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ZONAL ANATOMY OF THE PROSTATE GLAND

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Annotation: The article provides a historical background, presenting the approaches of morphologists and radiologists to the issue of the lobar structure of the prostate gland. Given the confusion regarding the term “central zone”, it is proposed to avoid its use in the conclusions of magnetic resonance and ultrasound examination. It is recommended to use the division of the gland into 39 sectors only when describing an MRI study of the prostate performed in accordance with the recommendations of the PI-RADSv2 system.

Keywords: prostate gland, zonal anatomy, magnetic resonance imaging, ultrasound examination.

Introduction

When analyzing the conclusions formed based on the results of MRI studies of the male pelvic organs, which are posted in the Unified Radiological Information System, it was noted that the authors use an extremely wide range of terms characterizing the location of the detected changes in the prostate gland. The gland is divided into lobes, zones, parts, segments, sectors, regions, floors, thirds, ends, etc. This situation is largely determined by the historically established interest of researchers to leave their contribution to history by proposing a new classification of the gland structure. This led to significant confusion in the terms found in the conclusions, and as a result - to an incorrect interpretation of the data of the studies conducted.

History of the issue

There are many classifications of the lobar structure of the prostate gland. Urologists traditionally distinguish 3 lobes - 2 lateral and a middle [1]. However, there were also other classifications: division of the prostate gland into 5 lobes - anterior, posterior, middle and 2 lateral [2], into 6 lobes - 2 posterior, 2 internal and 2 lateral [3]. Currently, the most common is the zonal anatomy of the prostate gland, developed by JE McNeal in 1981 [4]. He identified 4 glandular zones (central, peripheral, 2 transitional) and 4 fibromuscular layers (anterior fibromuscular stroma, preprostatic sphincter, longitudinal smooth muscle fibers of the urethra and postprostatic sphincter). A schematic representation of the location of the gland zones is shown in Fig. 1 and 2.

Based on the characteristics of the prostate radiographic picture, the classification proposed by MD Rifkin et al. in 1990 [5] is of particular interest. According to it, the prostate gland is divided into 3 parts. The anterior part corresponds to the fibromuscular stroma according to the classification

JE McNeal. This fibrous zone is practically not visualized by TRUS and, since it does not contain glandular tissue, does not play a role in the development of hyperplasia or prostate

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cancer. The “outer gland” or the external part of the gland is a combination of peripheral and central zones. The “inner gland” or the internal part of the gland includes transition zones, the zone of periurethral glands and the zone of muscle layers of the internal sphincter of the urethra. It would seem that this classification most logically defines the structure of the prostate gland used to analyze echographic and MR images (Fig. 3), but it has not managed to gain wide distribution in practical work. One of the reasons is the inconvenience of the terms themselves - “inner” and “outergland” and the difficulty of translating them into Russian. We proposed to translate the terms “inner” and “outergland” as the internal and external parts of the gland (see above), which could lead to greater uniformity in the conclusions [6].

As for MRI diagnostics of prostate cancer, an International Working Group was formed in 2007 to standardize it. The result of its work was the PI-RADS (Prostate Imaging and Reporting and Data System), which was published as recommendations of the European Society of Urogenital Radiology (ESUR) in 2012 [7]. This system recommended using a scheme for dividing the prostate gland into a number of segments. However, in 2015, the second version of this system was published [8, 9]. This version proposes to describe the localization of the suspected tumor based on the zonal anatomy according to McNeal and dividing the gland into thirds: base, middle third, apex. Accordingly, the location of the detected changes is tied to a scheme of 39 sectors: 36 sectors representing the prostate gland itself, as well as the seminal vesicles and the membranous part of the urethra.

