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BLADDER FUNCTION AFTER HEMIPELVECTOMY

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Bladder function was studied in seven patients, 5 to 90 months after hemipelvectomy. The urological investigation comprised i.v. urography, micturition-cysto-urethrography, cystoscopy, cystometry and urodynamic investigations in terms of simultaneous flow and pressure measurements. Hemipelvectomy was found not to give rise to disturbances in micturition.

Key words: hemipelvectomy; urodynamics, pressure, flow; urination; neurogenic bladder

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Hemipelvectomy is performed where amputation is required because of malignant tumours in the pelvis or the upper femur. This extensive operation causes a variable, unilateral damage to the innervation of the urinary bladder.

Normal bladder function is dependent on an intact nervous system, consisting of autonomic, somatic and sensory pathways. The innervation of the detrusor is mainly parasympathetic, while the function of the sympathetic innervation of the trigone is still disputed. The parasympathetic nerves run from the sacral medulla, segments II–IV (S_{II}–S_{IV}), to the pelvic plexus at the level of the lateral wall of the rectum, where they branch to the ureterovesical region. The sensory innervation of the bladder comprises proprioception (stretch) and exteroception (pain), proprioception being by far the more important, as it is responsible for the micturition reflex and the sensation of bladder dilation. Some of these fibres follow the sympathetic hypogastric nerve to the sympathetic trunk and the thoracolumbar medulla. The pelvic floor including the external sphincter receives somatic innervation from the pudendal nerve, which in addition is responsible for the sensory innervation of the urethra distal to the prostate. There is supposed to be unilateral innervation of the detrusor muscle and a complementary function of the three segments in the sacral medulla, with S_{III} as the most important. The sacral cord segments II–IV are the simple reflex arcs of the visceral and the somatic nerves, which are influenced by inhibitory and facilitative pathways from the medulla, cerebellum and cortex (Bors & Comarr 1971). In our patients, hemipelvectomy involves transection of the pudendal nerve, and in addition a risk of damage to the parasympathetic and sympathetic nerve supplies to the bladder at the periphery, where the nerve fibres are running in the pelvic and vesical plexus. We therefore consider it of some interest to examine the

Table 1. Age and sex, tumour diagnosis and time of urological follow-up in 7 patients submitted to hemipelvectomy.

Patient no.	Age	Sex	Tumour diagnosis	Type of operation*	Urological follow-up in months post operation
1	13	M	osteogenic sarcoma of the femur	A	10
2	17	M	osteogenic sarcoma of the pelvis	A	5
3	26	M	osteogenic sarcoma of the femur	A	72
4	29	M	osteogenic sarcoma of the pelvis	A	31
5	41	M	neurofibrosarcoma of the pelvis	B	90
6	25	F	chondrosarcoma of the pelvis	A	31
7	54	F	osteogenic sarcoma of the femur	B	44

* c.f. text: operative procedure.

Table 2. Spontaneous micturition in 7 patients 5 to 90 months after hemipelvectomy.

Patient no.	Maximal flow ml/s (micturition vol. ml.)	Residual volume (ml)	Urinary culture
1	21 (320)	0	sterile
2	22 (100)	0	sterile
3	19 (200)	0	sterile
4	24 (260)	50	sterile
5	17 (120)	0	sterile
6	21 (330)	90	sterile
7	35 (400)	0	sterile

bladder function in a number of patients who have undergone hemipelvectomy.

MATERIAL AND METHODS

Patients. The material consists of the seven surviving patients out of 23 patients who underwent hemipelvectomy in the Department of Orthopaedic Surgery at the University Hospital during the period 1964–1972. Table 1 shows age, sex and preoperative tumour diagnosis. None of the patients had any urological symptoms before operation. All patients were hospitalized for follow-up examination. The period from hemipelvectomy to urological follow-up examination varied from 5–90 months (Table 1).

Operative technique in hemipelvectomy. Hemipelvectomy was performed as described by previous authors (Gordon-Tayler & Monro 1952, Bertelsen & Meyer 1961, Ravitch & Wilson 1964, Den Otter 1972). Anteriorly, the pelvis was divided near or in the symphysis and posteriorly through the greater sciatic notch and up over the iliac crest, more or less close to the sacro-iliac joint. The iliac vessels were exposed anteriorly together with the ilio-psoas muscle. The femoral nerve and obturator nerve were transected from the inside of the pelvis, while posteriorly the sciatic nerve was transected where it emerges from the pelvic cavity through the foramen infrapiriformis. The pudendal nerve was transected together with the sacro-tuberous ligament and the sacro-spinous ligament. After dividing the pelvic wall, the bladder and rectum were exposed medially, employing blunt dissection in the paravesical and pararectal connective tissue space. During this dissection the pelvic plexus (i.e. the inferior hypogastric plexus) and the vesical plexus are in danger of damage. In five patients the hemipelvectomy was performed by transection of the pelvis anteriorly in the symphysis and posteriorly immediately lateral to the sacro-iliac joint (type A, Table 1). A slightly less radical intervention was carried out in two patients, the resection line anteriorly in the bone lying 2 cm lateral to the symphysis and posteriorly from the greater sciatic notch to midway between the superior and inferior anterior iliac spine (type B, Table 1).

Table 3. Cystometry and simultaneous pressure and flow measurements in 7 patients 5–90 months after hemipelvectomy.

