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Anatomy of the Prostate from Fetus to Adult – Origin of Benign Prostatic Hyperplasia

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Summary. The anatomy of the prostate was studied in specimens from humans ranging from fetal age to 79 years. At all ages, the prostate can be divided into two zones, inner and outer. The distribution and relative size of the prostatic lobes is similar in the fetus and in the adult. In the fetus, the inner zone can be subdivided into lateral, subcervical, and anterior lobes and mucosal glands. The anterior and subcervical lobes usually disappear in prepuberty but may reappear in advanced age. The outer zone can be subdivided into the middle and posterior lobes. Benign prostatic hyperplasia arises from the lateral, subcervical, and anterior lobes of the inner zone and the middle lobe of the outer zone. It is suggested that previous investigators failed to describe a demarcation line or territory between the lateral and posterior lobes.

Key words: Prostate anatomy, Benign prostatic hyperplasia.

Benign prostatic hyperplasia (BPH) develops in a characteristic pattern in the two lateral lobes and the middle subcervical, anterior, and subtrigonal lobes of the prostate [4]. Lowsley [2] identified seven lobes in prostates of fetuses and newborns: two lateral and the middle, subcervical, anterior, subtrigonal, and posterior lobes. He stated that BPH arises from six of these (all except the posterior). Franks [1] and McNeal [4], however, did not identify seven prostatic lobes.

The anatomy of the fetal prostate is somewhat different from that of the adult, and questions remain about when the change in relative size of the prostatic lobes occurs during development. There are also questions about whether the origin of five characteristic patterns of BPH in six of the prostatic lobes can be explained from developmental and anatomic theories. We studied these problems in prostates from individuals ranging from fetal to advanced age.

Materials and Methods

We examined 25 prostates from autopsy, pathological, and radical cystectomy specimens. The specimens were from fetuses aged 22, 27, and 36 weeks and from boys and men aged 5, 15, 36, 38, 39 (two), 40, 41, 44, 49, 66 (two), 70, 73, 74, 75 (two), 77, 78 (three), and 79 years. Fetal prostates were cut in thin serial transverse sections; the other prostates were similarly cut in serial sections with various orientations (transverse, clockwise sagittal, coronal, oblique coronal). The sections were mounted and stained with hematoxylin-eosin or trichrome stain and examined by light microscopy. Results from examination of the different types of sections were compared.

Results

Clockwise sagittal and oblique coronal sections were particularly useful for distinguishing the middle lobe from the posterior lobe. Frequently it also was possible to distinguish the middle from the posterior lobe in transverse sections. Therefore we primarily used transverse and clockwise sagittal sections for this study. The prostates were divided into three groups according to stage of development: fetal through prepuberal, post-puberal, and advanced age.

Fetal and Prepuberal Stage

The study material comprised three fetal prostates and one specimen from a five-year-old boy.

The inner and outer zones are clearly distinguishable in these specimens (Fig. 1). The inner zone can be further divided into two lateral lobes, the subcervical and anterior lobes, and mucosal glands (Fig. 2, 3). The outer zone can be divided into the middle and posterior lobes (Fig. 4). The acini of the inner zone are wrapped by the circular and longitudinal fibromuscular stroma. The anterior longitudinal muscle (the anterior fibromuscular stroma) covers the inner gland and contains part of the acini of the inner zone anteriorly and laterally. Part of this muscle lies between the inner

