MICTURITION CYSTO-URETHROGRAPHY IN THE INVESTIGATION OF URINARY TRACT DISEASES IN CHILDREN

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The wider use of micturition cysto-urethrography as a method of urological investigation in infants and children has been highly rewarding. Not only has it proved to be as accurate as endoscopy for assessing urethral lesions, but it has provided information about the upper urinary tract that can be obtained by no other means (Turner-Warwick, 1962). One surprising finding has been the circumscribed value of intravenous pyelography in the commoner urological problems, particularly recurrent urinary infections.

This paper reports the results of investigating a variety of urological and other complaints by means of three procedures—intravenous pyelography, micturition cysto-urethrography and endoscopy—performed within days of each other. Although this series has been discussed elsewhere from a radiological point of view (Burrows and Allen, 1964), certain clinical aspects and the comparative findings are of importance to paediatricians and other physicians who order selective procedures upon the urinary tract in children.

Material and Method

After reviewing almost 1,000 cysto-urethrograms performed upon 920 children, it was decided that the value of the paper would be enhanced by including only those patients who had undergone all three procedures. As a consequence, the series totalled 496, made up of 301 girls and 195 boys. The youngest was 6 days old, and the eldest a girl of 16 years. Altogether 52 follow-up cysto-urethrograms were performed, most of them on patients who had undergone surgery in the interval.

Before this series began, most of these patients would have been investigated according to local practice by intravenous pyelography only, followed perhaps by endoscopy. Very few micturition cysto-urethrograms were being performed. As the series progressed patients

were referred for both examinations—micturition cysto-urethrography followed by intravenous pyelography—on the same day. Endoscopy was then carried out a day or so later.

No elaborate radiographic equipment, only a dynamic radiological approach, is required, i.e. micturition cysto-urethrography should be a fluoroscopic procedure and therefore a matter for the radiologist rather than for a technician in his department. Radiologists have been slow to develop this procedure, consequently the criteria for an adequate examination have seldom been realized. They are as follows:

- (a) A bladder filled to capacity, to assess accurately trabeculation of its wall,
- (b) Continuous monitoring during emptying, to catch intermittent vesico-ureteral reflux,
- (c) Serial films of the urethra, during the act of micturition, and
- (d) A check upon the residue after voiding.

These criteria can be fulfilled in any radiological department equipped to do routine barium studies. The four-in-one spot film device is adequate for taking the serial films which are the essential part of the examination (Fig. 1 and Fig. 2). The morphology of the urethra may change from second to second, and a single film taken, for example, at the precise moment that the child ceases to micturate may simulate a bladder-neck contracture or an inflamed urethra. Only by studying several films of the contrast-filled urethra can the radiologist hope to venture a worth-while opinion upon it (Davis, Lich, Howerton and Joule, 1961).

There are probably no contraindications to the procedure (Heikel and Parkkulainen, 1959a), but there is the disadvantage of catheterization. 'Follow-through' urethrograms after intravenous pyelography (an attempt to overcome it) are of limited value for three reasons:

- (a) The contrast medium is usually too dilute to outline the urethra adequately.
- (b) The occurrence of vesico-ureteral reflux cannot be confirmed due to the continually-excreting kidneys.
- (c) The degree of bladder-wall trabeculation cannot be assessed because the bladder is seldom distended to its capacity.

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FIG. 1.—Micturition cysto-urethrogram of a 4-year-old girl with an acute urinary infection. Serial films confirm a constant 'fuzziness' of the urethral walls, and an oedematous mucosal fold running longitudinally within it. Vaginal reflux occurs commonly if the child is recumbent.

Clinical Aspects

Evaluation of the series from a clinical standpoint proved difficult since the presenting picture was often a mixed one, being the features of infection superimposed upon the effects of obstruction. No less than 296 patients (59.5%) presented with urinary infection, and a further 118 (23.8%) had enuresis. The remaining 82 cases (16.7%) were classified according to the main presenting feature in each instance (Table 1).

Into the last group (Table 1) went all cases that were being investigated extensively to exclude an organic basis for vague aches and pains. While this classification may represent an oversimplification of the clinical problems involved, it sufficed for our purposes which were to assess the value and place of micturition cysto-urethrography as a radiodiagnostic procedure in urinary tract symptoms and signs, and to compare its accuracy with other investigative methods (Table 2).

A. Enuresis. Enuresis has been described as 'the involuntary discharge of urine, and it assumes importance in a child over 3 years of age (Fisher and Forsythe, 1954).

