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Histological Effects of Aging on Male Albino Rats' Duodenum

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Abstract: Aging is a phenomenon that presents various alterations in neurochemical, behavioral and physiological processes. This study aimed to evaluate the effect of aging on the histology of the duodenum of male albino rats. Fifteen male albino rats were divided into three groups of 5 rats each: Group A: Included rats at the age of 2 months. Group B: Rats were continued to live to the age of 6 months and Group C: Rats were continued to live to the age of 12 months. At the end of the experimental period, the animals were anaesthetized, then the duodenum was dissected out and specimens were processed for histological examination. At the age of 2 months a shrinkage in the core of the villus and deterioration in submucosal layer were recorded in the duodenum of rats. while deterioration in muscularis layer was seen in rats aged 6 months,in addition to congestion in mucosa. Many histological changes were observed in rats aged 12 months beginning from congestin in submucosa apnd detorioraion of muscle fibers in muscularis reaching congestion in mucosa and inflammation in crypts region and ending with necrosis in crypts and villi.

Key words: Small intestine · Aging · Histology · Rats · Duodenum · Function

INTRODUCTION

Aging is simply a process which is characterized by the degeneration of essential functions in late or post reproductive phase of all multicellular organisms [1, 2]. It is characterized by a progressive decline in function and a decrease in the body's ability to maintain homeostasis [3-5].

The small intestine is a specialized tubular structure within the abdominal cavity in continuity with the stomach proximally and the colon distally. In human,the small bowel increases 20 times in length with aging, from about 200 cm in the newborn to almost 6 m in the adult and its length is approximated by three times the length of the infant, or height of the child or adult. The duodenum, the most proximal portion of the small intestine, begins at the duodenal bulb, travels in the retroperitoneal space around the head of the pancreas and ends on its return to the peritoneal cavity at the ligament of Treitz. The remainder of the small intestine is suspended within the peritoneal cavity by a thin, broad-based mesentery that is attached to the posterior abdominal wall and allows free movement of the small intestine within the abdominal cavity [6].

The effects of aging on distinct organs and tissues have been widely demonstrated, as well as their relationship with the alteration of the oxidative stress of organism [7-9]. According to the "aging free radical theory," introduced by Harman [10], aging is caused by an accumulative enhancement of the oxidative stress at various organs [11], tissues and cell components [7].

A spectrum of changes occurs in the function of the gastrointestinal (GI) tract throughout the life of the animal. It has been reported that, with aging, there is a decline towards newborn levels of the villus surface area and brush border membrane markers, but the absorption of some nutrients continues to increase (such as glucose and vitamin), whereas the absorption of some nutrients falls (such as cholesterol and fatty acids). With aging, the structure and brush border membrane composition of the intestine tends to regress towards newborn levels [12]. Furthermore, aging is known to be associated with secretory and morphologic changes in the (GI) tract [13, 14]. The (GI) tract is innervated by intrinsic enteric

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neurons and by extrinsic projections, including sympathetic and parasympathetic efferents as well as visceral afferents, all of which are compromised by age to different degrees [15]. In the present study we evaluate the effect of aging on the histology of the duodenum of male albino rats.

MATERIALS AND METHODS

Materials and methods for this experiment are described in full in our previous work [16]. Briefly, during January-October 2011, fifteen healthy male albino rats, were obtained and housed in the Animal House of Department of pharmacology-Faculty of Medicine, University of Jordan. The experiment was planned to last for 12 months. Rats were allowed the Ad libitum (AL) diet regime and divided into three groups of 5 rats each: Group A: Included rats at the age of 2 months. Group B: Rats were continued to live to the age of 6 months and Group C: Rats were continued to live to the age of 12 months. During the whole period of experiments,the animals were caged separately in plastic cages with open access to tap water and cubes of standard rodent diet. The room temperature was maintained at 23 ± 2°C. The experiment in this study was accomplished according to the protocol recommended by Local Animal Care Ethical Committee.

The animals were sacrificed at the appropriate age, at the end of the experiment. Duodenum was immediately taken from each animal. Small pieces of the duodenum were fixed in 10% formalin and processed using a standard histological procedure. Sections of 5 µm. thickness were stained with hematoxyline and eosin. The tissue sections were then evaluated for histological changes under Zewiss compound light microscope and photomicrographs were taken using Kodak digital camera 10.3 mega pixels.