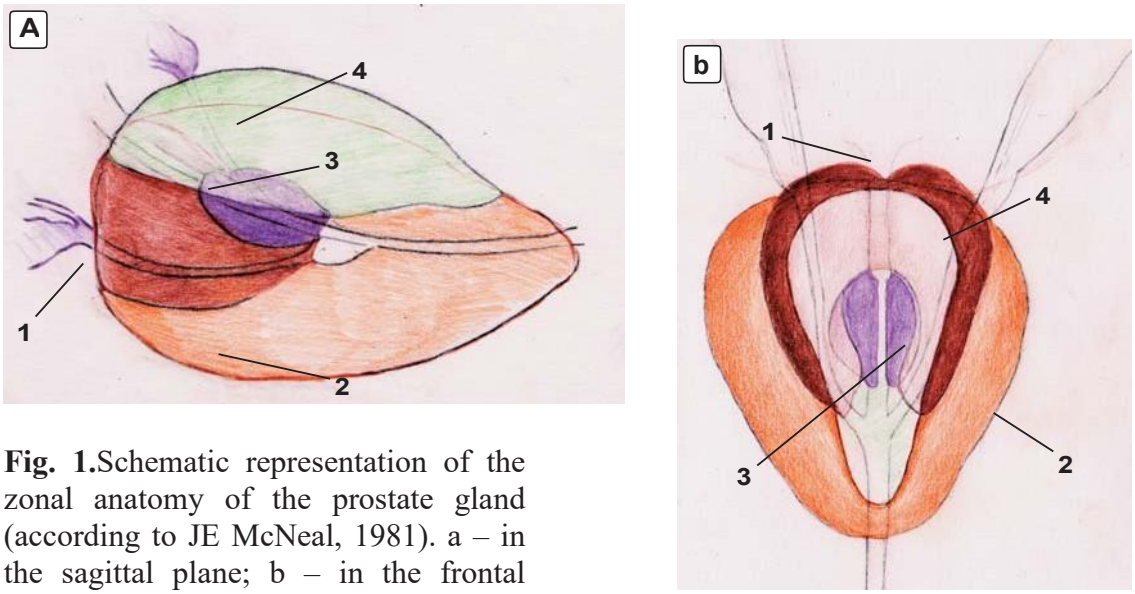

Fig. 1. Schematic representation of the zonal anatomy of the prostate gland (according to JE McNeal, 1981). a – in the sagittal plane; b – in the frontal (coronal) plane. 1 – central zone; 2 – peripheral zone; 3 – transition zones; 4 – anterior fibromuscular zone.

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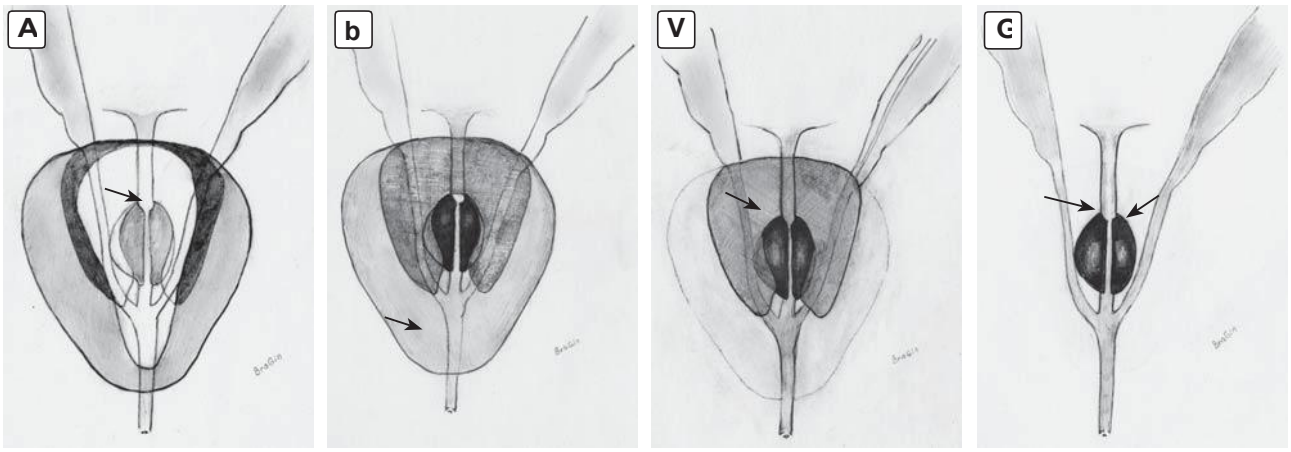

Fig. 2. Schematic representation of the zonal anatomy of the prostate gland (according to JE McNeal, 1981) in the coronal plane, the zones indicated by arrows are sequentially "removed". a – all zones of the gland are presented (arrow – anterior fibromuscular stroma); b – arrow – peripheral zone; c – arrow – central zone; d – arrow – transition zones.

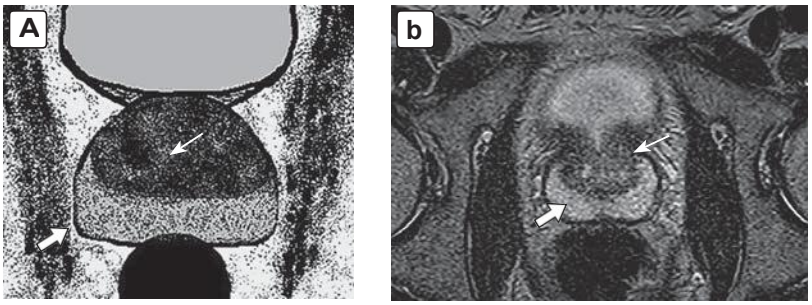

Fig. 3. Division of the prostate into parts. a – schematic image; b – T2-weighted MR image, axial plane; c – transverse TRUS image. Arrow – external part of the gland; thin arrow – internal part of the gland.