Figures varying from 5 to 25% have been given for its incidence in children aged 4 to 12 years. In the present series the 118 enuretic patients between 4 and 15 years of age represent more than one-quarter of all the patients in this age-group. Of more importance is the proportion of enuretic children in whom an organic lesion can be demon-

TABLE 1

Presenting Symptom	No. of Cases
Referable to genito-urinary tract	15
Pyrexia of unknown origin	14
Failure to thrive	11
Not referable to genito-urinary tract	14
Nothing much	28

FIG. 2.—Micturition cysto-urethrogram of a girl aged 7 years, with a three-year history of recurrent urinary infections. Urethroscopic examination showed the irregularities of outline to be inflammatory granulations.

strated. Campbell (1937) found it to be 60% (532 cases) and Fisher and Forsythe (1954) 45% (135 patients). In our series, 57 patients, or 48%, had organic lesions.*

* That is, by micturition cysto-urethrography. The endoscopic findings differ slightly (see Table 2).

About three-quarters of the 118 patients were under 7 years of age. There were 77 boys in the series, and 41 girls: of these, 30 boys and 27 girls had demonstrable abnormalities of the urinary tract (Table 3).

COMMENT. Enuresis is a symptom: it is neither

TABLE 2
PATHOLOGY DETECTED BY VARIOUS DIAGNOSTIC METHODS IN 496 CHILDREN
GROUPED ACCORDING TO CLINICAL PRESENTATION

Presenting Clinical Feature	No. of Patients	Micturition Cysto-urethrogram (No.)	Intravenous Pyelogram (No.)	Endoscopy (No.)
Enuresis	118	57	8	63
First genito-urinary infection	128	77	12	92
Recurrent genito-urinary infection	168	118	19	121
'Failure to thrive'	11	10	1	11
Fever of unknown origin	14	6	2	9
Other genito-urinary symptoms	15	6	2	8
No genito-urinary symptoms	14	1	2	6
'Nothing very much'	28	15	—	15
	496	290	46	325

a disease nor a radiological diagnosis. The results of our studies give little hope of finding a single cause for it. If, indeed, there is a single aetiological factor common to all patients, then it remains hidden behind the mask of a variety of organic lesions or, in nearly half the cases, an apparently normal lower urinary tract. In this series enuresis was a relatively more frequent presenting symptom in boys than in girls, and somewhat more indicative of a pathological condition than other presenting symptoms. For example, five of the eight boys with congenital posterior urethral valves, and 15 of the 43 boys with bladder-neck contracture were enuretic. The figure of 15, which represents 12.7% of the enuretic patients, contrasts with the statement of Miller (1956) that one-third of all enuretic children have a degree of bladder-neck obstruction. Miller emphasized that he did not believe bladder-neck hypertrophy to be the cause of the condition, despite the fact that surgical resection often cured it. More recently De Backer and Williams (1961) have postulated the converse, namely that enuresis is due to a deficiency of the internal sphincter that manifests itself as 'the wide bladder-neck syndrome' seen on micturition cysto-urethrography. The frequent association of enuresis with chronic inflammatory changes in the posterior urethra and at the bladder neck has never been disputed (Winsbury-White, 1941).

Summary. In about half the patients with persistent enuresis an organic abnormality can be found, and this is likely to be an obstructive lesion of the urethra. The diagnosis can be made by micturition cysto-urethrography as well as by endoscopy.

B. Genito-urinary Infection. 'A urinary infection is present when bacteria and pus cells are found in the urine, and considered to be persistent when it responds to chemotherapy but recurs after an interval' (Forsythe and Wallace, 1958).

Hawthorne (1941) found that 60% of boys with chronic urinary infections had congenital anomalies causing obstruction, and Forsythe and Wallace (1958) confirmed this high proportion. Our findings also accord with this figure.

The cases in our series were divided into two groups, namely, first infection and recurrent infection. Although the pattern of differential pathology was the same for both groups, the percentage of abnormality was far higher in the recurrent group, i.e. 70.4% as compared to 39.6% of the patients with a first infection.

Girls outnumbered boys by nearly three to one, and almost two out of every three girls, 156 out of

TABLE 3
FINDINGS AMONG PATIENTS WITH ENURESIS

Findings	Boys	Girls
Inflammatory urethral changes	1	11
Bladder-neck contracture	15	5
Posterior urethral valves	5	—
Meatal stenosis	—	5
Neurogenic defect	2	1
Normal urethra, but bladder-wall trabeculation and/or vesico-ureteral reflux* ..	7	5

* Some of the patients with abnormal urethrae showed trabeculation and/or reflux as well. Altogether there were 12 cases of trabeculation and 15 of reflux in the enuretic group.

