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Gross and Microscopic Anatomy of the Vater Papilla (Hepatopancreatic Ampulla) in Animals with and without Gall Bladder

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Abstract **The relevance of research problem.** Congenital absence of any organ is severe anomaly of development and often leads to the serious consequences. **Objective.** To study comparable macroscopic and microscopic features of Vater papilla in mammals those have and do not have a gall bladder. **Materials and methods.** Materials for our investigations were Vater papillae of 10 rats and 6 horses (they don't have gall bladder), 12 rabbits and 11 representatives of cattle (they have gall bladder). **Results of the study.** The comparative morphology of the Vater papilla of animals with and without gall bladder was studied. It was established that those animals that have a gall bladder larger than the Vater papilla have an ampoule with a complex network of folds, which is not the case for those who do not have a gall bladder. **Conclusions:** in rabbits and cattle that have a gall bladder, the Vater papilla forms a pronounced ampule (Vater ampule) with a complex network of folds, and in rats and horses that do not have a gall bladder, such an ampule was not found.

Keywords Vater papilla, Comparative morphology, Gall bladder

1. The Relevance of Research Problem

Congenital absence of any organ is severe anomaly of development and often leads to the serious consequences. Perhaps there are organs which have not all representatives of vertebrate animals closer to the living conditions and nutrition character. Gall bladder belongs to such organs. Some animals (rats, horses, camels, elephants, rhinoceros and etc.) and birds (pigeons, turtle-doves, ostriches and etc.) do not have it. This is a big biological problem which attracts the attention of investigators and current century far from its final decision.

At the same time, literature data regarding functional importance of gall bladder testifies that it takes part in regulation of digestive activity of the small intestine and influences to the functional activity of Oddy's sphincter (Vinnik Yu.S. et al., 2012, Osipenko M.F. et al. 2013). There are scientific works devoting to the features of structural organization of the major duodenal papilla (Kostirkina V.V. 2006, Horiguchi S.I., Kamisawa N. 2010), in which the presence of the sphincters' complex have been noted.

There are research works regarding the role of gall bladder (Tyuryumin Ya.L, Shanturova V.A., Tyuryumina E.E., 2011). It is natural that we have a question how does compensation of these functions happenin those animals that don't have gall bladder? Gall bladder by its construction (in general with common biliary duct) makes a pressure which promotes the opening of Oddy's sphincter. Therefore we can consider that in vertebrate animals which don't have gall bladder sphincter apparatus of the terminal part of biliary duct also should have its features. According to the data of literature (Pokhobova E.Yu., Belova G.V., 2012) the ampoule contains 3-5 layers of semilunar folds which form valves.

There are comparative-morphologic works devoting to this problem (Dundarov Z.A., Gavrilenko V.I., Golubeva N.N. 2007, Zimatkin S.M., Markovets N.I. 2016). The above mentioned data could allow us to consider that the causes of the absence of gall bladder in some vertebrate animals is not fully established and it is a big medical-biological problem that far from its final decision.

2. Objective

To study comparable macroscopic and microscopic

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features of Vater papilla in mammals those have and do not have a gall bladder.

3. Materials and Methods

Materials for our investigations were Vater papillae of 10 rats and 6 horses (they don't have gall bladder), 12 rabbits and 11 representatives of Bull 'cattle' (they have gall bladder). The structure of Vater papilla in horses and representatives of cattle has been studied by macroscopic method under binocular loupe. Vater papilla of rabbits and rats has been studied by macroscopic method by receiving a series of consecutive cuts.

Materials were fixedin 12% solution of indifferent formalin neutralized by saturated solution of borax. Histological processing of the material and embedding in paraffin have been carried out by general accepted scheme. Serial consecutive cuts of the material were stained by hematoxylin-eosine with the use of Van Gizon method and impregnated by using of Grimelius method.

4. Results of the Study

The ampulla of Vater, also known as the hepatopancreatic ampulla or the hepatopancreatic duct, is formed by the union of the pancreatic duct and the common bile duct. The ampulla is specifically located at the major duodenal papilla (figure 1, 2).

