

The Autonomic Innervation of the Human Prostate

Histochemistry of Acetylcholinesterase in the Normal and Pathologic States

U. Dunzendorfer, D. Jonas, and W. Weber

Universitätsklinik, Zentrum Chirurgie, Urologische Abteilung der Johann Wolfgang Goethe Universität, Frankfurt, F. R. G.

Received: July 14, 1975

Summary. The pattern of innervation of fibres containing AchE was examined by histochemical methods in fresh frozen sections of normal adult prostate, benign nodular hyperplasia, carcinoma of the prostate and the prepubertal prostate. Significant differences between the four groups investigated have been found.

Key words: Prostate, Benign prostatic hypertrophy, Prostatic carcinoma, Acetylcholinesterase, Histochemistry, Prostatic innervation.

Pain is a common feature of acute prostatitis, but not benign nodular hyperplasia or carcinoma of the prostate (1). The sympathetic innervation of the lower urogenital tract and the therapeutic effect of phenoxybenzamine has been investigated recently (2, 3, 4). The nerve fibres containing Acetylcholinesterase (AchE) were examined in the normal prostate, in benign nodular hyperplasia, carcinoma of the prostate and in the prepubertal prostate. The fact that exogenous testosterone stimulates DNA synthesis in the prostate of castrated rats (5) and transection of the hypogastric plexus results in atrophy of the epithelium and myxomatous degeneration of the stroma of the prostate (6) suggests that both testosterone and an intact innervation are necessary for normal function of this gland. Since with histochemical methods the nerve cells of parasympathetic ganglia and nerve fibres containing AchE can be visualised (7) it is possible to study the changes of innervation during the various pathological processes.

MATERIALS AND METHODS

Normal adult and prepubertal prostates were obtained from autopsies. Specimens of benign nodular hyperplasia and carcinoma of the pros-

tate were available from operation material.

AchE was stained by the method of Koelle and Friedenwald, modified by Gomori (8). Fresh frozen sections of 10 microns were cut in a cryostat, dried at room temperature for at least 24 hours and incubated for 3 hours.

RESULTS

Normal Prostate (Figs. 1 and 2)

The innervation by fibres containing AchE is shown to be extensive in both glandular and stromal tissues.

Benign Nodular Hyperplasia (Fig. 3)

The reduced number of fibres containing AchE is evident. Neither the glandular epithelium nor the stroma show normal innervation.

Carcinoma of the Prostate (Figs. 4 and 5)

There is a lack of innervation of the dedifferentiated epithelium. Tumour free areas show innervation with nerve fibres stained for AchE.