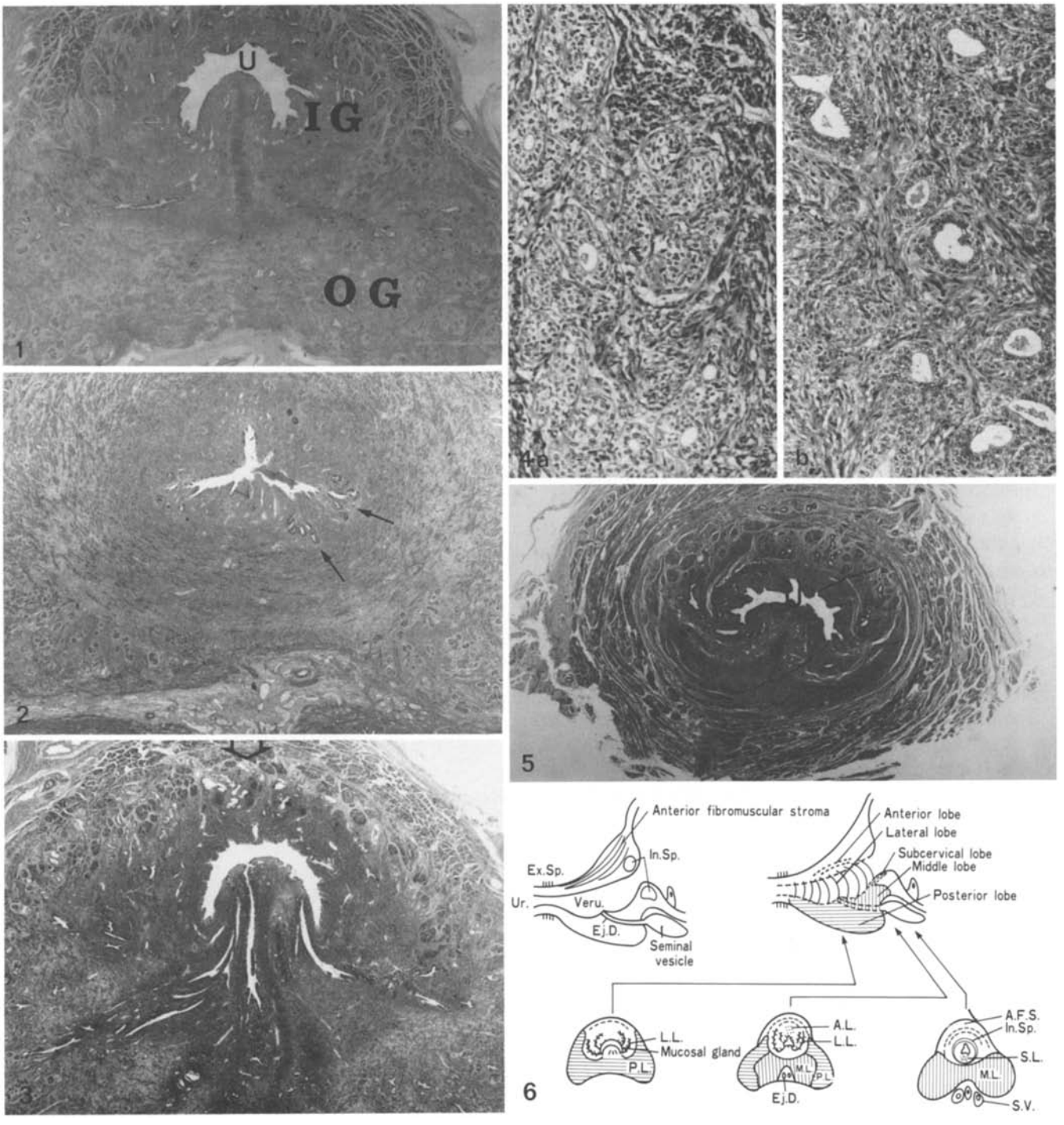


Fig. 1. Transverse section in a 36-week-old fetus. The fetal prostate is divided into two zones, the outer glands (*OG*) and the inner glands (*IG*). *Ut*, urethra. (Hematoxylin-eosin stain, x8.1)

Fig. 2. Subcervical prostatic lobe (*arrows*) of a 36-week-old fetus. Transverse section at the bladder neck. (Hematoxylin-eosin stain, x8.1)

Fig. 3. Anterior lobe (*arrow*) of a 27-week-old fetus. (Hematoxylin-eosin stain, x8.1)

