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Hyperthermia: Role and Risk Factor for Cancer Treatment

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ABSTRACT

Over the past decades, cancer is the major cause of incidence of death increasing every day. Different forms of tumor therapy including radiotherapy and chemotherapy are used to treat cancer. However, hyperthermia is the technique that neglects the use of chemicals or harmful radiations. The elevated body temperature can damage the cancerous cells with minimum injury to the normal cells. Successful therapy method in combination with radiation therapy and/or chemotherapy is provided to the cancer patient which proved to be beneficial to the patients. In this review, different studies of the clinical trials are reported on the patients with tumor and the therapy associated with it.

Contents

Introduction

Hyperthermia (also known as thermotherapy) is generally regarded as a mean body temperature higher than normal (Alexander, 2008). High body temperature is often caused by illness, such as fever or heat stroke. Research has shown that elevated body temperature can damage and kill cancerous cells with minimal injury to normal cells (van der Zee et al., 2000).

Abbreviations: CEM, cumulative equivalent minutes; US, ultrasound; EM, Electromagnetic; DFS, disease-free survival.

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The main mechanism involved is by killing the cancer cells by destructing proteins and the structure within cells. Thus, hyperthermia may shrink tumors (Wust et al., 2002). Hyperthermia may make some of the tumor cells more prone to radiations or damage other cancer cells which cannot be damaged by radiation. Many times, it also increases the effects of certain anticancer agents. In this study, we would focus on use of heat to treat cancer. Hyperthermia is widely applicable with different other forms of cancer therapy, including radiation therapy and chemotherapy (Alexander, 2001). The aim of the study was to treat many types of cancer including brain, liver, sarcoma, lung, esophagus, breast, bladder, rectum and peritoneal lining (Kapp et al., 1990; van der Zee et al., 2000). There are over 100 types of cancers present in the world and are classified according to cell type. According to GLOBOCAN statistics analysis (2012), 14.1 million new cancer cases, 8.2 million cancer deaths and 32.6 million people living with death were reported (Ferlay et al., 2013). The American Cancer society in 2014 provided the annual report, according to which there will be an estimated 1,665,540 new cancer cases diagnosed (ACS). Hyperthermia is under clinical trials (research study with people) and is not widely available. However, while receiving those combination therapies, only few have shown increased survival in patients (Falk and Issels, 2001). Various techniques of hyperthermia are presently under investigation, that include local, regional and whole body hyperthermia (Feldman et al., 2003; Chang et al., 2001). Many of these have shown a significant depression in tumor size when hyperthermia is combined with other treatment or therapy. Attaining temperature above the systemic temperature 37 °C in a specified target volume is a challenge and still under development. High temperature is induced by applying a power density specific absorption rate (SAR; measured in W/kg). Normal basal metabolism of human is above 1 W/kg. Perfusion counteracts the elevated temperature. In humans perfusion rate is around 5–15 ml per 100 g per min, but they differ widely. To reach the elevated temperature approx 42 °C at least in some parts of the body tumors require a power density of approx 20–40 W/kg at the target region (Tilly et al., 2001). (See Tables 1 and 2.)

Table 1
Clinical trials on hyperthermia.

Cancer site	Control therapy	Experimental work done	Primary endpoint	Survival benefit	Reference
Head and neck (primary)	Radiotherapy	Radiotherapy and local hyperthermia	Response at 8 weeks	No	Datta et al. (1990)
Melanoma	Radiotherapy	Radiotherapy and local hyperthermia	Complete response (Complete response)	No	Overgaard et al. (1995)
Superficial (head, neck, breast, miscellaneous)	Radiotherapy	Radiotherapy and local hyperthermia	Initial response	No	Perez et al. (1991)
Head and neck	Radiotherapy	Radiotherapy and local hyperthermia	Best response	Yes	Valdagni and Amichetti (1993)
Breast(advanced primary or recurrent)	Radiotherapy	Radiotherapy and local hyperthermia	Initial response	No	Vernon et al. (1996)
Breast cancer (Phase III)	Radiotherapy	Radiotherapy and hyperthermia	Disease-free survival	Yes	Jones et al. (2005)
Superficial (head, neck, breast, sarcoma)	Radiotherapy and 1× local hyperthermia	Radiotherapy and local hyperthermia	Best response	No	Emami et al. (1992)
Superficial (head, neck, breast, sarcoma)	Radiotherapy and 1× local hyperthermia	Radiotherapy and local hyperthermia	Initial response	No	Engin et al. (1995)
Superficial (head, neck, breast, sarcoma, others)	Radiotherapy 2× local hyperthermia	Radiotherapy and local hyperthermia	Initial response	No	Kapp et al. (1990)
Glioblastoma	Radiotherapy interstitial radiotherapy	Radiotherapy, interstitial radiotherapy, and interstitial hyperthermia	2-year survival	Yes	Sneed et al. (1998)
Rectum (T4 locally advanced)	Radiotherapy	Radiotherapy and endocavitary hyperthermia	Initial response	Yes	Berdov and Menteshashvili (1990)
Esophagus (stages I–IV, neoadjuvant)	Radiotherapy and chemotherapy	Radiotherapy, chemotherapy, and endocavitary hyperthermia	Histological complete response	Yes	Kitamura et al. (1995)
Esophagus (stages I–IV, neoadjuvant)	Chemotherapy	Chemotherapy and endocavitary hyperthermia	Initial response	Yes	Sugimachi et al. (1994)
Stomach (T3, locally advanced)	Surgery	Surgery and hyperthermic intraperitoneal perfusion	5-year survival	Yes	Hamazoe et al. (1994)
Melanoma (stages I–III)	Surgery	Surgery and hyperthermic isolated limb perfusion	Disease-free survival	Yes	Ghussen et al. (1984)
Melanoma (stages I–III)	Surgery	Surgery and hyperthermic isolated limb perfusion	Disease-free survival	No	Koops et al. (1998)
Primary or recurrent pelvic (cervix, rectum, bladder)	Radiotherapy	Radiotherapy and regional hyperthermia	Complete response	Yes	Van der Zee et al. (2000)
Localized tumor (phase III)	Radiotherapy with superficial hyperthermia	Radiotherapy with superficial hyperthermia	Partial response	Yes	Vernon et al. (1996)