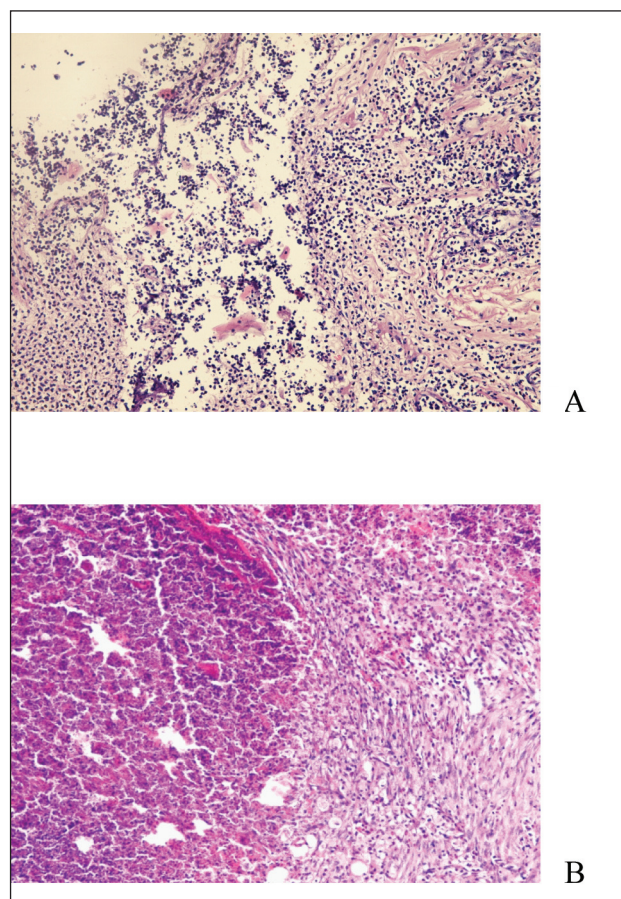


Figure 2. Staining with hematoxylin and eosin. Magnification: objective 20x, eyepiece10x

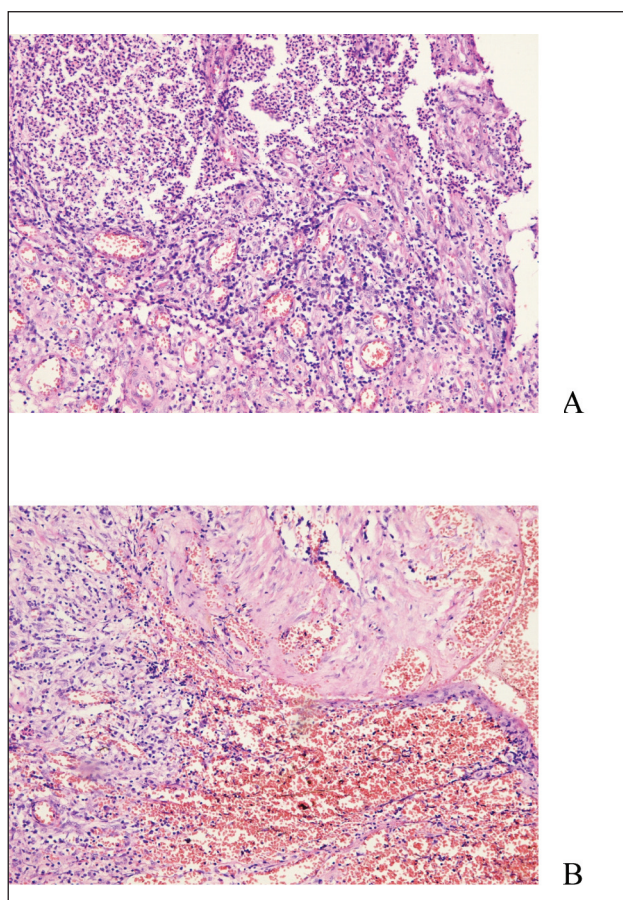


Figure 3. Staining with hematoxylin and eosin. Magnification: objective 20x, eyepiece 10x

were present in this period (Figure 4A). On Day 7 of the experiment, Group II patients had signs of marginal wound epithelialization. The wound was filled with newly formed well-vascularized granulation tissue, which still had a slight polymorphocellular infiltration, mainly with lymphohistiocytic elements inclusive of single segmental leukocytes. The fibrous and cellular components were equally well expressed (Figure 4B).

On Day 14, slides of the experimental Group I were characterized by granulation tissue, weakly infiltrated with neutrophils. Surface layers of the newly formed granulation tissue had cellular component prevailing over the fibrous one. The granulation tissue was poorly vascularized, yet having no signs of thrombosis and capillarostasis. By this time, signs of marginal epithelialization of the wound had been already present (Figure 5A). On Day 14 of the experiment, slides of Group II had the pronounced signs of young scar epithelialization. The wound was almost completely filled with mature newly formed well-vascularized fibrous tissue with a slight scattered polymorphocellular infiltration consisting of mainly lymphohistiocytic elements inclusive of additional segmental leukocytes. The fibrous component significantly prevailed over the cellular one. Newly formed fibrous tissue was well vascularized (Figure 5B).