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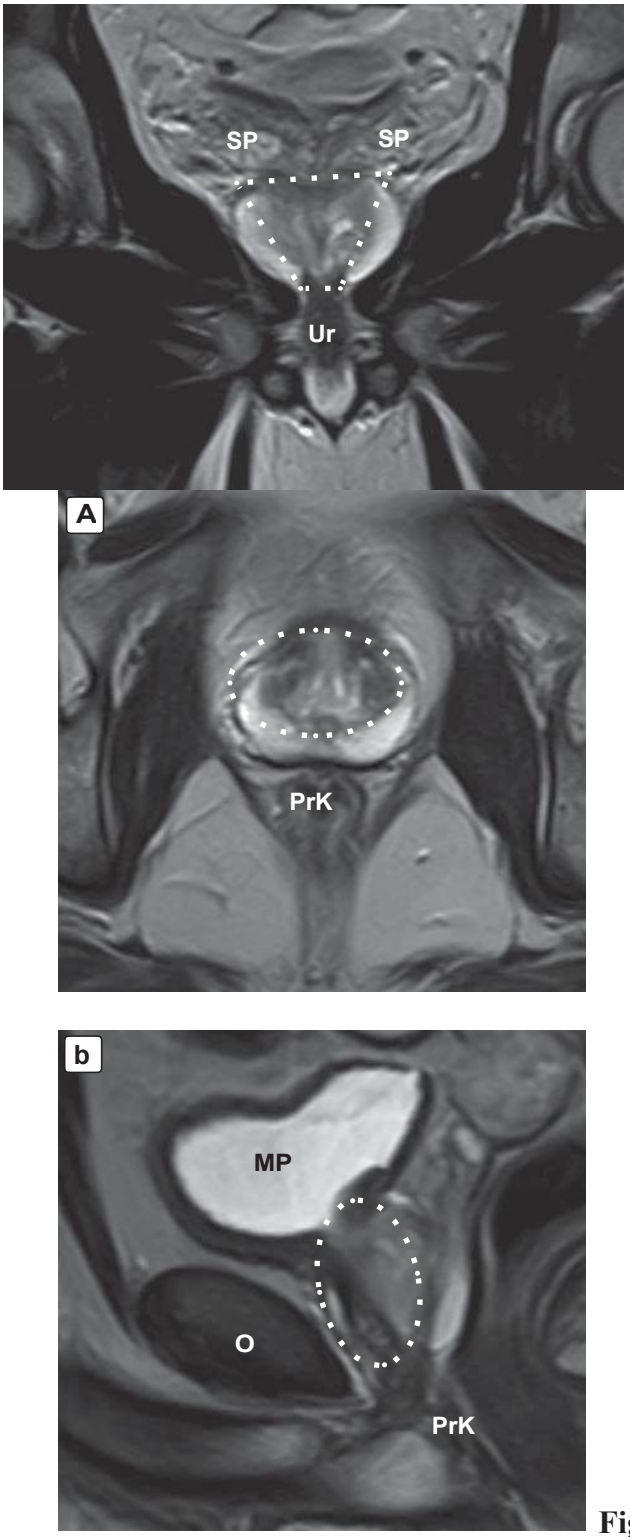

Fig. 4. Zonal differentiation of the prostate on normal T2-weighted MR images. a – axial plane; b – sagittal plane. Transitional zones are outlined by a dotted line. UB – urinary bladder; RB – rectum; LB – pubic bone

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Fig. 5.T2-weighted MR image of the prostatein the coronal plane. The central zone has the form of a cone directed from the base of the gland to the seminal tubercle (highlighted by the dotted line). SP – seminal vesicles; Ur – membranous section of the urethra.

Discussion

The main problem, in our opinion, is the misunderstanding of the term "cent""central zone of the gland". Many reports of practicing ultrasound and MR diagnostics specialists, moreover, in scientific publications describe changes in the central zone of the prostate gland, implying their localization in the transitional zones. The reason for this error is that the transitional zones, which have a reduced MR signal intensity on T2WI, are located on axial sections as if in the center of the prostate gland and are surrounded by a peripheral zone with a high signal intensity on T2WI (Fig. 4). The true central zone (according to the McNeal classification) can be identified almost only in young patients with no pronounced benign hyperplasia when scanning in the coronal plane. According to the PI-RADSv2 system, it is "the tissues of the gland surrounding the ejaculatory ducts from behind and above, from the base of the gland to the seminal tubercle; it has the shape of an inverted cone, with the base directed toward the base of the gland; contains more stroma than glandular tissue" (Fig. 5). At the same time, the same PI-RADSv2 system postulates that cancer affecting the central zone is a tumor spread from the peripheral zone. Thus, in practical work, examining patients mainly of middle and older age groups, in the presence of benign prostatic hyperplasia, we are unable to differentiate the "true" central zone of the prostate gland. However, if such a study is carried out in accordance with the PI-RADSv2 recommendations, then this system itself offers a solution to this terminological dispute.