The longitudinal fold of duodenum in the representatives of cattle was clearly manifested and Vater papilla was localize in the apex, the mouth of ampoule was as oval foramen (figure 2A). There is an ampoule in the stratum of longitudinal fold in terms of dilated part of canal of intraparietal section of the duct. Dilated cavity has oval form. In horses longitudinal fold of duodenum is not visualized. Canal of the intraparietal section of the biliary duct for all distance has the same size. Vater papilla has a form of the tube end with reflected sides. The orifice has chinked form (figure 2B).

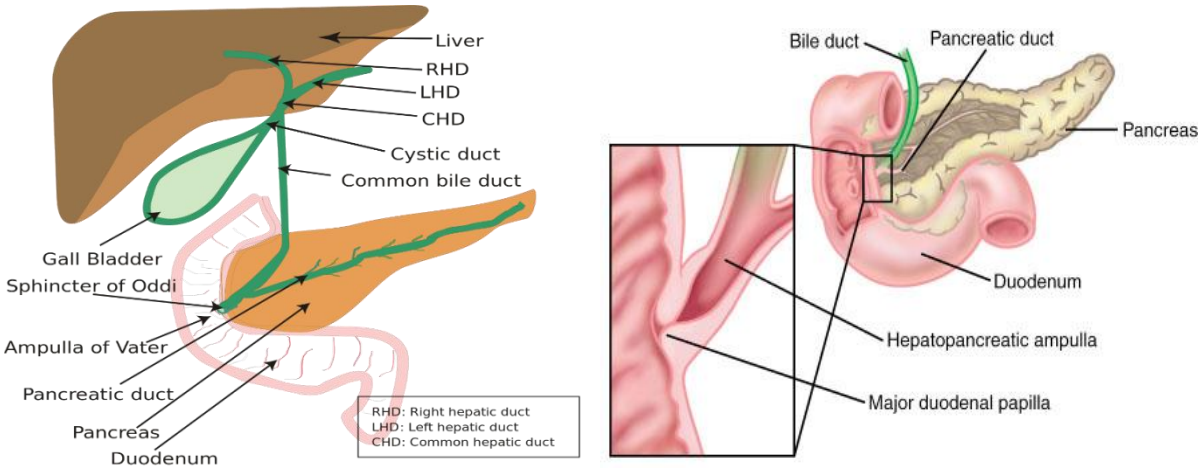
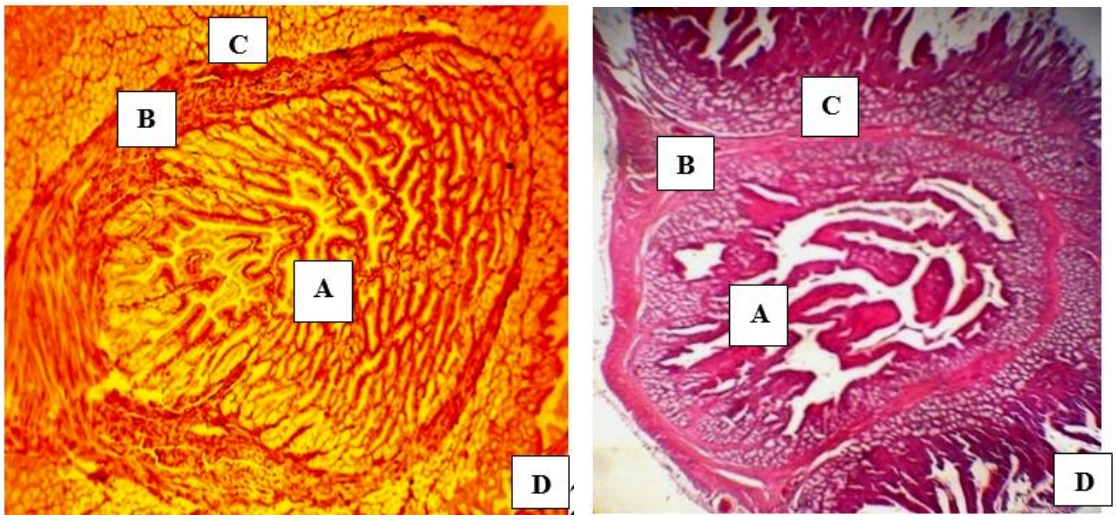