Fig. 4a, b. Sagittal sections at 7 o'clock position, of prostate from a 5-year-old boy. **a** Middle lobe; **b** Posterior lobe. (Hematoxylin-eosin stain, x81)

Fig. 5. Transverse section in a 36-week-old fetus at the apex of the prostate. The zone of the inner glands is present, but the zone of the outer glands is not recognizable at the apex. (Hematoxylin-eosin stain, x8.1)

Fig. 6. Schema of prostatic anatomy. The prostate can be divided into the lateral, anterior, and subcervical lobes and mucosal glands in the zone of the inner glands, and the middle and posterior lobes in the zone of the outer glands. *Ex.Sp.*, external sphincter; *In.Sp.*, internal sphincter; *Ur*, urethra; *Veru*, verumontanum; *Ej.D.*, ejaculatory ducts

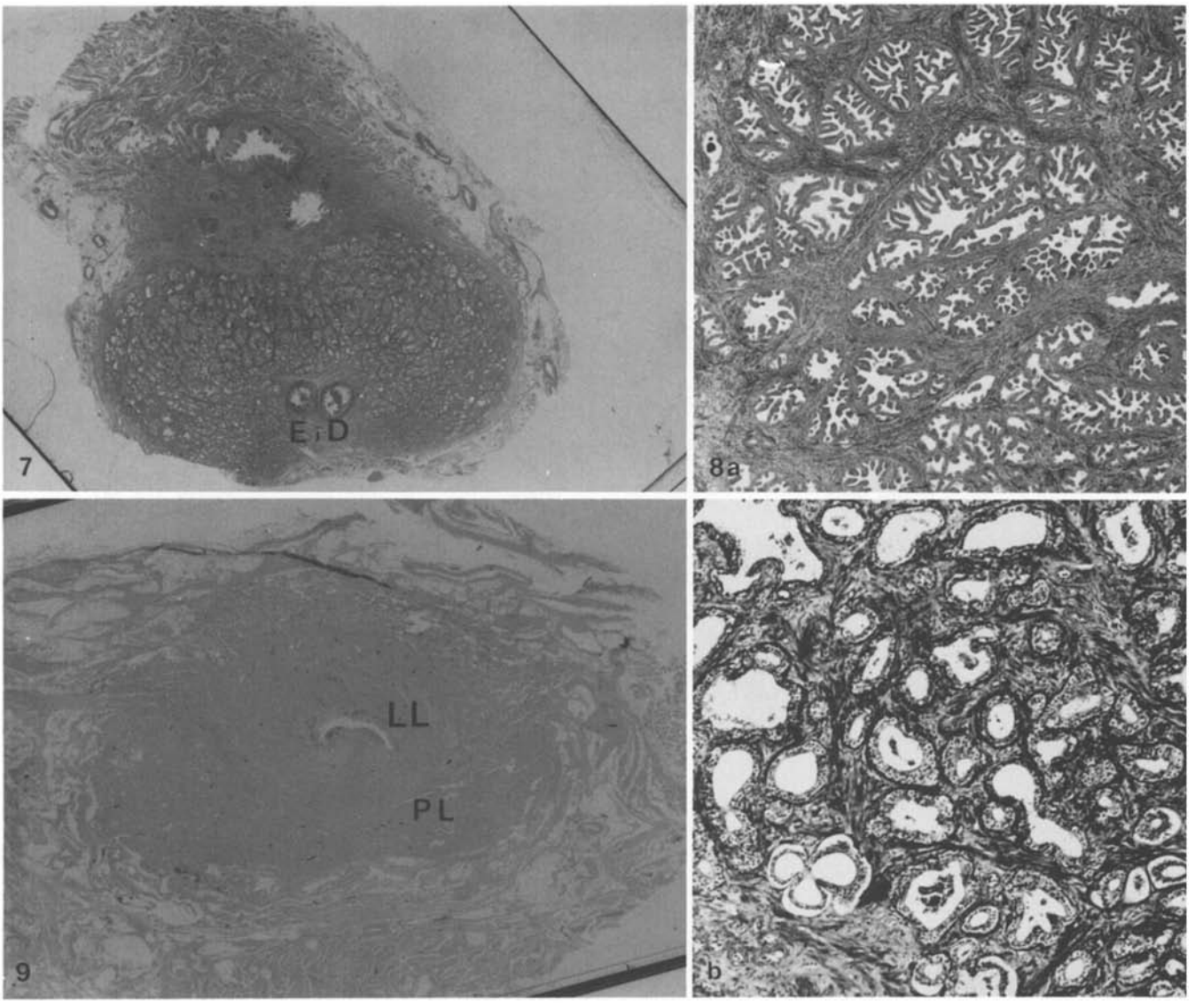


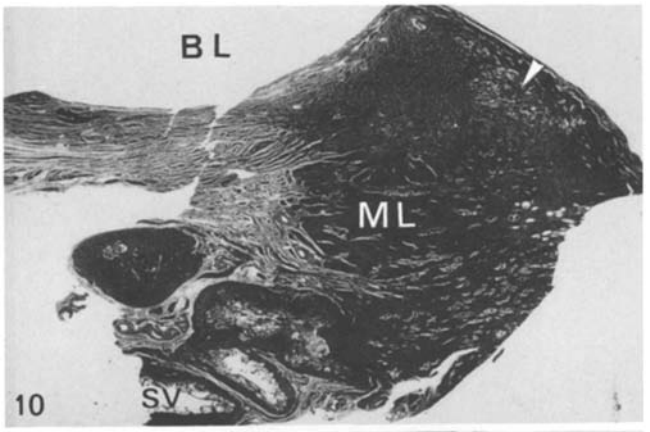
Fig. 7. Transverse section of the middle lobe of prostate from 15-year-old boy. *EjD,* ejaculatory ducts. (Hematocylin-eosin stain, x2.9)

Fig. 8a, b. Middle lobe acini in transverse section of prostate from 15-year-old boy (**a**). **b** Posterior lobe acini in transverse section of prostate from 37-year-old man. (Hematoxylin-eosin stain, x9.6)

Fig. 9. Transverse section at apex of prostate from 39-year-old man. The lateral lobes extend directly to the external sphincter except posteriorly. (Hematoxylin-eosin stain, x3.8)

and outer zones. The lateral lobes are located in the circular and longitudinal fibromuscular stroma between the urethral mucosa and the anterior longitudinal muscle laterally. The lateral lobes extend form the internal sphincter to the external sphincter. At the apex, the posterior lobe has not yet developed to the external sphincter (Fig. 5). The subcervical lobe can be recognized in specimens from the 22- and 36-week-old fetuses. It is localized at the bladder neck and disappears from the submucosal fibrous tissue layer at the internal sphincter. The mucosal glands are small and appear in a wide region within the submucosal fibrous tissue layer. The anterior lobe is located at the ventral region of the urethra, and its ducts open at the top of the urethral lumen. Its structure is alomost the same as that of the lateral lobes, and a membranous demarcation line is lacking; thus distinction between the anterior and lateral lobes in the fetus is possible only by their anatomical position.

In the outer zone, the middle lobe extends from the internal sphincter to the verumontanum and includes the ejaculatory ducts. The posterior lobe extends into the distal region (Fig. 6). The acini of the middle lobe are large and clustered like a bunch of grapes, with many cells and a narrow lumen. The amount of muscle exceeds that of the posterior lobe, whose acini are small with dilated, round lumina. The distinction between the middle and posterior lobes is clear in clockwise sagittal sections of the specimen



