

# Evaluation of the healing progress of phlegmon related to type 2 diabetes treated with the local hyperbaric oxygen therapy

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## Abstract

**Introduction.** Phlegmon is a disease which causes purulent inflammation of the subcutaneous tissue, being of unlimited character. This disease does not only affect the external coverings of the body; it may also be transmitted to the internal organs, and lead to their insufficiency.

**Case report.** The study presents the results of the physical therapy applied to phlegmon located in the right shank and foot of a 57-year old patient with type 2 diabetes after an ineffective typical symptomatic treatment. A local hyperbaric oxygen therapy has been used in this treatment which utilizes the therapeutic effect of gases with high oxygen content close to 100%, exceeding the pressure of one atmosphere.

**Results.** After completion of the 4-month therapy complete regression of pain symptoms was achieved assessed accordingly to the VAS scale, as well as the complete healing of wounds, reduction of the inflammatory reaction and skin congestion, thanks to which the amputation of the limb turned out not to be necessary. The thermographic assessment performed after the completion of the treatment confirmed normalization of the previously reduced temperature of tissues in the area of healed wounds.

**Conclusions.** The obtained initial results indicate that the therapy with the use of the local hyperbaric oxygen therapy may constitute a useful adjunctive method for treatment of patients whose wounds are hard to heal, including wounds with inflammatory origin.

**Key words:** phlegmon, chronic wounds, treatment, local hyperbaric oxygen therapy

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## Introduction

The treatment of chronic wounds continues to pose a serious interdisciplinary medical problem. Various solutions are searched for, which could help the suffering patients and their families [1]. In Poland, the problem of chronic wounds affects around 500 thousand people a year, who suffer for months not only because of pain but also because of social isolation. If we add up the

number of the caregivers for those persons, this figure increases twice. The necessity of continuing until the end of life – with merely periodic interruptions – an inconvenient and not fully effective therapy often causes psychological problems in patients [1, 2].

For many years in the treatment of chronic wounds the TIME system has been applied in line with the recommendations of International Advisory Board and Polish Association for Wound Treatment (TIME = tissue

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debridement, infection control, moisture balance, epidermization) [2]. In the local treatment of wounds the proper selection of a treatment method is important, adequate for the healing process, wound progression level, as well as the number of exudates produced. So far, medicine has not developed one universal method to be applied in the treatment of wounds which are hard to heal. Properly conducted wound treatment requires a complex and interdisciplinary approach, while throughout the treatment process – in line with the state-of-the-art – implementation of physical medicine (physiotherapy) procedures should be indispensable in therapy [3].

For a few years now, clinical studies have been conducted to assess the efficacy of application of 100% oxygen or a mixture of gases with high oxygen content, close to 100% under the pressure of more than 1 atmosphere in the treatment of wounds of various aetiology, which therapy is referred to as hyperbaric oxygen therapy [4–7]. In the conditions of a whole body hyperbaric oxygen therapy, oxygen pressure in alveolar air is elevated, the vesiculo-capillary gradient in the lungs increases, and — according to Henry's law — the diffusion force and oxygen solubility in blood plasma increase. In such conditions haemoglobin is practically fully saturated with oxygen (apart from the small amount of physiologically inactive haemoglobin) [4, 7]. Local hyperbaric oxygen therapy, in turn, leads to the intensification of oxygen diffusion and the increase of oxygen partial pressure in the tissues subjected to the procedure [8].

Phlegmon is an extensive inflammatory condition of the deeper layers of the skin, usually of the loose subcutaneous connective tissue, caused by a mixture of microorganisms, among which streptococci and staphylococci are the most abundant. People suffering from diabetes are particularly prone to develop this disease. The body areas which are especially exposed to skin lesions and development of phlegmon related to it include upper and lower limbs, particularly hands/palms and feet [9, 10].

At present, in the initial stage of phlegmon development the therapy involves the application of cold compresses made of 30-per cent isopropyl alcohol, whereas in case of more advanced inflammatory condition guided antibiotic therapy is applied along with anti-inflammatory and antioedematous drugs. Sometimes a surgical intervention is also necessary [9].

The diagnosis of phlegmon requires undertaking the treatment immediately, as failure to do so or delaying the treatment poses a threat to the patient's life. The inflammatory condition may extend to tissues located deeper in the body, eventually leading to the blood infection, and — as a consequence — to the inflammation of kidneys, lungs, or heart [9, 10].



**Figure 1.** Local state/condition before the beginning of the local HBO therapy

The aim of the work has been to present the therapeutic possibilities of the local hyperbaric oxygen therapy in the treatment of phlegmon in the right shank and foot area in a 57-year old patient after an ineffective conventional treatment.

