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Enhancing treatment efficacy using hyperbaric oxygen therapy in managing chronic hemorrhagic cystitis post radiation therapy

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Abstract

Introduction. A rare but serious side effect of pelvic radiation therapy is radiation cystitis, which is characterized by persistent hematuria brought on by gradual ischaemic damage to the bladder mucosa. Bowel irrigation, intravesical therapy, and coagulation methods are examples of conventional treatments that frequently only offer short-term respite without addressing the underlying disease. By improving oxygen delivery to hypoxic areas, hyperbaric oxygen therapy (HBOT) has become a viable substitute that encourages angiogenesis and tissue repair.

Case Presentation. We describe a case of a 77-year-old man who had persistent gross hematuria lasting for two weeks and had a history of prostate cancer diagnosed in 2016, for which he received radiotherapy, with the last session administered in 2018. A flexible cystoscopy showed gradual bleeding and spotty bladder irritation. Laboratoty tests revealed anemia with hemoglobin 9.6 g/dL without renal impairment or coagulopathy. HBOT was started since the hematuria continued even after bladder irrigation. After ten HBOT sessions, the patient's hemorrhage was completely resolved. He had mild adverse effects, such as brief nausea and vomiting, which were treated with medication. The long-term effectiveness of HBOT was demonstrated by follow-up visits, which verified that there was no recurrence of hematuria.

Conclusion. This case highlights the value of HBOT as a non-invasive and safe treatment for refractory hemorrhagic cystitis, a complication of radiotherapy. For individuals who fail to respond to conventional treatments, HBOT presents a viable alternative because it treats the underlying ischaemic damage rather than just treating the symptoms. Further research is required to develop standardized treatment procedures and assess long-term results.

Keywords: hyperbaric oxygenation; radiation injuries; hemorrhagic cystitis; hematuria; prostate cancer

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Оценка эффективности лечения хронического постлучевого геморрагического цистита методом гипербарической оксигенации

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Аннотация

Введение. Редким, но клинически значимым осложнением лучевой терапии органов малого таза является лучевой цистит, проявляющийся упорной макрогематурией на фоне постепенного ишемического повреждения слизистой мочевого пузыря. Стандартные методы лечения, такие как промывание мочевого пузыря, инстилляции и эндоскопические коагуляционные методики, нередко дают лишь кратковременный эффект и не устраняют патогенетические механизмы процесса. Гипербарическая оксигенотерапия (ГБО), за счёт улучшения доставки кислорода в гипоксические ткани, рассматривается как перспективный вариант, стимулирующий ангиогенез и репарацию повреждённых тканей.

Описание наблюдения. Представлено наблюдение 77-летнего пациента с длительной макрогематурией в течение двух недель; в анамнезе — рак предстательной железы, диагностированный в 2016 году, по поводу которого больной получал лучевую терапию (последний сеанс в 2018 году). При гибкой цистоскопии визуализирована диффузная кровоточивость и очаговые признаки раздражения слизистой мочевого пузыря. Лабораторно выявлена анемия (гемоглобин 9,6 г/дл) без признаков нарушения функции почек и коагулопатии. На фоне персистенции гематурии после промывания мочевого пузыря было начато лечение с применением ГБО; уже после десяти сеансов кровотечение полностью купировано. Отмечены лёгкие побочные эффекты в виде кратковременной тошноты и рвоты, успешно контролируемые медикаментозно. При последующем наблюдении рецидивов гематурии не зарегистрировано, что подтверждает устойчивый эффект проведённой терапии.

Заключение. Представленный случай демонстрирует эффективность и безопасность ГБО как неинвазивного метода лечения рефрактерного геморрагического цистита, являющегося осложнением лучевой терапии. У пациентов, не отвечающих на стандартные подходы, ГБО может рассматриваться как патогенетически обоснованная альтернатива, направленная на коррекцию ишемического повреждения стенки мочевого пузыря, а не только на купирование симптомов. Необходимы дальнейшие исследования для унификации протоколов применения ГБО и оценки отдалённых результатов.

Ключевые слова: гипербарическая оксигенация; лучевые повреждения; геморрагический цистит; гематурия; рак простаты

Финансирование. Исследование не имело спонсорской поддержки. **Раскрытие интересов.** Авторы заявляют об отсутствии конфликта интересов. **Информированное согласие.** Все пациенты подписали информированное согласие на участие в исследовании и обработку персональных данных.

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Introduction

Radiation cystitis is a known complication of pelvic radiotherapy, characterized by hematuria due to chronic ischemic injury and neovascular fragility of the bladder mucosa. Severe cases can be challenging to manage, leading to significant morbidity, recurrent hospitalizations, and impaired quality of life [1]. Conventional treatments, including bladder irrigation, intravesical therapy, and coagulation techniques, often provide only temporary relief and do not address the underlying tissue damage [2].

Hyperbaric oxygen therapy (HBOT) has emerged as an effective treatment for radiation-induced soft tissue injuries by enhancing oxygen delivery to hypoxic tissues, promoting angiogenesis, and facilitating tissue repair [3]. Studies have demonstrated that HBOT can significantly reduce hematuria, improve bladder function, and enhance overall quality of life in patients with radiation cystitis [4, 5].

