REVIEW

The Morphology of the Parenchyma of the Prostate

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Considering recent progress in prostatic research, it is incongrous that there remains a lack of agreement both on the regional morphology of the prostatic parenchyma external to the fibromuscular periurethral stroma and on the terminology applied to it. Definition of both is fundamental as an essential precedent to a concept of the gland as a functional organ in reproduction and to the identification of homologous structures in the animals which are commonly used in ultrastructural, biochemical, histochemical and endocrine research.

The various interpretations of the regional morphology of the parenchyma are depicted in Figure 1. The subdivisions apply to the functional parenchyma lying outside the fibromuscular sleeve which is a direct downward continuation of the deep trigone and surrounds the upper part of the prostatic urethra down to the verumontanum.

This sleeve has been termed the preprostatic sphincter by McNeal (9) because of its sphincteric function at the time of ejaculation to prevent reflux of seminal fluid into the bladder. The mucous and submucous glands enclosed by this sphincter, the "inner" glands of Franks (3) (Fig. 2), are occluded during ejaculation and unlike the acini external to it, cannot be functional at this time. A difference in the structure of these inner glands was first noted by Lowsley (7) who compared their collagenous supporting stroma with the individual investment by smooth muscle of each acinus of the "external" glands (3). This observation suggests the function of the latter in expelling secretion at the time of seminal ejaculation. Whilst the inner glands have been identified either alone or in conjunction with the fibromuscular stroma of the preprostatic sphincter as the location of origin of benign nodular hyperplasia, they have no other recognisable clinical significance.

The glands external to the preprostatic sphincter form the bulk of the parenchyma and are disposed postero-laterally to the urethra below the bladder neck; they surround the terminal vas deferens, the duct of the seminal vesicles and the common ejaculatory ducts as these pass forwards towards the urethra. It is in the subdivision of these functional "external" glands that there is both morphological and terminological confusion at the present time.

Lowsley (7) defined a lobular arrangement of the adult prostate from the distribution of the primitive prostatic ducts in the foetus and described an anterior, middle, posterior and two lateral lobes but was unable to identify any obvious demarcation between the lateral and posterior elements. Huggins and Webster (4) in a study of the differential response of the prostatic parenchyma to hormone stimulation or withdrawal concluded that there was duality in this and described a posterior lamella (Fig. 1) which responded in a different manner to the remainder. Hutch (5), from dissections, described a posterior lobe which morphologically included both the posterior and lateral lobes of Lowsley and which surrounded the posterior three quarters of the urethra (Fig. 1). He also described a median lobe which he found to be inconstant and which lay beneath the bladder neck and above the ejaculatory ducts.

The use of the term "lobe" by both Lowsley and Hutch in descriptions of the anatomical subdivision of the external glands of the parenchyma must be considered in relationship to the custom of using a similar terminology to describe the pathological entities resulting from hyperplasia of the inner glands. In this respect, "lateral lobe hyperplasia" risks confusion with Lowsley's lateral lobes whilst the hyperplasia arising in the inner glands in the subcervical
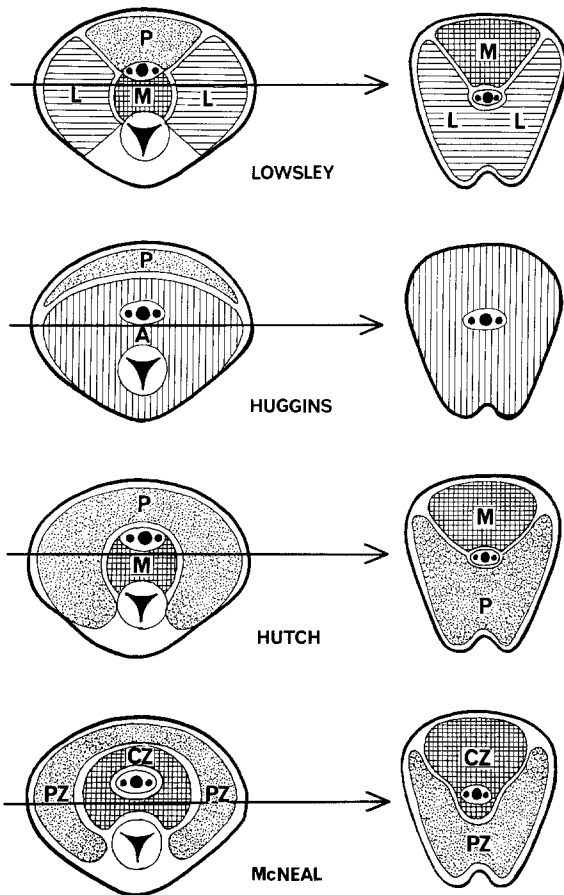
Fig. 1. The regional subdivision of the external glands of the prostate as described by Lowsley (7), Huggins and Webster (4), Hutch (5) and McNeal (8, 9).
Diagrammatic transverse sections of prostate above verumontanum and coronal sections posterior to the urethra.