220, showed some abnormality. This figure was somewhat lower in the boys, where the majority with first infections was found to have normal urethrae. Half the patients were children between the ages of 3 and 7; relatively few cases occurred after the onset of puberty.

Lesions in the 195 abnormal cases are listed in Table 4.

COMMENT. We expected to find a higher proportion of inflammatory changes in the urethrae of these patients, since all had clinical and laboratory evidence of genito-urinary infection. In fact, the statistical pattern of pathology was very similar to that shown by the enuretic cases. These figures confirm the view, already accepted by most paediatricians, that urinary infection, and particularly the recurrent type, may be the mode of clinical presentation of a variety of congenital and acquired lesions, and for this reason it always warrants thorough urological investigation.

SUMMARY. More than two-thirds of the cases of recurrent infection had demonstrable organic lesions of the lower urinary tract. Even a high proportion of patients suffering for the first time from a genito-urinary infection showed pathological changes.

C. Other Modes of Presentation

OTHER SYMPTOMS REFERABLE TO THE GENITO-URINARY TRACT (15 patients). These included a history of previous renal infection, haematuria, flank pain, and difficulties with micturition, i.e. dysuria,

TABLE 4
FINDINGS AMONG PATIENTS WITH
GENITO-URINARY INFECTION

	Boys	Girls
Inflammatory urethral changes	7	77
Bladder-neck contracture	20	13
Posterior urethral valves	5	—
Meatal stenosis	—	36
Neurogenic defect	1	2
Ectopic (urethral) ureter	1	1
Normal urethra, but bladder-wall trabeculation and/or vesico-ureteral reflux ..	9	23

See footnote to Table 3.

inability to start the act, or straining. The group consisted of 10 boys and five girls varying in age from 2 months to 13 years. Of the six showing abnormalities, four had vesico-ureteral reflux and/or bladder-wall trabeculation, one had an inflamed urethra and the other, a 15-year-old boy, hypertrophy of the verumontanum.

PYREXIA OF UNKNOWN ORIGIN (14 patients). Two of the six abnormal cases in this group had inflammatory urethral lesions and the remaining four showed reflux and/or trabeculation in the absence of urethral pathology. There were five boys and nine girls, varying from 1 to 12 years of age.

'FAILURE TO THRIVE' (11 patients). All but two of these patients were under 12 months old, and nine were boys. Only one case was considered normal; eight showed radiological and endoscopic evidence of bladder-neck contracture (seven of these were male infants), and the remaining two cases showed inflammatory changes in the urethra.

OTHER SYMPTOMS NOT REFERABLE TO THE URINARY TRACT (14 patients). These patients presented with a miscellany of clinical complaints—mostly referable to the gastro-intestinal tract (diarrhoea, steatorrhoea, constipation, black stools, etc.), but they included some cases of unrelated pathology (e.g. hydrocephalus) in whom the micturition cysto-urethrogram was part of the diagnostic work-up. Only one patient showed any abnormality—an apparently healthy 9-year-old boy with persistent constipation who showed reflux and trabeculation in the presence of an otherwise normal urinary tract.

'NOTHING VERY MUCH' (28 patients). This group was similar to the previous one, although the presenting symptoms were usually more vague and clinical signs absent. Nearly all complained of abdominal pain or cramps of short duration and not specifically referable to the kidneys or the bladder. Of these, 20 were girls, and 11 of these were more than 10 years old. Of the 28, 15 were abnormal: 12 had inflamed urethrae, two a degree of bladder-neck contracture and one patient, a 7-year-old boy, showed some obstruction at the peno-scrotal junction (suspensory ligament). In three of these cases reflux and/or trabeculation was demonstrated.

D. Comment. It is clear that without micturition cysto-urethrography or endoscopy most of the lesions in these patients would have remained undetected. Since the pattern of pathology exposed by it in each of the clinical groups discussed above is almost identical, it would have been a labour of despair to attempt a more accurate clinical diagnosis without it.

The manifestation of infection may be superimposed upon those of obstruction or mask them altogether, so that in any particular patient the underlying lesion cannot be identified. Recently Berman, Crotty and Tina (1961) classified the clinical presentation of 47 patients with proven bladder-neck contracture in this way, and found that two-thirds gave a history suggesting infection (fever, dysuria, pyuria), and the remaining one-third was equally divided between obstruction (dribbling, retention, enuresis, incontinence, infrequent micturition, palpable abdominal mass) and features of less clear-cut significance (haematuria, frequency, abdominal pain, etc.).

