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ABSTRACT

Introduction: The human prostate gland is a complex organ that consists of two main components – glandular and non-glandular. The first of them represents a compound of components of different origin, structure, location, and complexity of spatial organization. Their stereomorphology and microanatomical interrelations remain understudied for a number of reasons.

The aim: The objective of the research was to study the stereomorphological features of the glandular component of the peripheral zone of the prostate in view of its zonal structure concept.

Materials and methods: The material for the study was the glandular zone of the human prostate, which corresponds to the peripheral zone of the prostate according to the classification (Mc.Neal J.E., 1988). The following methods were used in the study: histological (4 mkm thick paraffin sections), microscopic (light microscopy using the Olympus BX-41 microscope), stereomorphological (obtaining waxed model reconstructions based on graphic ones). The study was conducted on 10 isolated prostate preparations (10 series of 50 preparations in each) taken from the deceased men without changes in the organ under investigation. The prostate gland was fixed in a 10% solution of buffered formalin, followed by obtaining serial plane-parallel sections and staining with hematoxylin and eosin according to the conventional technique.

Results and conclusions: The ducts of the glands of the peripheral zone of the human prostate normally have recurrent luminal dilatations, which, like the multi-cavity terminal portions, can serve as a place for depositing a secret.

The ducts of the peripheral zone glands, with the exception of the main duct, visually differ little in diameter. Their walls and walls of intra-acinar cavities are lined with homologous epithelial cells. Therefore, there is no clear morphological boundary between the transfer of the terminal portion to the duct and from one excretory duct to the other.

KEY WORDS: human prostate gland, peripheral zone, stereomorphology, duct-acinar system

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INTRODUCTION

The paper has been written within the research scientific work, carried out at the Department of Human Anatomy of the Higher State Educational Establishment of Ukraine “Ukrainian Medical Stomatological Academy”, entitled “Age-related aspects of the structural organization of the organs of the human immune system, glands of gastrointestinal and urogenital system in normal condition and pathology”; State registration number 0116U004192.

The human prostate gland is a complex organ that consists of two main components – glandular and non-glandular. The first of them represents a compound of components of different origin, structure, location, and complexity of spatial organization [1, 2]. Their stereomorphology and microanatomical interrelations remain understudied for a number of reasons [3, 4].

THE AIM

The objective of the research was to study the stereomorphological features of the glandular component of the peripheral zone of the prostate in view of its zonal structure concept.

MATERIALS AND METHODS

The material for the study was the glandular zone of the human prostate, which corresponds to the peripheral zone of the prostate according to the classification (Mc.Neal J.E., 1988) [5, 6]. Ten isolated prostate preparations were taken from men who died from diseases that did not cause changes in the organ under investigation. The prostate gland was fixed in a 10% solution of buffered formalin, followed by obtaining serial plane-parallel sections and staining with hematoxylin and eosin according to the conventional technique [7]. The histological sections obtained along the plane parallel to the passage of the ejaculatory ducts and the distal prostatic urethra gave us the most informative spatial representation of the relations between the glands of the two main prostate zones – peripheral and central.

Ten series, each containing on an average 50 slices, were successively studied. The volumetric reconstruction was carried out by the method of multilayer wax model reconstruction based on graphic reconstructions. This method allowed obtaining enlarged models of the studied structures, which, in turn, provided an overview of the shape, size, internal relief of the organ, and the features of the lumens of both the terminal and excretory ducts.