Patient no.	Cystometry	Simultaneous pressure and flow measurements				
		Micturition volume ml	Intravesical pressure prior to micturition mmHg*	Micturition pressure at maximum flow mmHg	Max. flow ml/s	Detrusor function
1	normal	200	20	60	10	+
2	normal	450	15	60	21	+
3	normal	400	35	60	16	+
4	normal	480	30	100	24	+
5	normal	300	30	100	8	+
6	normal	200	not performed	22	15	+
7	normal	750	20	55	36	+

* 1 mmHg pressure = 1.36 cm H_2O pressure.

Table 4. X-ray investigation and cystoscopy.

Patient no.	MCU	Reflux	Urography	Cystoscopy
1	normal	—	asymmetric bladder	not performed
2	normal	—	asymmetric bladder	normal
3	normal	—	normal	normal
4	normal	—	normal	cystitis
5	narrow posterior urethra	—	prostate impression in the bladder base	posterior urethritis prostate hypertrophy
6	normal	—	normal	normal
7	normal	—	normal	normal

Urological follow-up examination comprised microscopy and bacteriological examination of urine, serum creatinine determination, i.v. urography, micturition – cysto – urethrography (MCU), cystometry and urodynamic investigation (pressure flow study). MCU was performed in lateral projection in all patients, three films being made, one before, one during and one after micturition. Bladder configuration was evaluated from a bladder filling picture in i.v. urography and from cystoscopy.

The urodynamic studies were performed as described by Iversen Hansen (1973) and the parameters measured are indicated in Tables 2 and 3. The patients were asked to attend the examination with a full bladder and a spontaneous micturition curve was recorded using a flowmeter. A thin catheter was inserted into the bladder by the transurethral route and the residual urine was measured. A thin catheter was also inserted into the rectum, and pressures were recorded in both the bladder and the rectum. Successive pressure estimations were made after each instillation of 50 ml saline in the bladder, both "first sensation" and "definite sensation of fullness" (cystometric capacity) being recorded. The final pressure-flow study was performed after the bladder was filled through the transurethral catheter, pressures and flow being recorded simultaneously during micturition.

RESULTS

Table 2 shows the results of the examination of spontaneous micturition. All patients had maximum flow within the normal range. This was also the case in patients Nos. 2 and 5, who on examination

had micturition volumes less than the value usually required for evaluation of maximum flow.

Cystometry (Table 3) showed in all cases normal pressure during filling without uninhibited contractions or low pressure filling curve, i.e. without signs of neurogenic bladder dysfunction. Simultaneous pressure-flow measurement showed normal premicturition pressure in all patients except No. 6, whose pressure was not measured because of a fault in the apparatus. Micturition pressure at maximum flow was found to be elevated in two cases (patients Nos. 4 and 5, Table 3). Patient No. 4 showed pronounced inflammatory changes in the bladder on cystoscopy, which might explain the elevated micturition pressure. In patient No. 5, the elevated micturition pressure together with the low flow and the elevated residual urine suggest infravesical obstruction. Infravesical obstruction not caused by hemipelvectomy was confirmed by MCU, i.v. urography and cystoscopy (Table 4). In patient No. 7, both spontaneous micturition examination (Table 2) and determination of simultaneous pressure and flow (Table 3) showed a large micturition volume, 750 ml on last investigation. The other parameters in this patient were found to be normal. An MCU investigation could show no reflux in any of the patients (Table 4). In two cases urography showed that the bladder was asymmetrical (patients Nos. 1 and 2, Table 4). Cystometry and urodynamic investigation showed no signs of denervation of the bladder in these patients.

DISCUSSION

Following major operations in the true pelvis, e.g., extirpation of the rectum and radical hysterectomy, disturbances of micturition may often arise as a result of damage to the innervation of the bladder (Baumrucker & Shaw 1953, Bowers et al. 1957, Bors & Comarr 1971, Tank et al. 1972, Ward & Nay 1972, Roman-Lopez & Barclay 1973, Held 1974, Kontturi et al. 1974, Barclay & Roman-Lopez 1975, Eickenberg et al. 1976). In these types of operation it may be assumed that there has been bilateral damage to the pelvic plexus, resulting in infranuclear bladder paresis. In hemipelvectomy, damage to the nerve supply to the bladder is strictly unilateral, but presumably involves both the pelvic plexus and the pudendal nerve. As the present follow-up investigation shows, unilateral denervation of the bladder does not result in neurogenic bladder dysfunction. The result of our investigation is in accordance with animal investigations and with human investigations involving procedures other than hemipelvectomy. Kimmel (1966) has reported that in rats only one pelvic nerve is necessary to maintain good bladder function. Ericsson et al. (1970) found normal bladder function in patients with myelomeningocele causing unilateral neurological defects. Gunterberg et al. (1975) showed that resection of the sacrum with unilateral lesion of sacral nerves 1 to 5 did not abolish the micturition reflex. It is possible that by employing electrical stimulation of the detrusor muscle, electromyography or a denervation hypersensitivity test with carbacholine, the presence of unilateral denervation could have been demonstrated in the present investigation.

It may be concluded from the present investigation that hemipelvectomy, with possible unilateral denervation of the bladder, does not give rise to clinically or urodynamically recognisable disturbances in micturition.

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