The Upper Urinary Tract

Consideration of the traditional urological approach to obstructive urethral lesions, namely, post-voiding residue, bladder-wall trabeculation (or sacculaton) and vesico-ureteral reflux, tends to focus attention upon these important abnormal features.

Vesico-ureteral Reflux. Demonstrating the phenomenon of reflux is of vital diagnostic and prognostic significance. Although there may be subtle clues to its existence in an intravenous pyelogram, some type of cystographic examination is necessary to prove it. At the present time the most practical way of excluding its presence is to obtain a normal micturition cysto-urethrogram (Turner-Warwick, 1962). Its presence will not be detected at endoscopic examination.

We believe that the presence of reflux is always significant, while the amount is of little importance: once the protective barrier of the uretero-vesical mechanism has been pierced, the kidney is left unprotected against the effects of back-flow. Of the 496 cases in our series, 78 exhibited reflux of some degree. If the series is analysed on the basis of urethral pathology, the incidence of reflux in the cases with normal urethrae is only slightly lower than that in the abnormal cases, 13.9 as compared to 17.7%. Almost without exception the cases with normal urethrae presented clinically with recurrent infections, and in several of them inflammatory changes were observed at endoscopy. Campbell (1930) claimed that infection was the most frequent cause of damage to the uretero-vesical mechanism, but it is still not clear whether or not this must always be secondary to lower urinary tract obstruction. Edwards (1961) claimed that 'it is probably wise in the presence of reflux to assume that bladder-neck obstruction may be present even if there are no radiological signs of its presence'.

TABLE 5
MICTURITION CYSTO-URETHROGRAM VERSUS INTRAVENOUS PYELOGRAM IN 496 CASES

	Micturition Cysto-urethrogram			Intravenous Pyelogram
	Urethra	Bladder-wall Trabeculation	Vesico-Ureteral Reflux	
Inflammation	113	12	15	11
Obstruction {	Bladder-neck contracture	63	7	7
	Valves, etc.	12	1	1
	Meatal stenosis	41	10	3
Neurogenic defect	6	3	2	4
Ectopic (urethral) ureterocele	2	—	—	1
Other cases (with normal urethrae)	259	21	36	19
Total	496	54	78	46

Reflux and Pyelonephritis. An interesting parallel exists between the presence of reflux and renal abnormality as detected on the intravenous pyelogram. Analysis of the 46 abnormal intravenous pyelograms showed that 32 possessed radiological evidence of ascending infection, i.e. hydroureter, hydronephrosis or pyelonephritis, and of these no less than 25 (78%) showed reflux. This figure accords with the findings of Hodson and Edwards (1960) who investigated a similar problem in a group of patients with pyelonephritis and found that three-quarters of them had reflux. A tempting, though yet unproven, theory is that renal damage can only occur in the presence of refluxing urine (International Symposium at Henry Ford Hospital, Detroit, 1962). If this is so, then the cysto-urethrogram should take precedence over the intravenous pyelogram as the radiological investigation of choice in these cases.

Micturition Cysto-urethrography Versus Other Methods. Table 2 compares the three diagnostic methods used in this series in terms of the clinical presentation, and Table 5 compares micturition cysto-urethrography and intravenous pyelography in terms of pathology detected. From this can be seen the limited value of the intravenous pyelogram for investigating the lower urinary tract. Of the 237 patients shown by micturition cysto-urethrography to have abnormal urethrae, only 27 had abnormal intravenous pyelograms. In several of these the renal abnormality had no connexion with the urethral lesion (e.g. horseshoe kidney), so that it can be said that not more than one case of urethral pathology in every 10 in this series produced pyelographic abnormalities. This confirms the findings of previous workers (Heikel and Parkkulainen, 1959b).

Summary and Conclusions

The results of performing micturition cysto-urethrograms upon 496 infants and children are

reported, and the findings correlated with the intravenous pyelograms and endoscopies carried out upon each child at about the same time.

A high proportion of children with lower urinary symptoms have organic lesions that can be shown only by micturition cysto-urethrography or by endoscopy.

Micturition cysto-urethrography is the radiological investigation of choice for such symptoms as persistent enuresis or infection. It rivals endoscopy in accuracy of diagnosis and it is the examination to be preferred, since no general anaesthetic is required and vesico-ureteral reflux can be detected as well. In lower urinary tract lesions the intravenous pyelogram is of little diagnostic value.

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