DISCUSSION

Serious complications of diabetes mellitus include diabetic neuropathy and angiopathy [1, 2]. These complications are

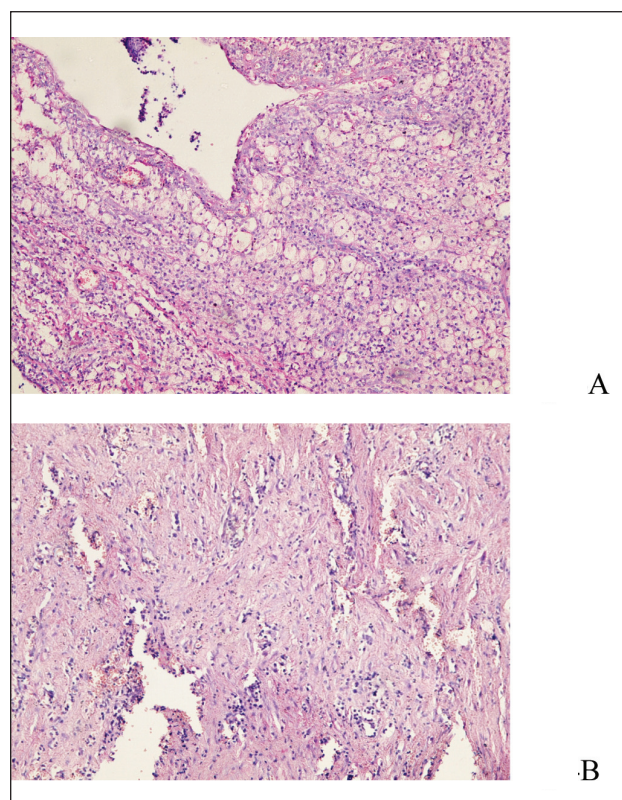


Figure 4. Staining with hematoxylin and eosin. Magnification: objective 20x, eyepiece 10x

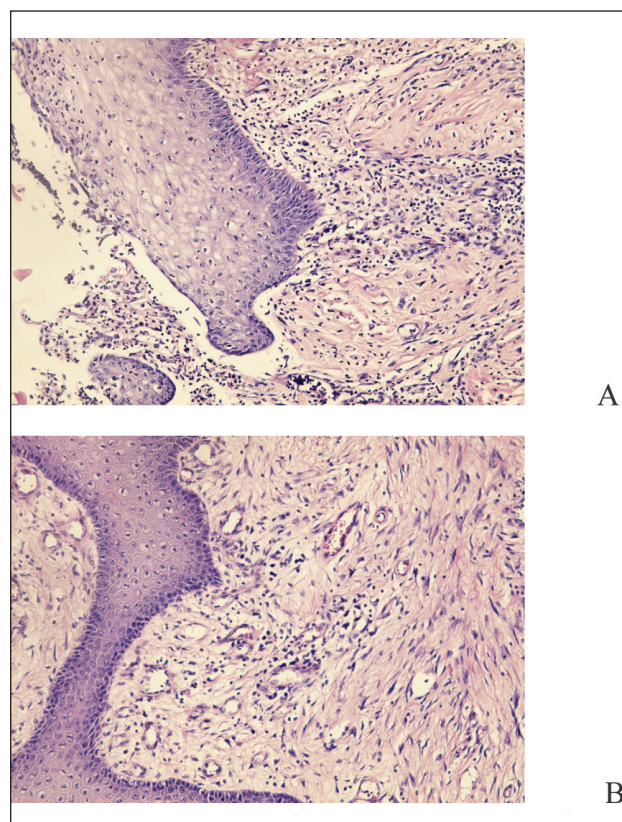


Figure 5. Staining with hematoxylin and eosin. Magnification: objective 20x, eyepiece 10x

characterized by specific manifestations in the oral cavity, inter alia [3]. Diabetes leads to alteration of the microcirculatory vessels of the oral mucosa and periodontal tissues, including a decrease of capillary patency, thickening of the basal membrane, and defected endothelial cells. Abnormally thick basal membrane interferes with a physiological fluid exchange and cell migration, thus leading to a weaker resistance to infections [4]. Altogether, these structural and functional abnormalities lead to delayed healing of even minor injuries in DM patients [5].

Diabetic patients with extracted tooth demonstrated a process of mutual burdening, characterized by slow healing of wound and the course of diabetes mellitus worsened by affected teeth and extraction surgery [6].

Therefore, researchers are in a constant search for opportunities to improve regenerative processes in DM patients [7]. For example, a property of visible light to improve the microcirculation of blood and lymph, increase the elasticity of vascular walls, normalize blood rheology, the immune, endocrine, central and peripheral nervous systems [8].

The research of targeted delivery of growth factors, cells and proteins to a damaged area with a possibility of influencing the angiogenic response is considered quite promising [9]. We studied the photon physiotherapeutic effect in combination with the use of PRF clot as a source of VEGF (vascular endothelial growth factor), PDGF (platelet-derived growth factor), TGF beta (transforming growth factor beta), and proteins. The application of this non-invasive method is promising in terms of preventing post-surgical complications following odontectomy in patients with underlying diabetes mellitus.

CONCLUSIONS

The study of pathomorphological features of post-extraction wound regeneration proved the therapeutic efficacy of the photon effect in combination with the transport of PRF on the extracted tooth socket in two DM patient groups (Group I patients with spontaneously-healed postextraction wounds, and Group II patients subjected to physiotherapy in combination with the use of PRF). In patients of the experimental Group II, the therapy exerted an anti-inflammatory effect (less ample inflammatory infiltrate with fewer polymorphonuclear leukocytes in biopsy samples); the regeneration processes accelerated, as evidenced by a larger number of fibroblasts on Day 3 and Day 7 of the follow-up and faster development of fibrous structures in the granulation tissue.

The Group II patients demonstrated earlier post-extraction wound epithelialization and more active angiogenesis.

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Conflict of interest:

The Authors declare no conflict of interest

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A – Research concept and design, B – Collection and/or assembly of data, C – Data analysis and interpretation, D – Writing the article, E – Critical revision of the article, F – Final approval of article