15829-Farhat-Histologic effects of isoniazid induced hepatotoxicity

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"HISTOLOGICAL EFFECTS OF ANTI TUBERCULOUS DRUG ON THE LIVER OF ALBINO MICE".

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ABSTRACT

Objective: The purpose of this study was to assess changes in the histology of liver in the isoniazid induced hepatotoxicity in male albino mice.

Methods: Forty male albino mice were divided into two groups, i.e. a group A served as a control and group B was experimental. Fifteen mice served as control and were fed on normal mouse diet, water ad libitum and each mouse was given additionally 10 ml/kg of distilled water by mouth for 30 days. Twenty-five mice were used as experimental in Group B and were treated with isoniazid 100mg/kg bodyweight for 30 days.

Serial sections of liver 4µm thick were stained with H & E and PAS for microscopic examination.

Results: Group A showed the normal histology. Group B showed that the deranged general architecture of liver; necrosis, apoptosis, pyknosis, vacuoles and periportal inflammation were also observed. Histological examination of the preparations from the treated group showed that the sinusoids and central veins of the liver were dilated and stuffed with blood cells, indicative of congestion. The liver parenchyma was infiltrated with inflammatory cells, mostly lymphocytes and macrophages. Fatty degenerative changes were also observed in the hepatocytes.

Conclusion: Isoniazid is a hepatotoxic agent and causes many toxic changes in hepatocytes of mice.

Key words: Isoniazid, necrosis, apoptosis, hepatotoxic.

INTRODUCTION

Tuberculosis is the primary cause of mortality among people with low immunity. Using the drug regimen of Isoniazid, Rifampicin, Ethambutol and Pyrazinamide many countries have successfully increased the rate of their tuberculosis treatment, but the side effects of these anti tuberculous drugs continue to threaten global tuberculosis control efforts. Isoniazid, also renowned as isonicotinyl hydrazine (INH) is the first drug of choice for prevention and treatment of tuberculosis. In 1951 it was establishing to be useful against *Mycobacterium tuberculosis*.[1]

Anti-tuberculosis drug pharmacokinetics is predisposed by patient age, sex, origin and GIT infections. Isoniazid is freely absorbed from the GIT and produces highest blood levels in 1 to 2 hours, when administered orally. It easily spreads to the cells, tissues, organs and in body waste (saliva, sputum, and feces). It is excreted mainly by kidneys and also by feces.[2]

Isoniazid is a drug when administered, is in an inactive form; it is metabolized in the body into a biologically active compound. It is activated by a bacterial catalase-peroxidase enzyme which in tuberculosis is called as KatG, which pairs the isonicotinic acyl with nicotinamide adenine dinucleotide (NADH) to form isonicotinic acyl-NADH complex. This compound sticks firmly to the enoyl-acyl carrier protein reductase (key enzyme in type II fatty acid synthesis) known as InhA, so blocking the natural enoyl- AcpM substrate and the action of fatty acid synthase. This procedure inhibits the production of mycolic acid, which is required for the mycobacterial cell wall synthesis.[3] Isoniazid is bactericidal to quickly-dividing mycobacterium but is bacteriostatic if the mycobacterium is slowly dividing.[4]

Toxicity of isoniazid has been related with intense seizures, peripheral neuropathy, hepatomegaly, blood disorders, allergy, psychological disorders, immunologic and gastrointestinal disorders.[5,6] amongst them; hepatotoxicity is the severest one and is the center of attention of the present study.

