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Literature Review

THE ROLE OF HYPERBARIC THERAPY IN THE GROWTH OF CANDIDA ALBICANS

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ABSTRACT

Background: Candida albicans is opportunistic pathogen fungi which cause many disease in human such as recurrent aphthous stomatitis, skin lesions, vulvovaginitis, candiduria and gastrointestinal candidiasis. Aim: Infection mechanism of C. albicans is very complex including adhesion and invasion, morphology alteration from khamir form cell to filamen form (hifa), biofilm forming and the avoidance of host immunity. Method: The ability of C. albicans to adhere to the host cell which is act as important factor in the early colonization and infection. Result: The phenotype alteration to be filament form let the C. albicans to penetrate to the epithelium and play important role in infection and separation C. Albicans to the host cell. Hyperbaric oxygen is the inhalation of 100 percent oxygen inside hyperbaric chamber that is pressurized to greater than 1 atmosphere (atm). Conclusion: The organism was found to be inhibited within a pressure/time range well tolerated by human subjects, suggesting that hyperbaric oxygen might be used successfully in treating human candidiasis.

Key words: Hyperbaric Oxygen, candida albicans, infection, host cell, immunity

ABSTRAK

Latar belakang: Candida albicans merupakan jamur patogen yang berpotensi menyebabkan beberapa penyakit di manusia seperti recurrent aphthous stomatitis, lesi kulit, vulvovaginitis, candiduria dan candidiasis pada gastrointestinal. Tujuan: Mekanisme infeksi C. Albicans sangat kompleks meliputi adhesi dan invasi, perubahan morfologi dari bentukan khamir sel menjadi bentuk filamen (hifa), pembentukan biofilm dan penghindaran terhadap sistem imun tubuh. Metode: Kemampuan C. albicans untuk melekat di sel tubuh yang merupakan faktor penting pada kolonisasi awal dan infeksi. Hasil: Perubahan fenotip menjadi filamen menyebabkan C. albicans berpenetrasi masuk ke epithelium dan berperan dalam infeksi dan pemisahan C. Albicans ke sel tubuh. Hyperbaric oxygen merupakan terapi dengan menggunakan 100 percent oksigen di dalam ruang udara bertekanan tinggi (RUBT)/hyperbaric chamber yang mendapatkan tekanan lebih dari 1 atmosphere (atm). Kesimpulan: Terjadi penghambatan organisme dalam tekanan dan waktu tertentu pada subyek manusia, menunjukkan bahwa hiperbarik oksigen mungkin dapat digunakan dalam terapi human candidiasis.

Kata kunci: Oksigen Hiperbarik, candida albicans, infeksi, sel tubuh, imunitas

INTRODUCTION

Candida albicans is the fourth most common hospital-acquired infection.^{1,2} Because *C. albicans* and other fungal pathogens are eukaryotes and therefore share many of their biological processes with humans, most anti-fungal drugs cause deleterious side effects and, at the doses used, are fungistatic rather than fungicidal. So, it is an important goal of *Candida albicans* research to identify appropriate targets for anti-fungal technologies.

Morphology

Candida albicans can exist in three forms that have distinct shapes: yeast cells (also known as blastospores), pseudohyphal cells and true hyphal cells. Yeast cells are round to ovoid in shape and separate readily from each other. Pseudohyphae resemble elongated, ellipsoid yeast cells that remain attached to one another at the constricted septation site and usually grow in a branching pattern that is thought to facilitate foraging for nutrients away from

the parental cell and colony. True hyphal cells are long and highly polarized, with parallel sides and no obvious constrictions between cells. Actin is always localized at the tip of the growing hypha.³ A basal septin band (green) forms transiently at the junction of the mother cell and the evaginating germ tube; the first true hyphal septum forms distal to the mother cell and well within the germ tube.⁴

