URINARY LITHIASIS IN INFANCY *

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At first thought, urinary stone and especially stone in the kidney is a subject pertaining to adult life. The discovery of the condition, especially of renal stone, in an infant or small child provokes an additional interest and concern owing as well to the tender age of the patient as to its comparative rarity of discovery before death.

Our chief sources of light on this subject are to be sought in the recent reviews, more especially of the German and French. In earlier literature the treatment of the subject has been with reference to older children, including those up to 15 years of age. In some of our modern textbooks, no mention is made of renal stone in infants; in some others, the subject is given scant attention. Stone in the bladder and gravel in the urine occupy places in the literature extending many years back, the treatment by medicinal and dietary measures being placed in the foreground. Until recent years—notably since the advent of the x-ray—little attention was given to the surgical aspect of stone in the infant kidney or ureter, though bladder stones have for generations been treated surgically.

My attention was first attracted to this subject a few years ago as the result of a case in an infant of 16 months which came under my observation. The interest attendant on a study of the literature led me to collect considerable material and in this manner the present paper found its beginnings. As a basis for discussion, the history of the above-mentioned case here follows:

CASE REPORT

History.—The infant was a 16-months'-old male, born in Minnesota, of Bohemian parents, neither of whom ever complained of any urinary trouble. The mother's brother, a lad of about 7 years, had been known to pass gravel with the urine in his early days.

The baby had been circumcised at 4 weeks of age, was breast-fed for the first year and suffered none of the usual children's diseases, with the possible exception of "colics," until the onset of the present trouble. Until several months of age, according to a certain custom, the baby was kept wrapped about, arms confined to the sides, by a long scarf or long quilted band allowing of no exercise of the arms or legs, except once daily when the band was removed for a short time.

Examination.—I saw the infant late one December afternoon, 1909. He had not urinated for twenty-four hours. Examination revealed a spherical stone

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(Fig. 1 "x") impacted in the extreme end of the urethra. On the extraction of the obstructing stone the baby passed a large teacup-and-a-half of urine. The stone, weighed later, proved to be $\frac{3}{4}$ grain and by analysis was composed of earthy phosphates. Three months following this onset of trouble the father brought to me several smaller stones which the infant had passed. Radiographic examination was advised to determine if possible the presence of other stones in the urinary tract. After a delay of three months the parents brought the patient for such an examination. The result of such examination, six months after the onset, shows (Fig. 2) two stones in the right kidney, one in the bladder, and a third somewhat irregular shadow appearing at about the crest of the right ilium—probably ureteral stone. Radiographs a few days later substantiated the findings at the first sitting. Surgical interference was positively refused by the parents.

Plates taken about nine months after the first radiographs revealed the calculi as before (Fig. 3) but with some destruction of kidney substance. In addition, shadows in the region of the left kidney appeared, showing the formation of calculi in that organ. The infant continued to pass small calculi at intervals. About a year later the child was operated on in Chicago for bladder stone.

At the present writing I am in receipt of a personal communication from the father to the effect that the child is in fair health—at the age of $4\frac{1}{2}$ years—though no relief has been attempted for the kidney stones. The same letter

Fig. 1.—Showing spherical stone "x," which was removed from child's urethra. The other stones were passed by the child at varying intervals.

also conveys the information that the child's uncle (the mother's younger brother, above referred to in the history) is just recovering from an operation for bladder stone "the size of a pigeon's egg." He was 10 when operated on, and my letter states that he had passed fine gravel which was first noticed when he was 3 months old and has done so at intervals since that time. During the last two years his condition has been very much worse.

The family history of stone in this case is of interest. As an example of extensive family occurrence it is interesting to note the experience of Clubbe, who operated on the three sons of a fisherman of Lowestoft, England, for stone, at ages of 2, 3 and 8. The father and mother always had gravel in the urine. The grandfather passed one and the grandmother passed seven stones. A great uncle was operated on for stone. Six uncles and four aunts all suffered from spells of gravel, and finally a cousin, an uncle's child, was accustomed to pass gravel.

Too much stress should not be laid on the family tendency, however. The experience of Clubbe is rather to be regarded as rare than common.

In Bokay's experience he has seen only one case in which he could lay any stress on heredity in the sense of families of stone formation.