Isoniazid hepatotoxicity ranges in severity from asymptomatic elevation of serum transaminases to hepatic failure. Isoniazid is directly or indirectly metabolized to acetyl hydrazine and hydrazine by N-acetyltransferase and amidohydrolase. Acetyl hydrazine and hydrazine might be oxidized by CYPs to form hepatotoxic metabolites.[7]

Human genetic studies have shown that cytochrome P4502E1 (CYP2E1) is involved in anti-tubercular drug hepatotoxicity. The CYP2E1 c1/c1 genotype is associated with a higher CYP2E1 activity and may lead to a greater production of hepatotoxins. Experimental studies on rats showed that Isoniazid and Hydrazine induce CYP2E1 activity. Isoniazid has an inhibiting effect on CYP1A2, 2A6, 2C19 and 3A4 activity. CYP1A2 is suggested to be involved in hydrazine detoxification.[8] Isoniazid can induce its own toxicity, possibly by the induction or inhibition of these enzymes; [8] the toxic effects of isoniazid on liver histology were evident by necrosis, apoptosis, fatty changes, focal central vein congestion, portal inflammation and loss of cellular boundaries.[9]

Previous studies generally reported the preventive effects of many drugs and herbs on isoniazid induced hepatotoxicity[10]. The current project reported the actual architectural damage to liver tissue on consumption of isoniazid in male albino mice.

MATERIALS AND METHODS

It was an experimental study. Simple random sampling by balloting method was used. Study was conducted on 40 non-tuberculous healthy male albino mice, which were obtained from Veterinary Research Institute (VRI), Lahore and were kept in an animal house of University of Health Sciences, Lahore; Pakistan. This research on experimental animals was approved by Ethical Review Committee for Medical and Biomedical research, University of Health Sciences; Lahore.

INCLUSION CRITERIA: Healthy adult male mice, 6-8 weeks of age, weighing 30g ± 5g were taken. They were divided into two groups A and B. Each group was housed in an individual stainless steel cage with wood shavings at the floor in the experimental research laboratory at controlled room temperature (23± 2°C), humidity (50±5%) and light and dark cycles of 12 hours each. Cage cards were used indicating identity regarding groups of the animals and their number. The animals were fed on standard mouse diet (wheat balls) and water ad libitum.

EXCLUSION CRITERIA: The experiment was started after acclimatization period of 1 week. Diseased animals, mice older than 8 weeks and with weight more than 35g were excluded from the experiment.

EXPERIMENTAL DESIGN: Group A served as control and consisted of fifteen mice. Group B was experimental and consisted of twenty-five animals. Group A was fed on normal mouse diet, water ad libitum and each mouse was given additionally 10 ml/kg of distilled water by mouth for 30 days. Group B was administered isoniazid orally in a single daily dose of 100mg/kg for 30 days to produce hepatotoxicity.

Isoniazid was obtained in powdered form, from Sigma Chemicals Company (St. Louis, MO, USA). Dose of isoniazid was based on previous studies in which isoniazid

was given at 100 mg/kg/day, orally for 30 days, [9,11] dissolved in 10 ml distilled water,[12] using mouse as experimental models.

The animals were dissected on the 30th day of experiment. The livers of the mice were removed soon after sacrificing the animals and 3-5 mm thick pieces were excised after gross examination of the organ. Livers were fixed in formalin solution for 2 days and processed to prepare paraffin blocks. 4µm thick serial sections of liver were obtained and stained with Haematoxylin and Eosin (H & E) and Periodic Acid Schiff's (PAS) stains.

RESULTS

Gross features

On gross examination, the liver was smooth in texture. It was dark brown in color, with four lobes, surrounded by thin layer of connective tissue capsule. Obvious gross abnormalities were not present either in control or treated group.

Histological features

Typical hepatolobular architecture was observed in the control group A under 10, 20 and 40 X objectives. Hepatocytes were rounded to polyhedral in shape; having single or double nuclei, with clear nuclear membranes (Fig 1-B). Normal hepatic lobules with central vein and peripheral portal triads were seen. The hepatic cells were arranged as cords radiating from central veins to the periphery with sinusoids in between them (Fig 1-A). Scattered kupffer cells with cytoplasmic processes and rounded prominent nuclei were also observed. The hepatic sinusoids were seen to be anastomosing irregularly with each other and opening into the lumen of central vein (Fig 1-B). Small cytoplasmic vacuoles of variable sizes and shapes, presumably indicating glycogen or fatty content of the cytoplasm were noticed in the hepatocytes. Vesicular nucleus with 1-2 nucleoli was recorded. Some nuclei were pyknotic.