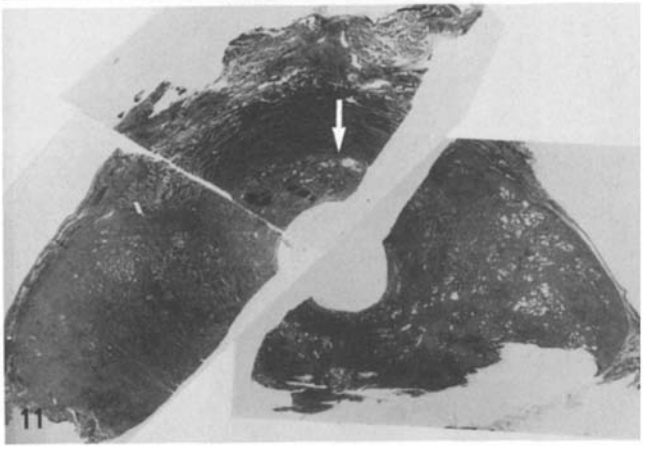


Fig. 10. Sagittal section of prostate at 6 o'clock position, in specimen from 75-year-old man. Subcervical lobe hyperplasia (*arrow*) can be recognized in the periurethral region between the mucosa and the middle lobe at the bladder neck. *ML*, middle lobe; *SV*, seminal vesicle; *BL*, bladder lumen. (Trichrome stain, x2.7)

Fig. 11. Transverse section of prostate from 73-year-old man, showing anterior lobe hyperplasia (*arrow*)

from the five-year-old. However, there is no boundary membrane between these two lobes and the distinction is therefore difficult to make from transverse sections of the fetal prostates.

Post-puberal Stage (15 to 49 Years of Age)

In Post-puberal specimens the prostate can be divided into the inner and outer zones as in fetal specimens. Compared to the inner zone, the outer zone has grown and increased in volume. The middle lobe has extended and thickened (Fig. 7). The distinction between the middle and posterior lobes is made more readily from clockwise sagittal sections than from transverse sections. The acini of the middle lobe are large and papillary and are surrounded by abundant muscle (Fig. 8). The subcervical and anterior lobes could not be found at this stage. At the apex of the prostate, the posterior lobe sometimes wraps around the lateral lobes and sometimes is absent. The lateral lobes often extend directly to the external sphincter, except posteriorly (Fig. 9).

Aged Stage (66 to 79 Years of Age)

At this stage benign prostatic hyperplastic nodules could be identified in both lateral lobes of all 12 prostates examined. Hyperplastic nodules were also identified in the middle lobe in two prostates (Fig. 11). Hyperplasia of glandular elements of the subcervical and anterior lobes was recognized in two prostates (Fig. 10, 11). The subtrigonal lobe could not be identified in this stage nor in either of the earlier stages.

Discussion

We found the extent of the lateral and posterior prostatic lobes to be different from that reported by Lowsley [2]. Lowsley may have failed to define a demarcation line or territory between the lateral and posterior lobes, and this may have led him to report too wide an extent for the lateral lobes and too small an extent for the posterior lobe. We demonstrated that the relative extent of the lobes is similar in fetal and adult prostates.

McNeal [3] divided the adult prostate into peripheral, central, and transition zones and periurethral glands. The peripheral zone may correspond to our posterior lobes, and the central zone may be our middle lobe. The transitional zone, located between the internal sphincter and the verumontanum, may correspond to part of our lateral lobes. However, our lateral lobes extended from the internal sphincter to the external sphincter. Therefore the apex of the hypertrophied lateral lobe usually reaches beyond the verumontanum distally, even in cases of small BPH. McNeal did not identify the subcervical and anterior lobes and found no BPH in the central zone. He stated that the origin of BPH was only in the transition zone and part of the periurethral glands. His theory can explain lateral lobe hypertrophy but not subcervical, anterior, and middle lobe hypertrophy. He usually used coronal and oblique coronal sections, which are more useful for distinguishing the middle lobe from the posterior lobe than are transverse sections. However, transverse and clockwise sagittal sections were more useful in defining the other lobes.

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