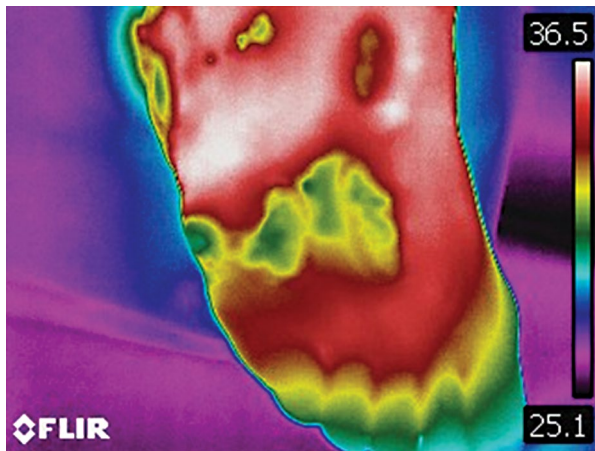
### Case report

Patient, 57 years of age, has been admitted to the Department of Internal Diseases, Angiology and Physical Medicine of Medical University of Silesia in Bytom, Poland, due to phlegmon which developed in relation to type 2 diabetes, and was located in the right shank and foot area, with a very high risk of limb amputation. The lesions persisted for several weeks despite the previously introduced treatment. On admission to the ward, after initial diagnostics (physical examination, consultations by an internist, a specialist in angiology, and a surgeon), numerous deep wounds were found in the patient, located in the shank and foot area of the right leg. Inflammatory condition persisted in the wound area with purulent infiltration. What was also found was oedema, increased tension, and intense tissue tenderness on palpation. The skin affected by the inflammatory process was reddened, warmer, painful, and swollen (Fig. 1).

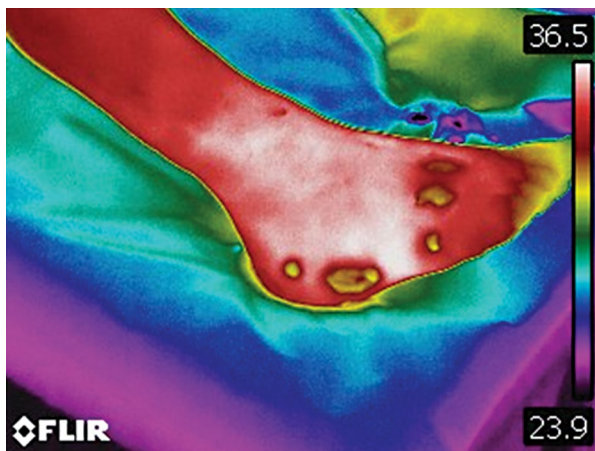
The value of the ankle-brachial index (ABI) for the right leg was 0.7 which was indicative for moderate ischemia of this leg in the course of a vascular type diabetic foot syndrome.

The pain intensity during the two weeks preceding the start of the cycle of physical treatment was assessed subjectively by the patient using the abridged questionnaire of pain intensity assessment as scoring 10 points out of 10 in the visual analogue scale VAS (0 points – no pain, 10 points – maximum pain intensity).

Thermographic temperature distribution assessment was also performed for the patient in the area being subjected to procedures by means of the FLIR thermographic camera in the infrared range (Figs 2, 3).



**Figure 2.** Temperature distribution in the right foot area, before the application of a cycle of local hyperbaric oxygen therapy, assessed by means of thermography



**Figure 3.** Temperature distribution in the right shank area, before the application of a cycle of local hyperbaric oxygen therapy, assessed by means of thermography

The analysis of the obtained thermographic images demonstrated the presence of significant disturbances in blood supply in the area of the wounds and right foot toes, which resulted in a reduced temperature of tissues which is shown in the thermogram areas displayed in green and yellow.

### Physical treatment applied

In order to stimulate wound healing, the patient was qualified for medical treatment by means of local hyperbaric oxygen therapy (HBOT) with the use of OXYBARIA-S apparatus, produced by the company Fasser Polska, which takes advantage of therapeutic action of gases with high oxygen content, close to 100%, under pressure exceeding 1 atmosphere [11]. The therapeutic



**Figure 4.** The apparatus OXYBARIA-S for local hyperbaric oxygen therapy interventions (manufactured by FASER S.A., Poland)

process comprised 3 cycles of 15 procedures each, performed once daily for 5 days a week, with interruption on Saturday and Sunday, with 4-week breaks between the cycles. During the procedure (each lasted 30 minutes) the patient was in reclining position, while the limb was placed directly in the cylinder chamber of the apparatus, to which special tubes provided 100% oxygen from a bottle with the constant pressure of 1.5 atmospheres (Fig. 4). After the completion of the procedure, the limb was provided with protective dressings. Also, a guided therapy with antibiotics was applied during treatment.