RESULTS

At the age of 2 months a shrinkage in the core of the villus was recorded in the duodenum of rats (Fig.1) and deterioration in submucosal layer (Fig.2). while deterioration in muscularis layer was seen in rats aged 6 months,in addition to congestion in mucosa (Fig. 3). Many histological changes were observed in rats aged 12 months beginning from congestin in submucosa (Fig. 4) and detorioraion of muscle fibers in muscularis (Fig.5) reaching congestion in mucosa and inflammation in crypts region (Fig. 6) and ending with necrosis in crypts and villi with inflammatory cells (Fig.7).

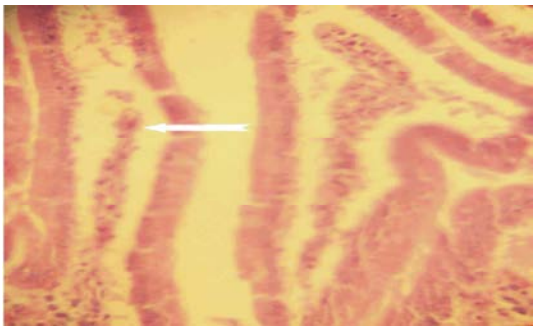

Fig. 1: Transverse section of duodenum of rat aged 2 months. ? shrinkage in the core of the villus. 400X. (H&E stain)

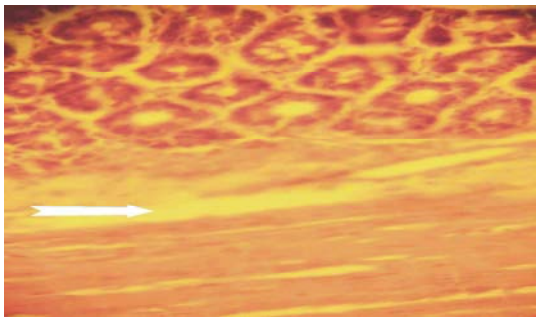

Fig. 2: Transverse section of duodenum of rat aged 2 months. ? deterioration in submucosal layer. 400X. (H&E stain)

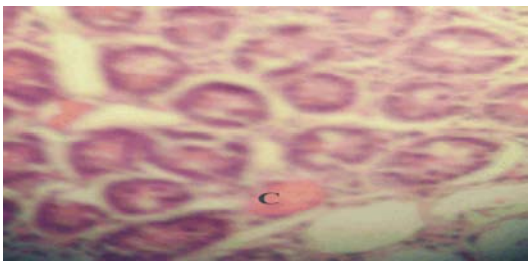

Fig. 3: Transverse section of duodenum of rat aged 6 months. C: congestion in blood vessels in mucosa between crypts. 400X. (H&E stain)

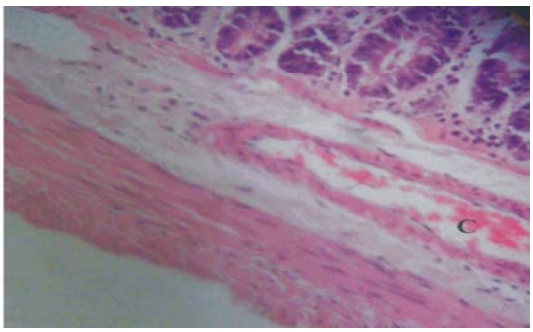

Fig. 4: Transverse section of duodenum of rat aged 12 months. C: congestion in submucosa. 400X. (H&E stain)

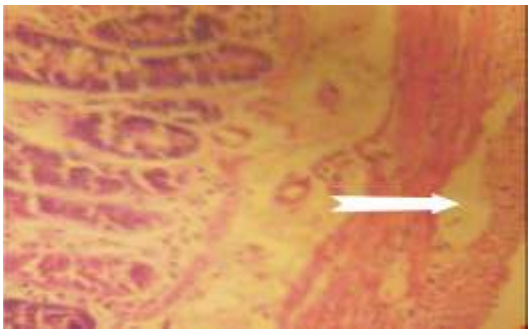

Fig. 5: Transverse section of duodenum of rat aged 12 months. ?disintegration in muscularis layer. 400X. (H&E stain)