Candidiasis

Candidiasis or thrush is a fungal infection (mycosis) of any species from the genus *Candida* (one genus of yeasts). *Candida albicans* is the most common agent of Candidiasis in humans.⁵ Also commonly referred to as a yeast infection, candidiasis is also technically known as candidosis, moniliasis, and oidiomycosis.⁶ Candidiasis encompasses infections that range from superficial, such as oral thrush and vaginitis, to systemic and potentially life-threatening diseases. *Candida* infections of the latter category are also referred to as candidemia or invasive candidiasis, and are usually confined to severely immunocompromised persons, such as cancer, transplant, and AIDS patients, as well as nontrauma emergency surgery patients.⁴ Superficial infections of skin and mucosal membranes by *Candida* causing local inflammation and discomfort are common in many human populations.^{5,6} While clearly attributable to the presence of the opportunistic pathogens of the genus *Candida*, candidiasis describes a number of different disease syndromes that often differ in their causes and outcomes.^{7,8}

Hyperbaric Oxygen

Hyperbaric Medicine is the fascinating use of barometric pressure for delivering increased oxygen dissolved in plasma to body tissues. Hyperbaric oxygen therapy (HBO) is a form of treatment in which a patient breathes 100% oxygen at higher than normal atmospheric pressure that is greater than 1 atmosphere absolute (ATA). Therapy is given in special therapeutic chambers, which were earlier used primarily to treat illnesses of deep sea divers. In the sixties HBO went out of practice because of its use without adequate scientific validation. Over the last two decades, animal studies, clinical trials and well-validated clinical experience has proved efficacy of HBO in many indications and there is recently a renewed interest in this field all over the world.⁹

The Effects Of Hyperbaric Oxygen On Fungi

Many effort have been made for a number of years and various reasons to determine oxygen toxicity limits of yeast. Cairney has reviewed this problems associated with studies on the effects of hyperbaric oxygen on the fungi.¹⁰ Oxygen is the most prevalent and most important element for the human body. It passes from the ambient air to the alveolar air and continues through the pulmonary, capillary and venous blood to the systemic arterial and capillary blood. It then moves through the interstitial and intracellular fluids to the microscopic points of oxygen consumption in the

perioxomes, endoplasmic reticulum and mitochondria.¹⁰ The interactions between oxygen and antimicrobial agents have important implications for the therapy of infections, because oxygen tensions could influenced the static and cidal activity of human body against specific fungies. Increased oxygen tensions can stimulate changes in host tissues (e.g decreased reduction – oxidation potential and increased pH) that might affect the metabolism and/or activation of certain fungies.

Systemic fungal infections generally only occur in patients with other debilitating conditions like diabetes, severe burns or the immunocompromised. Research has shown that there was no response to increase atmospheric pressure alone, but addition of 100% oxygen under pressure led to growth inhibition of pO₂ of 900 mmHg and killing of microorganism at a pO₂ value of 1800 mmHg.¹¹

The Effect Of Hyperbaric Oxygen On *C.albicans*

The effects of hyperbaric oxygen at a steady level of 3 ATA was possessed the same result with McAllister et al who reported total inhibition of *C. albicans* at 2 ATA oxygen.¹² Gifford and Pitchard describes responses of *Candida utilis* to hyperbaric oxygen.¹³ Cultures of organisms in an exponential growth phase did not undergo any further development when exposed to 10 ATA oxygen. When the exposure was continued for several days, all cells died. In the study of Gifford reported that exponentially growing populations were more sensitive than stationary phase populations. The study of Cairney WJ, 1978 showed significant result using 3 ATA oxygen for 4,5 hours of 24 hours period is sufficient to cause inhibition of growth and ability to form pseudohyphae and chlamydo spores. This work has confirmed that *C. albicans* is inhibited in vitro within a pressure range readily tolerated by human subjects. This suggests that hyperbaric oxygen treatment might be effective in treating human candidiasis and that exposure tables used for gas gangrene causing by *Clostridium ssp* could be used with some expectation of success.¹⁴

One study of Gottlieb SF et al, 1964 indicated that exposure of *C. albicans* to 10 ATA of oxygen for 14 days killed the organism. It was possible of low oxygen tensions and shorter exposures times a large number of *C. albicans* could have been killed with only a few cells able to survive the exposure to oxygen. In this study they have designed quantitative approach to obtain information regarding fungicidal versus fungistatic effects of HBO on *C. albicans*. They investigated the effects of (i) pressure, (ii) 900 mmHg O₂, (iii) 1800 mmHg O₂ on the growth of organisms.¹⁵

CONCLUSION

Most studies of Hyperbaric oxygen correlated with *C. albicans* have shown that the effect is inhibitory rather than cidal.

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