Patient's Information

A 77-year-old man with a known history of prostate adenocarcinoma, diagnosed in 2016, who completed a course of radiotherapy in 2018. He presented with a two-week history of frank hematuria, which was painless but persistent and associated with the passage of blood clots. The patient denied any recent trauma, strenuous physical activity, or history of urinary tract infections. He also reported no significant weight loss, fever, or lower urinary tract symptoms such as dysuria, urgency, or frequency. His medical history was otherwise unremarkable, and he was not on any anticoagulant or antiplatelet therapy.

Clinical Presentation

The patient presented to the Emergency Department of Hospital Universiti Sains Malaysia. His laboratory investigations revealed a hemoglobin level of 9.6 g/dL, with a platelet count of 302,000/μL and a normal coagulation profile, INR of 1.06. Renal function tests were within normal limits, with no evidence of acute kidney injury. An immediate abdominal and pelvic computed tomography (CT) scans were performed revealing no evidence of malignancy or other structural abnormalities.

During initial evaluation, a flexible cystoscopy was performed, which revealed diffuse mucosal hyperemia, telangiectasia, and areas of ulceration. With the prior history of radiotherapy, hence a diagnosis of radiation-induced cystitis was made. Bladder irrigation was initiated to manage the hematuria; however, the bleeding persisted despite these measures (Fig. 1).

Given the refractory nature of his hematuria and the failure of conventional therapies, the patient was referred for HBOT. He underwent a total of 10 HBOT sessions, during which he experienced transient episodes of nausea and vomiting, which were effectively managed with anti-emetic therapy. By the completion of the HBOT course, the hematuria had completely resolved (Fig. 2), and the patient reported significant improvement in his overall condition. He was discharged in stable condition with close outpatient follow-up. At subsequent follow-up visits over the next six months, there were no recurrent episodes of gross hematuria, and his hemoglobin levels remained stable.

Discussion

A chronic side effect of pelvic radiation therapy, radiation cystitis is brought on by gradual ischemic damage to the bladder mucosa [6]. Patients are at risk for chronic hematuria due to endothelial damage, which causes fibrosis, neovascularisation, and increased fragility of the bladder vasculature [4]. Bladder irriga-

Figure 1. Gross hematuria persisted despite bladder irrigation prior to the initiation of HBOT

Figure 2. A clear urine after 10 sessions of HBOT

Table 1. Summary of studies

Author (year of publication)	Study Type	Preceding Symptoms	Preceding History	Intervention (number of sessions)	Outcome
C. Ferreira et al. (2014) [10]	Prospective study (70 patients)	Hematuria, dysuria, and urinary frequency	Radiation cystitis	HBOT (N/A)	91.4% success rate in symptoms resolution
S. Degener et al. (2015) [11]	Retrospective study (15 patients)	Hematuria	Hemorrhagic cystitis with a history radiotherapy or chemotherapy treatment	HBOT (6 – 128 sessions)	80% complete resolution of hematuria
S.R. De Gracia et al. (2016) [12]	Case report	Hematuria	Post allogeneic hematopoietic stem cell transplantation	HBOT (41 – 43 sessions)	Significant improvement in hematuria
L. Lin et al. (2025) [13]	Case report	Severe hematuria	Radiotherapy for bladder cancer within the last 10 months	HBOT (196 sessions)	Significant improvement
K.H. Lin et al. (2025) [14]	Retrospective study (42 patients)	Hematuria	Radiotherapy administered over the past 2 – 26 years	HBOT (10 – 87 sessions)	Majority experienced resolution or improvement
Current case	Case report	Painless hematuria	Completed radiotherapy in 2018	HBOT (10 sessions)	Complete resolution of hematuria

tion, intravesical instillations, and coagulation therapy are examples of conventional treatments that often provide only short-term relief and fail to address the underlying ischemic pathology [7, 8].

By improving oxygen transport to hypoxic areas, encouraging angiogenesis, and aiding in tissue repair, HBOT has become a successful therapeutic approach. According to T.K. Yang et al. (2024), 55% of patients experience total remission after HBOT, dramatically lowers hematuria [5]. Furthermore, HBOT was observed to relieve symptoms more than control therapies in a randomized controlled trial [9].

Table 1 summarizes articles demonstrating the efficacy of HBOT in treating chronic hemorrhagic cystitis. These articles include prospective and retrospective analyses, as well as case reports, with patients presenting symptoms such as hematuria, dysuria, and urinary frequency following radiation therapy or other treatments. The majority of patients experienced significant improvement or complete resolution of symptoms after HBOT, with session numbers ranging from 6 to 196. These findings align with the outcome of the current case, in which the patient achieved complete resolution of hematuria following 10 HBOT sessions.

Conclusion

This case highlights the efficacy of HBOT in managing refractory radiation cystitis. HBOT offers a non-invasive and effective alternative when conventional therapies fail, promoting angiogenesis and tissue repair to address the underlying ischemic pathology. However, further research is essential to refine treatment protocols, establish standardized guidelines, and optimize long-term outcomes for patients with this challenging condition.

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