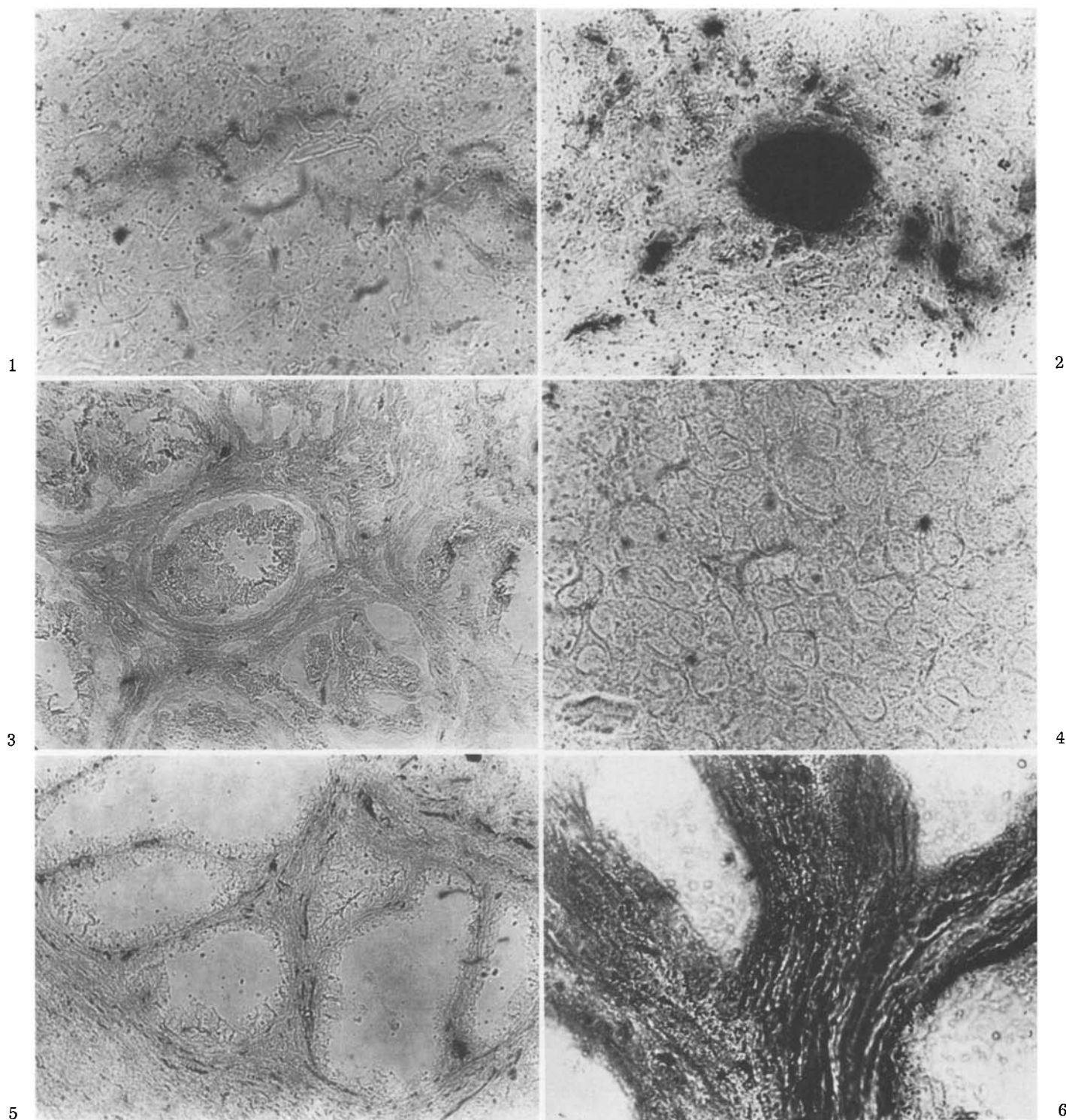


Fig. 1. AchE containing fibres of the normal human prostate (375 X)

Fig. 2. Ganglion cell and neurones of the normal human prostate visualised by histochemical staining for AchE (1600 X)

Fig. 3. AchE and the pattern of innervation in benign nodular hyperplasia (375 X)

Fig. 4. Carcinoma of the prostate after staining of fibres for AchE (585 X)

Fig. 5. Tumour free areas in a malignant gland revealing a pattern of innervation similar to benign nodular hypertrophy (375 X)

Fig. 6. Intense innervation with AchE containing fibres in the stroma of the prepubertal prostate and little innervation of the glandular areas. (1600 X)

Prepubertal Prostate (Fig. 6)

In these cases there is dense innervation with fibres containing AchE in the stroma whereas in the glandular parts innervation is relatively scanty.

DISCUSSION

To our knowledge no study exists concerning the innervation of the human prostate by fibres containing AchE. In benign nodular hyperplasia of the prostate the reduction of fibres containing AchE might be due to the lack of neural hyperplasia. Atrophy of nerve fibres due to pressure could be an additional reason. On the other hand transection of the hypogastric nerve causes proliferation of the stroma of the prostate (6). Therefore besides hormonal imbalance the reduced innervation by fibres containing AchE might be an additional factor for benign nodular hyperplasia of the prostate (9).

The lack of nerve fibres containing AchE in carcinoma of the prostate suggests that neoplasia develops without neural control. This is in contrast to the innervation of the glandular epithelium of the prepubertal prostate that also appeared to have a reduced number of fibres containing AchE. In this case it suggests that maturation of the prostate depends on both the rise of plasma testosterone and intact innervation of the glandular prostate during puberty (5,6).

The authors gratefully acknowledge the technical assistance of the histochemistry laboratory (Prof. Dr. G. Thomas) of the Neurological Institute (Edinger Institute) of J. W. Goethe University and of the Department of Neuropathology of the Max Planck-Institute for Brain Research (Direktor Prof. Dr. Krücke) Prof. Dr. Thomas assisted in the preparation of this paper.

REFERENCES

1. Harbitz, T.B., Haugen, O.A.: Histology of the prostate in elderly men. *Acta pathologica et microbiologica Scandinavica Sect. A* 80, 756 (1972)
2. Nergårdh, A., Boreus, L.O.: Autonomic receptor function in the lower urinary tract of man and cat. *Scandinavian Journal of Urology and Nephrology* 6, 34 (1972)
3. Krane, R.J., Olson, C.A.: Phenoxybenzamine in the neurogenic bladder dysfunction. A theory of micturition. *Journal of Urology* 110, 651 (1973)
4. Gennser, G., Owman, C., Owman, T., Wehlin, L.: Significance of adrenergic innervation of bladder outlet during ejaculation. *Lancet* 1969 I, 154
5. Chung, L.W.K., Coffey, D.S.: Biochemical characterization of prostatic nuclei. II. Relationship between DNA synthesis and protein synthesis. *Biochimica et biophysica acta* 247, 589 (1971)
6. Kato, T., Watanabe, H., Shima, M., Kaiho, H.: Studies on the innervation of prostate. 2. Histological changes of the dog prostate after transection of its innervating nerves. *Japanese Journal of Urology* 62, 704 (1971)
7. Gerebtzoff, M.A.: Cholinesterases. A histochemical contribution to the solution of some functional problems. London, New York, Paris, Los Angeles: Pergamon Press 1959
8. Gomori, G.: Microscopic histochemistry. Principles and practice. Chicago: The University of Chicago 1952
9. Kaufmann, J.: Untersuchungen zur kausalen Genese der Prostatahypertrophie. *Zeitschrift für Urologie* 61, 229 (1968)

Dr. U. Dunzendorfer
Univ.-Klinik, Zentrum Chirurgie
Urologische Abteilung
Theodor-Stern-Kai 7
D-6000 Frankfurt/Main 70
Federal Republic of Germany