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Changes in the Bladder Wall Muscle Associated with Benign Prostatic Enlargement

A Clinical and Morphometric Study

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Summary. In a study of 28 patients with prostatic obstruction, an attempt was made to correlate bladder wall hypertrophy and hyperplasia with objective measurements of prostatic enlargement. Correlation could only be established between the cell and nuclear volume ratio of the bladder muscle and the average urine flow rate.

Key words: Prostate - Bladder muscle - Morphometry.

Thickening of the bladder wall may be a feature of outflow tract obstruction. Experimental constriction of the bladder neck causes hypertrophy and hyperplasia of the bladder wall muscle (3). In a clinical study, we have compared the degree of enlargement of the prostate with thickening of the bladder wall.

MATERIAL AND METHODS

Studies were performed on 28 patients aged between 64 and 85 years (average age 70.7 years) who presented with prostatic obstruction. Fourteen of these patients had indwelling catheters. The duration of symptoms varied from 1 to 7 years with an average of 2.5 years. Preoperative investigation consisted of an intravenous urogram, cystogram (200-250 ml radiological contrast medium) with measurement of the bladder wall thickness, urethrogram, cystourethroscopy with determination of the distance from bladder neck to verumontanum and three measurements of urinary flow rate in those patients without indwelling catheters.

At prostatectomy a full thickness section of bladder wall measuring at least 1 x 1 cm was removed with scissors. Enucleation of the prostate was performed transvesically. The prostate was weighed and examined histologically. The excised bladder wall was pinned onto a cork board and fixed in 3 per cent formalin. After processing it was embedded in paraffin, 10μ thick sections vertical to the

Table 1. Clinical results: The range and average values of the maximum (FM) and average (FA) urine flow rate, prostate weight (PW), bladder wall thickness (BT) and distance from bladder neck to verumontanum (BV)

	Maximum Range	Minimum Range	Average
FM (ml/s)[a]	13.0	6.0	8.5
FA (ml/s)[a]	6.0	3.0	4.5
PW (g)	167.5	17.0	49.8
BT (cm)	0.8	0.1	0.36
BV (cm)	7.5	2.5	4.5

[a] 14 patients

Table 2. Morphometric results: prostate weight (g), cell volume (μ^3), nuclear volume (μ^3), cell volume: nuclear volume ratio (V/v)

Case no.	Prostate weight (g)	Cell volume (V) (μ^3)	Nuclear volume (v) (μ^3)	V/v
1	45.0	10,121.0 ± 943.1	566.78 ± 187.72	17.86
2	42.0	10,027.2 ± 1212.8	360.98 ± 113.45	27.78
3	17.0	16,708.7 ± 4182.2	481.21 ± 87.14	34.72
4	80.0	6,457.6 ± 1340.2	284.13 ± 63.27	22.73
5	18.0	14,212.9 ± 1384.4	375.22 ± 103.27	37.88
6	81.0	6,353.7 ± 772.1	198.24 ± 37.70	32.05
7	35.0	8,551.4 ± 256.3	314.69 ± 44.60	27.17
8	15.0	10,700.9 ± 1613.3	402.36 ± 134.0	26.60
9	55.0	17,910.6 ± 1089.2	444.18 ± 198.8	40.32
10	75.6	6,167.12 ± 1264.57	404.56 ± 51.15	15.24
11	60.0	9,971.28 ± 2960.69	510.53 ± 220.99	19.53
12	75.6	10,511.73 ± 1227.34	386.83 ± 69.09	27.17
13	67.4	10,249.95 ± 1418.54	311.60 ± 62.18	32.89
14	49.2	6,476.48 ± 992.96	378.20 ± 83.18	17.12
15	120.0	11,809.97 ± 1288.23	547.98 ± 103.50	21.55
16	40.66	7,994.21 ± 899.33	415.70 ± 135.67	19.23
17	85.81	11,487.14 ± 3988.48	735.18 ± 72.65	15.62
18	32.07	11,660.14 ± 1733.79	363.80 ± 141.47	32.11
19	78.2	15,061.34 ± 2749.41	572.33 ± 146.54	26.32
20	32.68	7,762.03 ± 503.07	478.14 ± 51.95	16.23
21	20.9	11,672.11 ± 2318.78	634.96 ± 70.81	18.38
22	22.0	9,530.58 ± 1393.49	297.35 ± 62.64	32.05
23	167.5	14,943.79 ± 2378.72	585.80 ± 188.60	25.51
24	56.0	14,335.17 ± 1304.21	435.79 ± 154.93	32.89
25	40.0	13,351.42 ± 1682.90	555.42 ± 60.89	24.04
26	40.0	9,551.14 ± 1512.85	527.22 ± 124.97	18.12
27	45.0	12,693.12 ± 1374.37	599.11 ± 158.40	21.19
28	48.0	8,118.60 ± 863.40	571.55 ± 127.03	14.20

