Urological Research 5, 163-167 (1977)

Urological Research

ORIGINALS

The Zonal Anatomy of the Prostate in Man and in the Rhesus Monkey (Macaca Mulatta)

N. J. Blacklock and K. Bouskill

Royal Naval Hospital, Haslar, U.K.

Received: April 18, 1977

Summary. Study of whole sections of human prostate has confirmed McNeal's (4) concept of a dual morphology of the external glands (2) in the terms of a central zone cranially and a peripheral zone caudal to this. A study of the non-human primate, Macaca Mulatta, has shown cranial and caudal prostatic entities in this animal whose anatomical relationships and histological characteristics suggest homology with the central and peripheral zones of the human.

Key words: Prostate - Morphology - Human - Monkey - Central zone - Peripheral zone.

THE HUMAN PROSTATE

McNeal (4), in describing the anatomical subdivisions of the parenchyma of the functional prostate, or external glands (2), designated these as "zones" and in so doing helped to distinguish normal anatomy from areas of focal pathology within the gland. These zones are identified both by morphological differences and by differential susceptibility to inflammation, degeneration and neoplasia. He defined two subdivisions of the prostate which are comparable in many respects with those described by Hutch (3). The central zone is a wedge of glandular tissue of variable size with its apex at the verumontanum and its base superiorly behind the bladder neck. In contrast to other descriptions, however, this zone surrounds the common ejaculatory ducts and distal extremities of the vas deferens and ducts of the seminal vesicles (1). The acini of the central zone constitute the base of the prostate whilst those of the peripheral zone caudally form the remainder of the parenchyma and partially enclose the apex or lower part of the central zone. The central zone comprises about one third of the external gland mass.

THE PROSTATE OF THE NON-HUMAN PRIMATE

Price (6) described the monkey prostate as lying entirely on the dorsal aspect of the urethra and neck of the bladder (Fig. 1) and having two discrete lobes. The cranial entity had a furrowed surface which closely resembled that of the seminal vesicles in external appearance. The caudal lobe was smooth on its external surface and again lay on the dorso-lateral aspect of the urethra (Figs. 2, 3, and 4). Price noted that the two lobes differed histologically. Van Wagenen (8) found the secretion from the cranial lobe to coagulate the secretion of the seminal vesicles and in this respect it appeared to have similar properties to the secretion of the coagulating gland of the rodent. Schoonees et al. (7) in describing a similar general anatomy in the baboon, found differential zinc concentration between the two parts of the gland. There was a significantly greater concentration of zinc in the caudal lobe and, furthermore, both castration and exogenous testosterone appeared to influence the zinc content of the caudal entity more than that of the cranial. More recent work has shown very high acid phosphatase content of the caudal lobe of the baboon prostate and greater susceptibility of this lobe to antiprostatic drugs (5).

MATERIAL AND METHODS

The bladder, prostate and membranous urethra were removed from human cadavers at post-mortem in various age ranges. The bladder, seminal vesicles, prostatic complex and upper urethra were removed from 13 rhesus monkeys

Fig. 1. Cross section of rhesus monkey prostate

(Macaca mulatta), both mature and immature, under terminal anaesthesia. Specimens were sectioned in the fresh condition either in the coronal or sagittal plane and fixed in formol-saline. Whole histological sections were made and stained with a variety of tissue stains.

RESULTS

The Human Prostate

There was confirmation of McNeal's description both in sagittal (Fig. 5) and coronal (Fig. 6) sections of the prostate. A cranial zone corresponding with McNeal's central zone was defined occupying the base of the gland behind and below the bladder neck and enclosing the common ejaculatory ducts, terminal vas deferens, ducts of the seminal vesicles and the utriculus masculinus. The demarcation between this zone and the peripheral zone caudally was sometimes well-defined by a condensation of fibromuscular stroma (Fig. 6).

Before puberty, the central and peripheral zone acini are morphologically indistinguishable and consist of simple straight tubules, widely separated by a coarse fibromuscular stroma and lined by a stratified cuboidal epithelium. Following puberty, the acini in the two zones develop distinct histological differences.