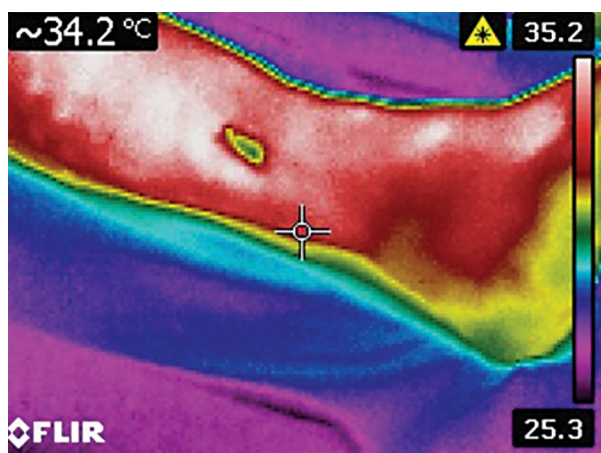
### Results

Throughout the therapeutic cycle, a continuous healing of wounds has been observed, with gradual formation of new granulation tissue and progressing epidermization, finally, after 4 months, all wounds were completely healed. Moreover, after 9 days of treatment, the patient reported complete subsidence of pain complaints (pain intensity in the VAS scale — 0 points), which resulted in the patient's discontinuation of taking analgesics. Simultaneously, there was an intense reduction of limb oedema, as well as progressing evacuation





**Figure 5.** Local condition/state after the end of a cycle of local hyperbaric oxygen therapy interventions



**Figure 6.** Temperature distribution in the foot area, after completion of treatment with the use of local hyperbaric oxygen therapy

of purulent secretion. The limb became softer, more flexible, without the presence of skin blisters.

During the treatment, the patient did not report any side effects of the therapy conducted. The local status of the treated limb after completion of the full therapeutic cycle (45 procedures in total) is presented in Figure 5.

After completion of treatment, a thermographic assessment was performed, which demonstrated normalization of the previously reduced temperature of tissues in the area of healed wounds and toes as a result of improved blood supply (Fig. 6).

The beneficial result of treatment allowed the patient to return to independent living, which included the restoration of basic Activities of Daily Living, which significantly improved the quality of his life [12].

### Discussion of the results

The treatment of wounds, especially chronic ones, because of their complex etiopathogenesis, should be

conducted in a comprehensive manner, with the use of various therapeutic methods. Search for new solutions, which may enhance the efficacy of routine treatment of those wounds, presently poses a substantial clinical challenge, which calls for extensive knowledge and experience of specialists in various fields [3, 13].

In recent years, significant progress was made regarding the processes involved in wound healing. That provided the basis for introducing numerous innovative therapeutic methods, which influence the acceleration of the healing process. Traditional treatment methods, consisting merely of daily change of dressings and application of topical substances are usually insufficient for achieving complete healing of chronic wounds [1, 2]. According to the present knowledge, valuable adjuvant therapeutic methods may include physical medicine procedures implemented at the proper stage of healing, with suitably matched physical parameters. Hyperbaric oxygen therapy undoubtedly belongs to such methods, as its mechanism of therapeutic action comprises, among others, improvement of blood supply to tissues, as well as increasing the pressure of oxygen supplied to tissues, which is conducive to stimulating the processes of regeneration of destroyed tissues and intensification of epidermization processes, thus speeding up the healing process [4, 7].

The results of treatment in the case reported here show that local hyperbaric oxygen therapy, demonstrating strong analgesic and biostimulation action, may constitute an effective method adjunctive to classical treatment of wounds caused by phlegmon in the course of diabetes.<sup>4,6</sup> The method is well tolerated by patients, has no significant contraindications, and causes no side effects, which may occasionally occur during whole body HBOT procedures conducted in hyperbaric chambers. What is more, the apparatus used for the application of this method is relatively cheap and simple to operate [11, 14]. Having in mind the above, it seems that hyperbaric oxygen therapy should find ever increasing applications in Polish and worldwide centres which specialize in the treatment of complicated and chronic wounds.

### Conclusions

The application of the local hyperbaric oxygen therapy in the treatment of phlegmon being a consequence of type 2 diabetes enables a complete healing of wounds, and thanks to the advantageous cosmetic effect, improves the patient's life quality.

### Conflicts of interest

None.

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