Portal area comprised of tributary of portal vein, and branches of hepatic artery and bile duct. The portal vein tributary had wide, endothelial lined lumen containing erythrocytes; the hepatic artery branch had narrow lumen and thicker wall. Bile duct branch was lined by low cuboidal epithelium. No periportal inflammation was observed.

In the treated group B, liver architecture was disturbed with loss of radial arrangement hepatic cords and sinusoids. Hepatocyte boundaries were illdefined.

Darkly stained nuclei indicating pyknotic changes and clumping of nuclear material were recorded in this group. Necrosis evident by pyknosis, karyolysis and karyorrhexis was also an observable feature of this group. Apoptotic bodies were clearly seen and fatty change was evident by signet ring formation (Fig 1-C). Larger, swollen and empty looking hepatocytes, with the loss of cytoplasmic contents appearing as micro and macro vacuoles, were noticed in this group (Fig 1-D). Vessels were dilated and congested. Periportal and focal areas of inflammation were present.

DISCUSSION

The histological observations on liver from treated group showed marked changes. It was observed that the general architecture of liver in isoniazid group was deranged, possibly on account of hepatocyte swelling. These results are similar to a previous study, in which rats treated with isoniazid shows hepatocellular disintegration and vacuolation in centrilobular region.[13] This loss of radial arrangement of hepatocytes along with hypertrophy of cells and ballooning degeneration was also reported in previous by Noorani *et al*. (2010) who observed that isoniazid caused liver damage in albino rats.[14] Bhadauria *et al*. (2007) reported that subchronic administration of CCl_4 caused degeneration and disintegration of liver cell architecture.[15]In his study, hepatic lesions were characterized by massive hepatic necrosis and a large vacuolation.

In our study, in group B, INH caused necrosis, pyknotic nuclei without nucleoli and at some places fragmented nuclei were present; these were indicative of degenerative changes and toxic effects of INH on liver. Pyknosis is the irreversible condensation of chromatin in the nucleus of a cell undergoing apoptosis. Pyknotic nuclei appear as dark and condensed chromatin material (Fig 1-C and D).

The histopathological features of INH produced hepatotoxicity were characterized by focal inflammatory infiltration, necrosis, and vacuolization and ballooning degeneration[16]. In our study, mice in experimental group B also showed lymphocytic infiltration around bile duct called periportal inflammation (Fig 1-C and D). The histological preparation of the liver from group B also showed empty spaces, indicative of degeneration of hepatocytes and/or an increased content of fat which was removed during the process of preparation of slides. It has been reported that toxic

isoniazid metabolites bind covalently to cell macromolecules. Hydrazine is the toxic metabolite of isoniazid, which is metabolized by cytochrome P- 450 system in the liver. Hepatotoxicity could be due to any disturbance in cytochrome P- 450 system or in detoxification pathway. Hydrazine causes steatosis and hepatocyte vacuolation.[8]

It had been reported previously that animals receiving isoniazid showed periportal inflammation, fatty changes, liver cell necrosis, ballooning degeneration, vascular congestion, pyknosis and apoptosis.[1, 17-19]

Both human and animal experimental studies proved that it is manifested mainly as hepatocellular steatosis, ballooning degeneration and minimal cholestasis and it has been recommended that toxic isoniazid metabolites bind covalently to cell macromolecules.[17] Hydrazine is the toxic metabolite of isoniazid and is reported to produce hepatocyte vacuolar degeneration and necrosis.[9] Lipid vacuoles along with mitochondrial swelling are found in hepatocytes; both periportal and midzonal as reported by Tostmann *et al*. (2008)[8]. In another study, diffuse micro vesicular fatty infiltration with mild portal triaditis and moderate to heavy lobular inflammation and piecemeal necrosis was reported.[20] Kupffer cell hyperplasia had also been observed by Bigonyia *et al*. (2009) along with fibrosis and nodular regeneration.[13] Anbarasu *et al.* (2011) observed in an experiment that INH produced enlargement of liver.[21]

CONCLUSION

It is concluded that anti tuberculous drug treatment has potential hepatotoxic effects on male albino mice.

