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Fasting and Apoptosis: A Mini Review

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ABSTRACT

Fasting, that is usually described as abstinence from all food and drink for a period of time, has been experienced for ages. Health, protest, religious expressions of devotion and purification are the most important reasons for fasting. Many changes occur in the body during fasting including metabolic, mineral, hormonal, immunological and psychological. Its use as one of the oldest therapies among human populations has been recognized. Also its effects on many abnormalities for medical and therapeutic purposes have been investigated in animals and human. Recently studies have considered its role in apoptosis (or programmed cell death), and subsequently its outcome on the cell processes. Apoptosis is a dynamic process that occurs in multicellular organisms and is described by changes in many cellular processes, and biochemical alterations that lead to morphological cell changes, self-destruction and cell death. It also limits the accumulation of tumor cells. In this mini-review article the relationship between fasting and apoptosis has been summarized.

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Fasting is principally a self-discipline action that is taken for a specified amount of time without consumption of food or drink and represents one specific form of caloric restriction (CR). CR (or calorie restriction, or energy restriction) is a dietary regimen that reduces calorie intake without acquiring malnutrition or a reduction in essential nutrients. The reasons for fasting include health, protest, religious expressions of devotion and purification. It has been thought and used as one of the oldest therapies in medicine. Fasting is known to induce a variety of alterations such as metabolic, mineral, hormonal, immunological and psychological (1-4). Many physiological changes occur in the body during fasting. Usually in the body uses its glycogen reserves and the brain, which has high fuel requirements, still needs glucose and will obtain glucose from break down of muscle tissue during the second day of the fast, and consequently some muscle loss, will occur. Weight loss occurs most rapidly during the first few days of fasting (5). The effects of fasting on apoptotic processes in the body have also been investigated. Apoptosis or programmed cell suicide is a genetically regulated, active process that eliminates cells in both physiological and pathological processes and characterized by profound and distinct changes in cellular architecture leading to self-destruction. It is a normal physiological response to specific suicide signals, or lack of survival signals and has an essential role in shaping tissues during development, endocrine dependent atrophy and normal cell turnover in many tissues. It also limits the accumulation of harmful cells, such as self-reactive lymphocytes, virus-infected cells and tumor cells (6). Studies have investigated the relationship between fasting and apoptosis. Some data shows fasting increases apoptosis (7-10). It has been revealed that after one day of fasting in early starvation phase, depletion of glycogen and triacylglycerol in rat liver occurs, and also loss of protein mass happens via the increase of protein catabolism through the activation of the lysosomal pathway

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(11). A direct relationship between the catabolic side of protein turnover and the apoptotic process has been investigated (8). Starvation of animals for prolonged duration has shown that cell proliferation in several tissues is depressed and also cell death was increased (12). It has been revealed that after 48 hours of fasting, apoptosis was induced in the small intestine of rat that shows sensitivity of small intestinal mucosa to fasting-induced apoptosis (13). The correlation between fasting and aging has also been shown. The effect of chronic caloric restriction on the aging process has been investigated (14). Calorie restriction has been known to extend life span and also dietary restriction (DR) is known to prolong life in laboratory animals (15, 16). It has also been reported that intermittent (alternate-day) fasting or short-term repeated fasting increase the life span of animals (17). The relationship between life span and carcinogenesis is also a logic matter. The exact mechanisms of aging process are not well defined so far. Data indicates that aging has an important role in apoptosis process (18). The relationship between apoptosis and malignant situations has been long recognized (19). The apoptosis and the genes that control it have strong effect on the malignancy. Some oncogenic mutations disrupt apoptosis, leading to tumor initiation, progression or metastasis and now it is well recognized that most cytotoxic anticancer agents induce apoptosis (20). Food limitation enhances apoptosis of preneoplastic cells and restriction of dietary calories reduces cancer formation in experimental animals and perhaps also in humans. This effect is generally attributed to the inhibitory effect of fasting on cell proliferation (21). It has been concluded that initiation of apoptosis in apical enterocytes is coincident with cessation of feeding and fasting, and goes together with programmed cell death in these cells (22). Moreover, chronic caloric restriction leads to loss of body and liver weight and its effects on carcinogenesis processes are well known. After feeding, proliferation of the intestinal cells was increased and also apoptosis was decreased (23). The strong effect of drug therapy on treatment of some type of cancers is clear. The efforts are aimed to find ways of increasing this effect. It has been demonstrated, *in vivo* and *in vitro*, that following short-term-starvation (STS), particularly in combination with chemotherapy, the growth of colon carcinoma cells is delayed, (9). Based on the mentioned data, probably it might be thought that there is great potential for prompting apoptosis following fasting. Considering apoptosis as a defense mechanism against malignancies, it may be concluded that fasting can also affect the malignancy related processes. For more clarification further investigations are recommended.

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