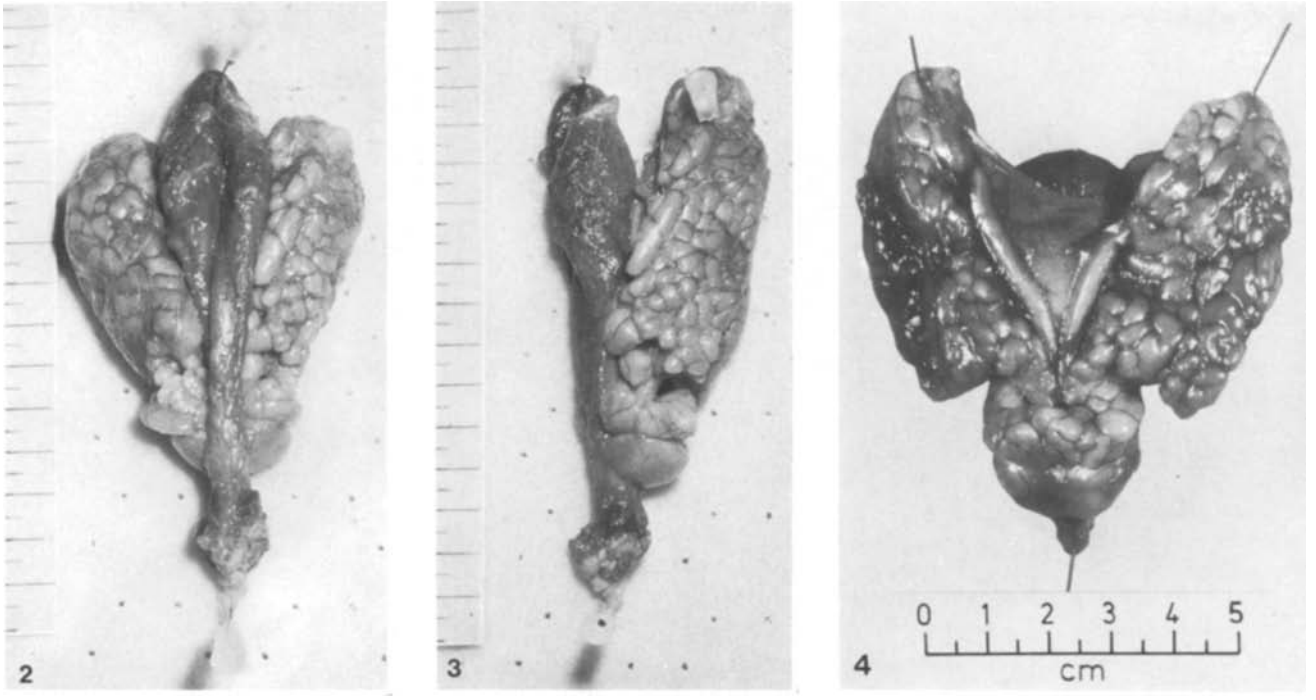

Fig. 2. Anterior view of bladder, urethra, seminal vesicles and prostate of rhesus monkey
Fig. 3. Lateral view of bladder, urethra, seminal vesicles and prostate of rhesus monkey
Fig. 4. Posterior aspect of bladder, urethra, seminal vesicles and prostate of rhesus monkey