Lowsley P - Posterior lobe
         M - Middle lobe
         L - Lateral lobe
Huggins P - posterior lamella
         A - remainder of gland
Hutch   P - Posterior lobe
         M - Median lobe
McNeal CZ- central zone
         PZ- peripheral zone

Fig. 2. Diagramatic transverse section of the prostate to show the inner and external glands (3) separated by the periurethral fibromuscular stroma of the preprostatic sphincter (9).

M - median, L - lateral lobes of inner gland seen and described endoscopically in benign prostatic hyperplasia

hyperplastic process and in whole-gland sections these can often be seen to remain substantially unaffected.

In their usage of lobar subdivisions to describe the anatomy of the parenchyma of the functional prostate external to the preprostatic sphincter Hutch and Lowsley have probably contributed to the tendency to regard the inner and external glands as a single homogeneous structure.

McNeal (8) by describing anatomical subdivisions of the functional prostate as "zones" differentiated normal anatomy from areas of focal pathology. The definition of these zones was made both on the basis of morphology and a variable susceptibility to disease. McNeal (8) commented on the importance of using planes other than the conventional transverse section to reveal differences between one part of the functional prostate and another. He used both sagittal and coronal sections and sectioned the gland also in a plane parallel with the ejaculatory ducts since this followed the long axis of the Wolffian duct system with which the function of the prostate is largely associated. Using these planes there appeared to him to be two subdivisions of the parenchyma of the external glands which were comparable in many respects with those described by Hutch (5) and broadly comparable with the original description of Lowsley (7) if his posterior and lateral lobes were considered as one. McNeal identified a central zone cranially as being histologically different in a number of respects from a peripheral zone which lay caudal to the central zone and partially enclosed the apex of its lower part (Fig. 1). The fundamental difference in his description from those of Hutch and Lowsley was that the central zone with its apex at the verumontanum and its base superiorly behind

region and called a middle or median lobe, tends similarly to be confused with the middle (7) and median (5) lobes of the external glands. Although there is considerable distortion of the intrinsic anatomy of the parenchyma when hyperplasia is present, the external glands have not so far been identified as taking part in the
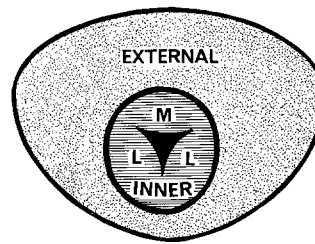
the bladder neck completely surrounded the ejaculatory ducts such that at no point did the peripheral zone come in contact with these in their course through the gland to the urethra. Tisell and Salander (12) have made a similar observation. McNeal found the central zone to comprise approximately one third of the external gland mass.

The morphological differences between the central and peripheral zones can be seen both grossly and microscopically in coronal and sagittal sections of the whole gland. The branching of the duct system in the central zone is more elaborate and its fibromuscular stroma is more prominent and well-defined. The acini are large and rectangular on cross section with prominent intraluminal partitions and the lining epithelium consists of multiple layers of darkly-staining cells. The peripheral zone has a finer stroma, a simpler form of duct branching and smaller, round acini which have a more regular epithelial lining with small, pale-staining cells. This zonal differentiation is best seen in coronal sections and in some of these a fibromuscular condensation separates the one from the other whilst in others the demarcation appears accentuated by linear cystic degeneration. The material in a personal series (1) has confirmed McNeal's description and there appears to be a tendency for the central zone to be further subdivided into right and left halves. This has also been noted by Tisell and Salander (12) using dissection methods and is of significance in the consideration of structures homologous with the central zone in the lower orders of animals.

Studies of the prostate of the non-human primate, Macaca Mulatta (2, 10) have revealed a gland with significant resemblance to the human as described by McNeal. Cranial and caudal lobe entities were found as has been previously described both in the monkey and baboon prostate but the disposition and relationships of the cranial lobe were observed to be identical with the human central zone of McNeal's description.

In the more available and commonly-used experimental animal, the rat, the prostate is less homogeneous and consists of ventral, dorso-lateral and cranio-dorsal entities which cannot be immediately identified with homologous structures in the human. On the basis both of the anatomical relationship of the cranial-dorsal lobes of the rodent prostate and a characteristic of its secretion in causing coagulation of seminal vesicular fluid there is similarity to the cranial lobe of the monkey. Extrapolation

from this may in due course allow a direct comparison between the craniodorsal lobe (coagulating gland) of the lower orders and the central zone in man. In respect of the high zinc concentration found in the lateral entities of the dorso-lateral lobe of the rodent there is similarity to the caudal lobe of the baboon (11) and the peripheral zone of the human (6).

There is substantial evidence that the morphological description of the parenchyma of the prostate defined by McNeal (8, 9) is representative and allows, perhaps for the first time, the recognition of homologous structures in lower animals. Both this and a general acceptance of the terminology which he has proposed can promote a clearer understanding of the gland and make more meaningful the animal research which is being carried out into its physiology and pathology.

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