mucous membrane surface were prepared and stained with haematoxylin, eosin and the van Gieson techniques.

Microscopic measurement of the bladder wall was carried out according to morphometric principles. Only complete lengthwise muscle bundles were evaluated. The cytoplasmic volume (V) was determined from the number of nuclei/mm^2. Incompletely cut nuclei were evened off using the Henning formula (6).

Nuclear volumes (v) were determined by a point system: 500 points were counted per section. Nuclear volume was calculated according to the Delesse theory (2, 6).

The relationship between the individual clinical parameters and the morphometrically computed cell volumes, nuclear volumes, and their ratios, were evaluated by correlation analysis. Bladder wall biopsies taken from 5 children between the ages of 6 and 9,

Table 3. Correlation between prostate weight, the morphometric results (cell volume V, nuclear volume v, cell volume to nuclear volume ratio V/v), and clinical values (distance from bladder neck to verumontanum BV, bladder wall thickness BT, maximum flow FM, average flow FA)

	Weight	V/v
V	0.05	
v	0.19	
V/v	-0.3	
BV		0.37
BT		0.01
FM		-0.06
FA		0.56

who were operated on for hypospadias, were used as controls for our morphometric values.

RESULTS

Clinical Results

The maximum (FM) and average (FA) volume of urine voided per second, prostate weight (PW), bladder wall thickness (BT) and distance from bladder neck to verumontanum (BV) are shown in Table 1.

Morphometric Results

The cell volumes (V) and nuclear volumes (v) of the bladder wall sections and their ratios V/v are shown in Table 2. The bladder wall sections removed from the group of children showed the following average values: cell volumes 6.347 $\mu \pm 1.342$; nuclear volumes $142\mu \pm 52$; V/v 44.6 ± 3.4. These values are comparable to those of Brent (4) for this age group.

Correlation Analysis

The results of a) and b) were correlated. The ratio V/v was used as the independent variable (x) for the clinical parameter y (= dependent variable). The measured morphometric values were correlated with the prostate weights. The results, expressed as correlation coefficients (r), showed that correlation could only be established between V/v and the average volume of urine/sec (FA) (r = 0.56) (Table 3).

DISCUSSION

In 1963, Arbuckle (1) produced mild bladder neck obstruction in rabbits and caused vesical wall thickening in all animals. Brent (3) performed a similar animal experiment in 1975 with measurement of the resulting vesical thickening. It was seen that, in proportion to the duration of obstruction, an increase in the muscle cell volumes (< 5 x) occurred and later, up to 3-fold increase in the number of cells. Obstruction of more than 8 weeks duration results in irreversible morphological changes in humans and dogs (7).

In these experiments the degree and duration of the obstruction was known. An attempt was made to determine the factors responsible for vesical thickening on the basis of clinical examinations. The duration of the obstruction noted in the history was considered too inexact - and was discarded. Only objective measurements were taken into account. The only relationship which could be established by correlation analysis was between the cell volume/nuclear volume ratio (V/v) and the average urine flow rate (FA). There was no statistically significant relationship between the weight of the excised prostatic adenoma and thickening of the bladder wall (as expressed by cell and nuclear volume). It was further seen that the factors responsible for bladder wall thickening are not detectable by routine clinical examinations. It may be assumed that the circumference and shape of the bladder neck as well as its elasticity are of greater importance for the degree of obstruction than the prostatic enlargement (8).

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