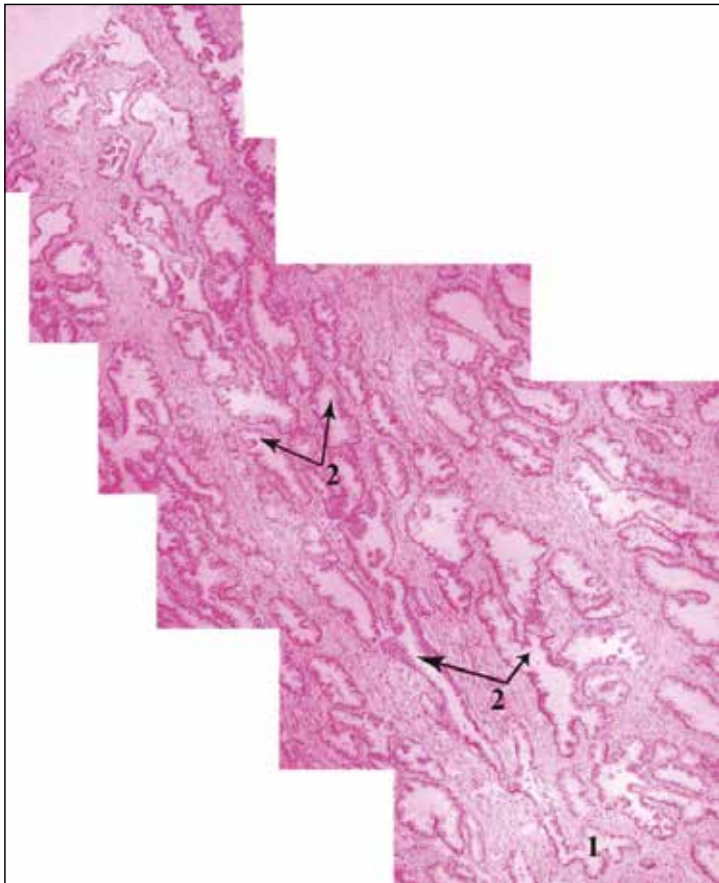


Fig. 1. Photo reconstruction of the central duct and its branches in the peripheral zone of the prostate. Staining with hematoxylin and eosin. Magnification: objective 40x, eyepiece 10x: 1 – central duct; 2 – branching of the central duct.