Figure 1. Structure ampulla of Vater

A **B**

Figure 2. Macroscopic structure of Vater papilla of bull (A) and horse (B). Macropreparation. MBS.Ob.4, ок.6



1 2

Figure 3. Cryostat (1) and paraffin (2) sections of the ampulla of the Vater papilla of an adult rabbit. 1-impregnation according to Grimelius. 2-staining with hematoxylin-eosin. Ob. 20, Ok. 10. A–cavityampoules with folds. B–muscleshell of the ampoule. B–submucous membrane of the duodenum with Brunner's glands, D –cavityof the duodenum

Longitudinal fold of duodenum in adult rabbits in the distal part is formed Vater papilla. The orifice of the ampoule as a pointed outlet is seen in the lower maximal protruded part of longitudinal fold. The lower of the orifice longitudinal fold is narrowed and gradually become not perceptible. Common biliary duct "enters" into the external wall of duodenum on-the-miter from 30° to 48°. Initially the common biliary duct is fastened on the external wall of duodenum and gradually plunged into it. At this level mucous membrane of the common biliary duct forms longitudinal folds. Muscular membrane of the intestine and the common biliary duct are connected original. The external longitudinal layer of the muscle membrane of duodenum is joined with the same membrane of the common biliary duct forming of the general muscle layer. Mucous membrane of the duct forms the wide folds of the longitudinal orientation. As far as plunging of the common biliary duct the muscular membrane of the intestine and duct are fully joined and duct is left inside this membrane. It is necessary to note that in such place almost all muscular membrane is located circularly forming the own sphincter of the common biliary duct. At the same time it is impossible to separate muscular membrane of duodenum from the common biliary duct which allows us to suggest that they are complexly functioned.

At these levels the folds of mucous membrane are become high acquire different configurations and the anastomoses between them are appeared. The duct's lumen is enlarged in the contrast with the previous level and become to form the ampoule of Vater papilla. Then the common biliary duct is gradually pierced through muscular membrane of the intestine and the basic mass of this membrane is located laterally from the duct. The lumen of the duct is enlarged forms the ampoule and the folds of the mucous membrane are become long anastomosing with each other as they divide the walls of ampoule into separate cameras of the various configurations. The mucous membrane of the common bile duct becomes much thicker and glands appear in it. Gradually, the muscular membrane from the side of the intestinal lumen becomes thinner, and the ampoule is surrounded on three sides by the mucous membrane of the duodenum. This intestinal membrane also contains many mucous glands. Then the lumen of the ampoule becomes wide, all the folds anastomize among themselves and they form a single complex (figure 3). The muscular membrane from the side of the intestinal cavity is thinning. The ampoule has a maximum width. It should be noted that when studying micropreparations of the internal relief of the ampoule of the Vater papilla from fixed and non-fixed material, a significant difference was revealed. When fixing the material, some wrinkling of the material apparently occurs under the action of the fixative, and when studying micropreparations from this material, the folds of the ampulla of the Vater papilla seem to compact and the distance between them (the free cavity of the ampoule) is relatively wider (figure 3.2). On micropreparations prepared in a cryostat from fresh (unfixed) material, the folds have a high density and the distance between them is negligible (figure 3.1).

This is confirmed by our morphometric studies: if the ratio of folds and free space on micropreparations from a fixed material is from 1,2 to 1,6 conventional units, then in the preparations from non-fixed material, these figures are respectively 1,8 and 1,9. In rats, the intramural part of the common biliary (hepatic) duct, like horses, does not form a pronounced ampule with complex folds of the mucous membrane. A slight expansion of the duct at the mouth is noted. However, the mucous membrane of this expansion does not have pronounced folds, the cavity is free. The mouth is slit-like and mobile folds are also not visible in it.

Thus, in rabbits and cattle that have a gall bladder, the Vater papilla forms a pronounced ampule (Vater ampule)

with a complex network of folds, and in rats and horses that do not have a gall bladder, such an ampule was not found.

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