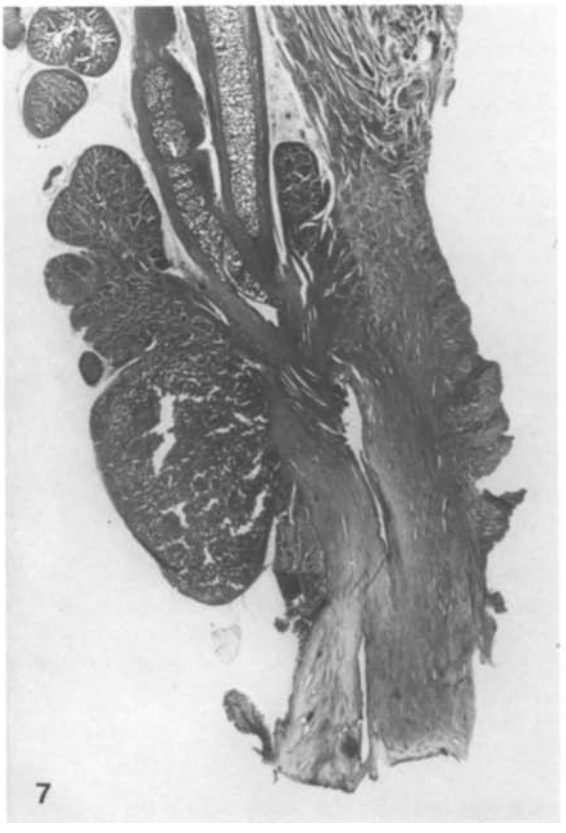

Fig. 5. Human prostate, sagittal section. Van Gieson

Fig. 6. Human prostate, coronal section. H & E

Fig. 7. Rhesus monkey prostate, sagittal section. Van Gieson

Fig. 8. Rhesus monkey prostate, coronal section. H & E

The acini in the central zone become large and angular with a complex, mixed cribriform and papillary pattern similar to the pattern of the seminal vesicles. Several acini are grouped together and separated from adjacent groups by a coarse, fibromuscular stroma (Fig. 9).

The acini of the peripheral zone are much

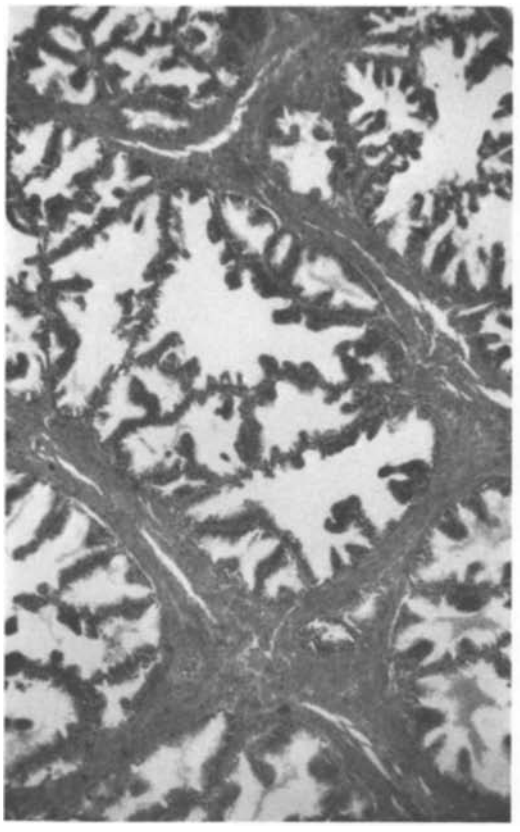

Fig. 9. Human prostate, acini of central zone. H & E

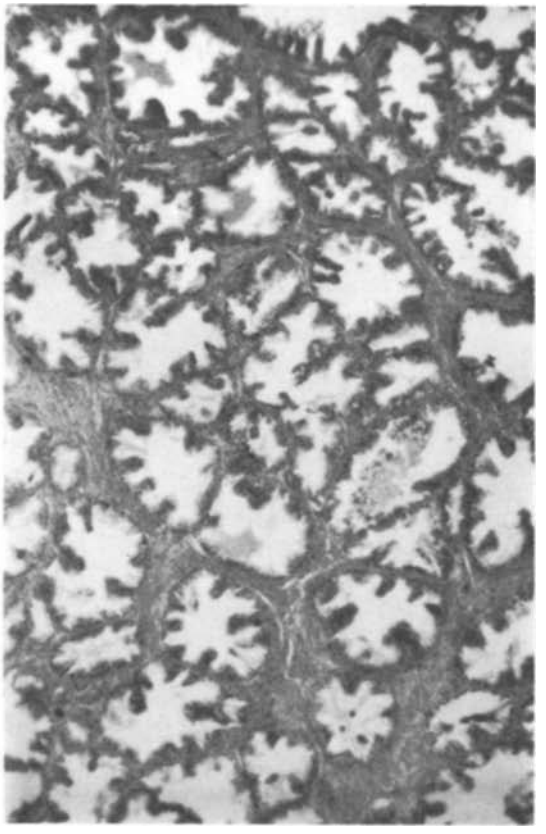

Fig. 10. Human prostate, acini of peripheral zone. H & E

smaller with a more regular, simple, tubular appearance and less papillary infolding of the epithelium. They are not grouped together and each acinus is separated from its neighbour by a delicate, fine fibromuscular stroma (Fig. 10).

The epithelium lining both types of acinus is too variable to allow distinction between the two zones and varies from a single-layered cuboidal epithelium to a stratified, tall columnar epithelium in either zone.