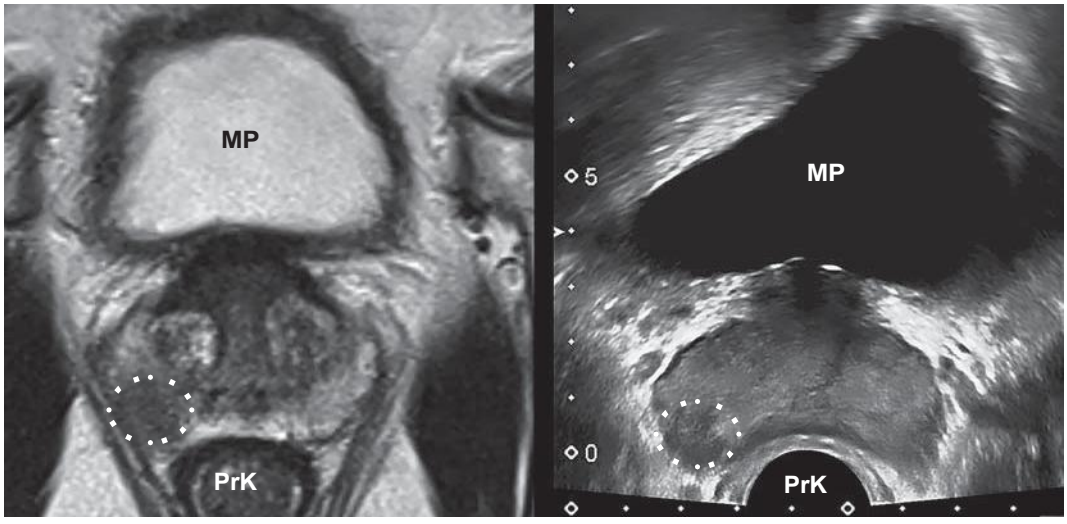

Fig. 6. Combined MR-TRUS image obtained using Fusion technology. The tumor lesion in the peripheral zone of the right lobe at the level of the middle third of the gland is outlined in oval. a – T2-weighted MR image in oblique axial plane. There is a clear differentiation of the prostate gland into peripheral and transitional zones; b – transrectal ultrasound scanning of the prostate in the transverse plane. The peripheral and transitional zones have similar

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echogenicity and structure. The border between them is a faint hypoechoic band. UB – urinary bladder; RC – rectum.

By using the proposed 39 sectors to localize pathological foci, we stop using the usual terms based on zonal anatomy, and, finally, we can agree on the uniformity of indications of the topic of detected changes in the prostate gland.

However, it should be taken into account that a significant part of MR examinations of the pelvis in men is aimed at detecting tumors in the bladder or rectum. The protocols for such studies, naturally, do not meet the requirements of the PI-RADSv2 system and we have no right to use the recommended division of the gland into 39 sectors. The same situation occurs with ultrasound examinations; it is not possible to divide the prostate gland into 39 segments due to the peculiarities of the echographic image. Moreover, in transrectal ultrasound images, only the boundaries of the transition zones can be seen in the structure of the prostate gland, although not as clearly as in MRI (Fig. 6). It is almost impossible to differentiate the "true" central zone from the peripheral one, since both, as a rule, demonstrate a similar level of echogenicity. Therefore, there is a need to have a unified approach to topical diagnostics in the prostate gland, different from the PI-RADSv2 recommendations.

Conclusion

When describing images of the prostate gland, we propose the following approach:

- when describing an MRI examination of the prostate performed in accordance with the PI-RADSv2 system, be guided by the localization of pathological foci in 39 sectors;
- When describing MRI studies that do not meet the requirements of the PI-RADSv2 system (for example, pelvic examinations for neoplasms of the bladder or rectum), as well as TRUS, we propose using the following system for localizing pathological changes:
  - base, middle third and apex of the gland;
  - right and left lobes of the gland;
  - peripheral and transitional zones;
- To avoid confusion regarding the term "central zone", we propose to avoid it altogether in the conclusions of both magnetic resonance and ultrasound examinations.

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