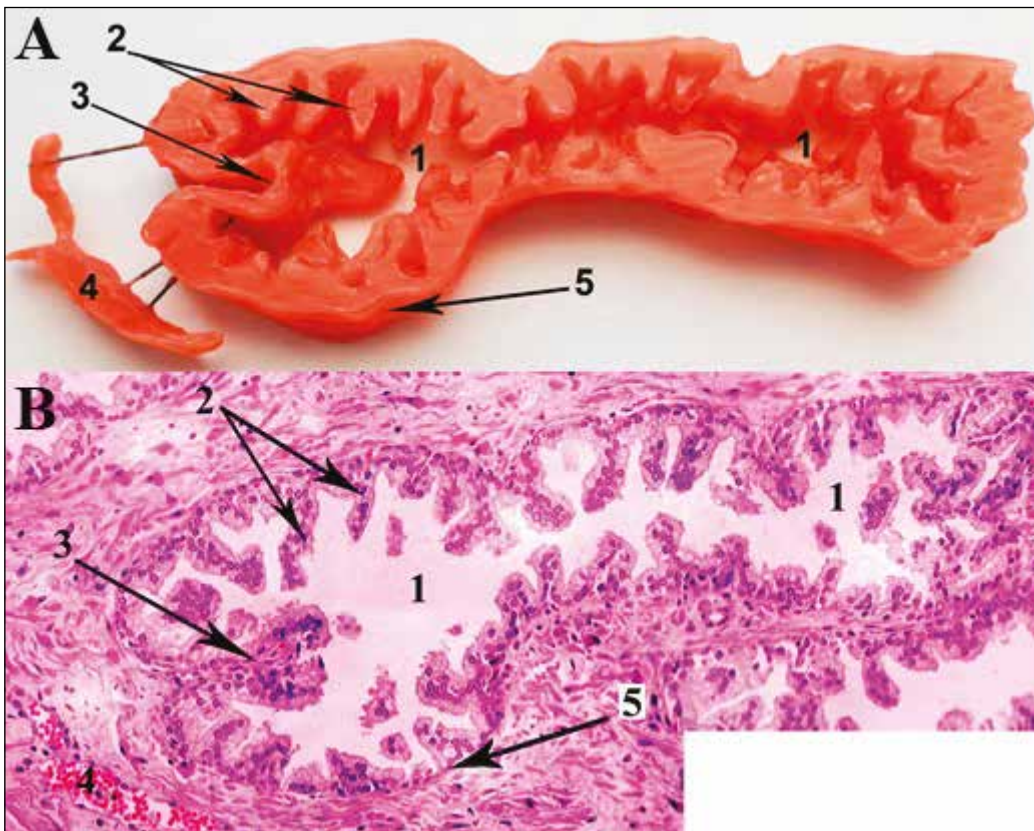


Fig. 2. Wax model reconstruction of the lateral ducts in the main gland of the peripheral zone of the prostate. A – a wax model 3D reconstruction. Linear 400x magnification. B – one of the serial sections used to make 3D reconstruction. Staining with hematoxylin and eosin. Magnification: objective 40x, eyepiece 10x: 1 – luminal contour; 2 – folds of the epithelium; 3 – wall invagination; 4 – venous microvessels; 5 – outer contour

RESULTS

Several glandular zones are found in the human prostate. Each of them spatially relates to a segment of the prostatic urethra. According to the data obtained, the excretory ducts of the glands of the peripheral zone on slices, which were made in the horizontal plane of the section, are located and formed within its limits along the length from the capsule towards the distal urethra. Smaller ducts that form them approach them both from the front and from the rear, and visually the front “inflows” are somewhat larger in their length and diameter than the ducts approaching from the dorsal side. Groups of ducts, as a rule, are located along the central excretory duct from the urethra up to the capsule (Fig. 1.).

In turn, smaller ducts are localized at an acute angle, their branches spread only a short distance, giving rise to groups of terminal portions with a homogeneous density of their arrangement in space.

Analyzing the serial sections of the peripheral zone of the human prostate, it can be argued that the formation of the main excretory ducts of the prostate directly flowing into the urethra or merging before it in pairs, and then flowing into it, resemble the construction and principle of the formation of the main excretory duct of the pancreas [4]. In contrast to it, the entire duct-acinar system looks very complicated within the peripheral zone of the human prostate, mainly due to the terminal portions with diverse shape and size. They can be visualized on sections as simple (single) enlargements of the epithelial tube with one rounded cavity of a sufficiently large volume – up to very complex multi-chamber formations. On the slices, depending on whether the terminal portion gets into this or that plane of the section, it may look different, for example, in the form of sufficiently narrow slit-shaped intra-acinar cavities connected with each other. Such a complex configuration of the luminal contour of the terminal portion is due to a certain number of folds of their epithelial lining and invaginations of the wall. It can contain a stromal-muscular component. It should also be noted that these formation can reach 2/3 of the width of the lumen and their parts are often localized in different planes with respect to the plane of the slice, thus they appear isolated from the fold or invagination in the lumen.

Between the extreme forms of the terminal portions, there are other more or less complex, in particular, two-cavity, three-cavity terminal portions, which are integrated with a single excretory duct. Integrating terminal portions are usually very short. Depending on the spatial orientation, they and their terminal portions fall into the plane of the section with their different sides, indicating a certain “chaotic” spatial order in the volume of this prostate zone. Their dense location within the individual gland and very close relations of the glands with each other in the peripheral zone of the prostate greatly complicate the task of revealing the regularity of their three-dimensional organization. This problem, as our experience shows, is successfully solved using the methods of 3D reconstruction based on serial histological sections [8, 9]. The spatial

organization of the glandular duct system of the peripheral zone, especially of small caliber, is also quite complicated in visualization, which number is very large even in one field of view. Such ducts cannot be reliably microscopically differentiated, since they have approximately the same caliber, identical histological wall arrangement and equal extent. Those ducts that are localized in the immediate vicinity of the central excretory ducts are the most easily differentiated (Fig. 2).