In serial coronal sections forward from the posterior surface of the gland to the mid-urethral plane there was the appearance of a further subdivision of the central zone into right and left halves by its enclosure of the common ejaculatory ducts and utriculus masculinus.

This study in the human therefore confirms McNeal's description of the morphology of the parenchyma of the external glands or functional prostate in the terms of central and peripheral zones.

The Prostate of the Rhesus Monkey (Macaca Mulatta)

In the dissection of material removed from the rhesus monkeys, there was confirmation that a capsule invested both entities of the prostate and the urethra and a loose capsule bound the cranial prostate to the seminal vesicles. The surface of the cranial lobe was deeply furrowed and in this respect resembled the seminal vesicles. The caudal lobe was more closely applied to the urethra than the cranial lobe and had a smooth surface (Figs. 2, 3 and 4).

The cranial lobe could be easily separated from the seminal vesicles above (Figs. 3 and 4). It was found to surround the terminal vas deferens and the duct of the seminal vesicles of each side as these passed downwards and forwards to the urethra. It could be separated from these structures with ease and also from the urethra in front. There was anatomical separation between the cranial and caudal lobes peripherally but antero-medially the tissues of the two lobes merged where the ducts from the cranial lobe in company with the common ejaculatory ducts penetrated the flat upper surface of the caudal lobe before passing through the wall of the urethra at the level of the verumontanum.

Large histological sections both in the sagittal and coronal planes confirm these gross findings (Figs. 7 and 8).

The histological appearance of the cranial and caudal lobes is quite different. The acini in the

cranial lobe consist of large, irregular branching tubules with a prominent fibromuscular stroma which widely separates individual acini. The acini are lined by tall columnar stratified epithelium with strongly eosinophilic cytoplasm and dense basal nuclei with their long axis at right angles to the basement membrane.

The acini in the caudal lobe are much smaller and consist of simple tubules with a regular appearance overall. The fibromuscular stroma is more delicate and individual acini are in close proximity to each other. The acini are lined by a single layer of cuboidal or low columnar epithelium with pale eosinophilic cytoplasm and vesicular basal nuclei with their long axis parallel with the basement membrane.

The seminal vesicle is morphologically identical to that in the human and has a complicated papillary pattern.

CONCLUSIONS

This study of the parenchyma of the human prostate confirms McNeal's concept of a dual morphology of the external glands represented by the central and peripheral zones which he described. There is a direct comparison with the prostatic complex of the monkey, the cranial lobe of the monkey having features in common with the central zone of man, the monkey caudal lobe resembling the human peripheral zone.

If homology can be further established, the monkey prostate may prove a convenient model for further studies and appears particularly suitable for the study of prostatic function.

Acknowledgements. This work has been supported by a grant from Schering Chemicals Limited, United Kingdom.

The authors are grateful to the Medical Officer in Charge, Institute of Aviation Medicine, Farnborough, U.K. for animal facilities and to Mr. James Cookson for expert technical assistance.

REFERENCES

1. Blacklock, N.: The morphology of the parenchyma of the prostate. Urological Research 5, 155 (1977)
2. Franks, L. M.: Benign nodular hyperplasia of the prostate; a review. Annals of the Royal College of Surgeons of England 14, 92 (1954)
3. Hutch, J. A.: Anatomy and Physiology of the Bladder, Trigone and Urethra. London: Butterworth 1972
4. McNeal, J. E.: Regional morphology and pathology of the prostate. American Journal of Clinical Pathology 49, 347 (1968)
5. Muntzing, J., Myhrberg, H., Saroff, J., Sandberg, A. A., Murphy, G. P.: Histochemical and ultrastructural study of prostatic tissue from baboons treated with antiprostatic drugs. Investigative Urology 14, 162 (1976)
6. Price, D.: Comparative aspects of development and structure in the prostate. National Cancer Institute Monographs 12, 1 (1963)
7. Schoonees, R., de Klerk, J. N., Murphy, G. P.: Correlation of prostatic blood flow with 65 zinc activity in intact, castrated and testosterone-treated baboons. Investigative Urology 6, 476 (1969)
8. Van Wagenen, G.: The coagulating function of the cranial lobe of the prostate gland in the monkey. Anatomical Record 66, 411 (1936)

N. J. Blacklock, M. D.
Royal Naval Hospital
Haslar, Gosport
Hants. P012 2AA
United Kingdom