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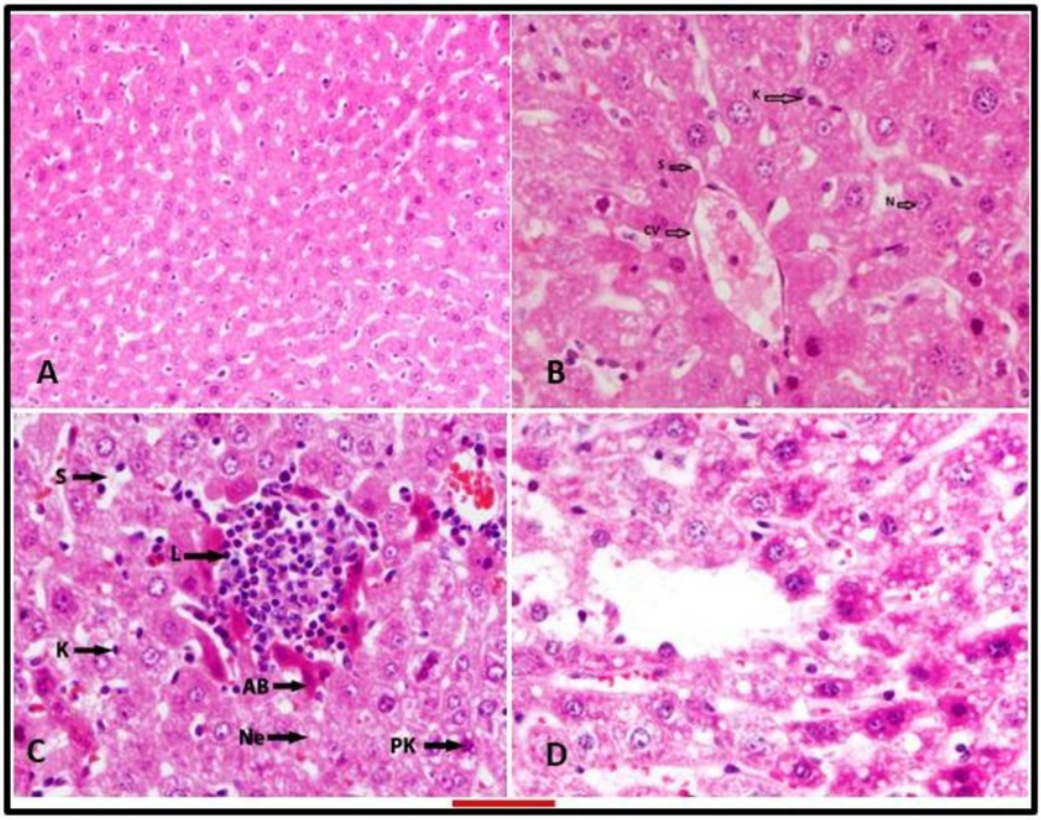

Fig 1

Figure 1-A:
Liver section from group A, showing radiating hepatic cords with sinusoids in between them (H & E Stain. Scale bar is 100 µm approximately)

Figure 1-B:
Liver section from group A. Round to polyhedral hepatocytes having vesicular nucleus (N) with clear nuclear membrane are seen. Sinusoids (S) are opening in the central vein (CV). Kupffer cells (K) are seen in the lining of the sinusoids. A few binucleated hepatocytes are also seen in the micrograph. (H & E Stain. Scale bar is 50 µm approximately)

Figure 1-C:
Liver section from group B. Areas of necrosis (Ne) evident by fragmented and pyknotic nuclei (PK). Focal collection of lymphocytes (L) and apoptotic bodies (AB) can be seen. Kupffer cells (K) with prominent nuclei projecting in sinusoids (S) are also visible. (H & E Stain. Scale bar is 50 µm approximately)

Figure 1-D:
Liver section from group B. There is steatotic hepatic change with vacuolar degeneration and signet ring appearance. (H & E Stain. Scale bar is 50 µm approximately)

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