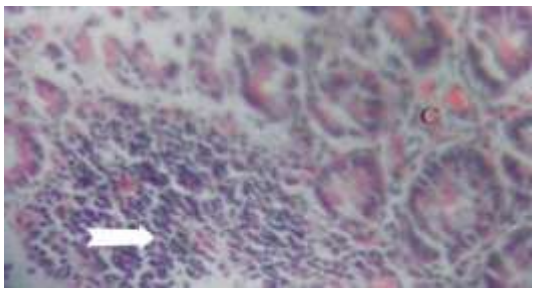

Fig. 6: Transverse section of duodenum of rat aged 12 months. C: congestion in mucosa and? inflammatory cells in crypts region. 400X. (H&E stain)

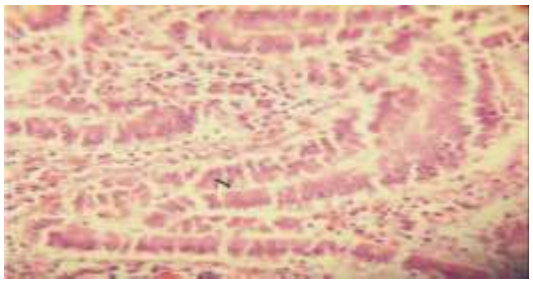

Fig. 7: Transverse section of duodenum of rat aged 12 months. N: necrosis in crypts and villi with inflammatory cells. 400X. (H&E stain)

DISCUSSION

The incidence of duodenal ulcer increases with age [17, 18]. Some studies suggest that impaired duodenal mucosal secretion of bicarbonate is an important factor in the pathogenesis of duodenal ulcer [19, 20]. The ability of the mucosa to respond to acid seems very important in the maintenance of the surface pH gradient and in the protection of mucosa [21, 22].

In the present investigation, it is observed that aging has a significant effect on histological structures of duodenum. Aging is a process that presents various alterations in behavioral, physiological and neurochemical processes [23-25]. A number of studies in rats have examined the changes in the morphology of the small intestine with advancing age [26, 27]. Hohn *et al*, [28] observed that, in 30 month old rats, the mucosa of the duodenum appeared atrophic compared with the same area of the small intestine in 4 month old rats. Raul *et al* [26] found that the intestinal segments of the senescent rats contained higher mucosal mass and protein content compared with the young and mature animals.

In other studies, Hamrouni *et al* [29] has reported that McN-A-343 relaxes the rat duodenum via muscarinic receptors of the M1 subtype and these receptors are probably located on enteric neurones from which their stimulation releases gamma-aminobutyric acid (GABA) [29]. Moreover Balogh *et al* [30] found in this study on duodenum rat, that $1,25(OH)_2D_3$ modulation of PKC activity and isoenzyme subcellular distribution are impaired with aging and may explain age-induced alterations in the intestinal processes under the control of the hormone [30].

Jang *et al* [31] found in an electron microscopic examination, that morphologically a less dense brush border membrane (BBM) structure in the duodenum of rats aged 23 months was detected than that of rats aged 5 months. Specific activity of alkaline phosphatase (ALP) in the duodenum from 5 months old rats was significantly higher than from rats aged 2.5 weeks and 23 months. The mucosal tissues from 5 weeks old rats had significantly higher specific activity of gamma-glutamyl transpeptidase (gamma-GT) than did tissues from the other ages. In sucrase and maltase specific activities, 5 months old rats had higher activities of these enzymes than other age groups, especially 2.5 weeks and 23 months old rats. There was also a significant effect of site on intestinal BBM enzyme activities in post-weanling rats. Regional gradients of ALP and gamma-GT along the entire small intestine (duodenum > jejunum > ileum) were remarkable. Disaccharidase activities peaked in the jejunum and declined toward both the duodenum and ileum.

Vigueras *et al* [32] indicates in their study, which was performed in 69 male Wistar rats with ages ranging from one day to one year old, that the number of villi in the small intestine decreased from 1 to 35 days of age, whereas the other intestinal parameters all increased during the same period. After 35 days the rates of increase or decrease were lower. In other studies, Kim *et al* [17]

indicate that there is an age-related decrease in bicarbonate secretion stimulated by exposure of the duodenal mucosa to acid. Their results obtained from three different age groups of rats clearly reflect an age-related change and suggest a progressive breakdown in mucosal defense mechanisms in the proximal duodenum with increasing age [17].

CONCLUSION

From the present study it is concluded that, as age advances in male rats, a significant histological changes involved the duodenum and at age 12 months the histological changes were more and obvious.

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