It should also be noted that there is no clear anatomical classification of excretory ducts of the human prostate, for example, similar to other compound glands [4, 5]. Their constantly occurring extensions can be interpreted by pathomorphologists as cystic changes. It is necessary to say that we earlier described such extensions and narrowing of the lumen of the excretory ducts under the normal conditions by the example of salivary and lacrimal glands of an adult [10].

DISCUSSION

The domestic scientific literature does not contain scientific data that are obtained after the system analysis of the structure of the human prostate. Many questions remain understudied due to the complexity of morphological techniques and large labor costs. This, in the first place, concerns the study of the structural hierarchy of glandular components (the system of excretory ducts and terminal portions of the prostate). The cellular composition of the wall of excretory ducts and the degree of their participation in the mechanism of secretion, its progress along the ducts, and the mechanism of excretion require further study. The spatial (three-dimensional) organization of the circulatory microvasculature of the human prostate and the interrelations of its variously distinctive links with excretory ducts are of practical interest. To clarify the mechanism of secretion along the duct, it is important to regard it, from the point of view of physics, as a “closed system” having one or more holes on the surface of the mucosa. The mechanisms and conditions due to which a viscous prostatic fluid moves and is excreted from such a “labyrinth” as the highly branched system of excretory ducts of the prostate gland. In turn, the features of the spatial architectonics of the system of excretory ducts and their hemocirculation can influence this process. The solution of these problems, as follows from the above, has both theoretical and practical interest and significance.

Today, there is a zonal concept of the human prostate structure, which is based both on the visual differences in anatomical structures and their heterogeneity and on the histospecificity of its diseases [2, 6]. The glands of the peripheral zone of the human prostate are undoubtedly of the greatest interest, as they form the main part of its glandular tissue and not morphological analogs in women. The peripheral zone glands normally undergo the most significant morphofunctional changes during the whole ontogenesis, and thus they are of undoubted interest in the period of morphological maturity and the greatest functional activity, i.e. in men of young and middle age

(WHO). The localization of the glands under investigation is the glandular zone of the prostate, which is formed by numerous individual glands that are usually localized subcapsularly in its posterior and lateral regions at different distances from the prostatic urethra where the opening of the excretory ducts is found on its surface. Their number, together with the intramural glands, is more than three dozen (obviously, it gave birth to the idea of the number of prostate glands – 30-50).

The problem of the morphological support of human prostate functions was paid great attention in the last decade. Especially it concerns the formation of the secret, its process along ducts, changes in osmotic concentration, quality and composition [4]. Qualitative changes in the composition of the prostatic secretion along with the hyposecretion, a violation of the mechanism of fluid excretion along the ducts, stagnant phenomena and organic lesions of the glands trigger the development of many diseases of the prostate [11].

We have obtained the necessary information using the combinations of traditional morphological methods and modifications thereof [7, 8, 9, 12, 13], a thorough and comprehensive analysis of available scientific literature and consideration of the fundamental provisions of modern morphology and medicine.

CONCLUSIONS

Glands of the peripheral zone of the prostate have a tubular-alveolar structure, their terminal portions can contain one to several small rounded cavities – multi-cavity terminal portions representing a considerable volume for the secretion.

Within the glandular zone, the main excretory ducts are central in relation to the smaller ducts that enter them and lie along the length from the capsule to the distal urethral segment. They can merge in pairs before entering the urethra or open into it by themselves.

The ducts of the glands of the peripheral zone of the human prostate normally have recurrent luminal dilatations, which, like the multi-cavity terminal portions, can serve as a place for depositing a secret.

The ducts of the peripheral zone glands, with the exception of the main duct, visually differ little in diameter. Their walls and walls of intra-acinar cavities are lined with homologous epithelial cells. Therefore, there is no clear morphological boundary between the transfer of the terminal portion to the duct and from one excretory duct to the other.

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