Other cases of urinary stone are quoted by various authors as having

Fig. 2.—Radiograph showing two calculi in right kidney, one in the bladder and a third shadow at the crest of the right ilium—probably stone in the ureter.

been found early in infancy or even before term. Langenbeck found a calculus in the bladder of a six-months fetus. Southworth, in 1895, presented the New York Pathological Society with the kidney of a new-

born child containing calculi. Brendel quotes three cases two days after birth. Meigs records the recovery of a calculus post-mortem from the kidney of an infant of 6 months. Two cases of renal stone discovered in infants of 20 months are recorded by Hance and Partridge. The latter's case presented no symptoms of calculus during life. It was discovered at

Fig. 3.—Radiograph, taken nine months after that shown in Fig. 2, showing two calculi in right kidney and destruction of kidney substance. Also the bladder stone as in Fig. 2. In addition, two shadows are shown in the left kidney region.

autopsy. Jacobson cites a case of a child operated on in which the bladder was found to be in a condition of complete incrustation. At autopsy both kidneys were found to be absolutely filled with stone. G. Newton Pitt records three cases of renal stone in infants, discovered at autopsy. The first was in an infant of 15 months. Death occurred

from diphtheria. A stone weighing 4 grains was found at autopsy. The second was 11 months old when death occurred from diphtheria. The kidney stone in this case weighed 2 grains. The third infant was 21 months old when death occurred from bronchopneumonia. Hematuria had been noticed during life in this case. The stone recovered at autopsy weighed also about 2 grains.

OCCURRENCE

Civiale found that 45 per cent. of 5,900 cases of calculus occurred in children, and that children under 5 years are especially prone to the condition. The principle of "survival of the fittest" holds its sway with remarkable tenacity respecting urinary stone. A high percentage of the known cases appear to be those discovered at autopsy. It will be seen by referring to Tables 1 and 2 that of the patients under 5 years, about 92 per cent. are 2 years or under, and that practically all of these are cases which have reached the autopsy table. In the past, therefore, it would seem that urinary lithiasis, especially of the renal type, laid just claim to a high mortality.

Holt, basing his information on 1,000 autopsies, says that small renal calculi are very common in infants, but that they are probably voided during the first two years of life because of the fluid diet of the first two years.

While it is possible that the fluid diet may influence favorably some cases, it is also possible that the fluid diet may in some cases be largely responsible for the condition of urinary lithiasis. As an instance let me quote Robin's goat-milk case: An infant of 16 months was raised on goat's milk. The infant passed uric acid gravel. Analysis of the milk showed excess of casein. Excess of azote or nitrogenous food was found to be the prevailing diet of the goat. The food of the goat was thereon changed, and very promptly the infant's nephritic colics disappeared.

Charvin and several others are inclined to the belief that renal stone in infants and children is a rare condition. Rafin, who collected 39 cases in infants and children either operated on or revealed at autopsy, says: "The small number of cases attests to the rarity of the surgical form of renal and ureteral calculus during infancy," and he then raises the question as to whether this is a real rarity.

Durand-Fardel and Civiale believe nephritic colic in the infant is not a rarity. Gibbons reports six cases in infants of 9 to 23 months. Bokay has collected in Hungary some 1,836 cases of urinary stone in infants and children of ages ranging as high as 15. Of these, 45 were 12 months of age or under, as follows:

Age Months	Cases
2½	1
3	1
5	3
6	6
8	4
9	4
12	26

The bladder stone cases numbered 1,319; one-half the cases were urethral and nine of the cases were of kidney stones. The greater number of cases occurred at 3 to 4 years.

The literature is far from being replete with cases of renal stone discovered and treated, whether successfully or unsuccessfully, during life.

How important in the mortality statistics from birth to 2 or possibly 5 years is the factor of the stone or stones *per se*? How many of the bladder or kidney stones forcing themselves into recognition in later life might be discovered in infancy or childhood? These questions will be taken up later in the course of this paper.

According to Senator it is impossible to make a hard and fast morphological distinction between renal and vesical calculi. Carl Beck believes most vesicle stones come from the kidney. Porter says nephritic calculi are not relatively so rare very early in life as are vesicle calculi.

Certain it is that many of the calculi do not produce any morbid phenomena until they reach the bladder. Moreover, there are numerous instances on record to show that definite and very troublesome cases of stone discovered in young adult life had their origin during infancy or childhood. I have called attention above to the relative of my little patient who was operated on about nine years after gravel was first noticed in his urine. The cases quoted by Monsseaux and Charvin which are arranged in Table 3 are illustrative of this fact also.

The endemic, hereditary, dietary and systemic phases in the occurrence of urinary stone are ably reviewed by Hugh Young in Osler's *Modern Medicine* and will not be dwelt on here. It is a significant fact, however, that the children of the poor are more prone to harbor urinary stone than those of the rich. Von Preindlsberger, in reviewing his 271 cases about Bosnien-Herzegovina, claims that lithiasis is far more prevalent in the Christian population than in the Jewish, most likely by reason of the unfavorable conditions essential to living and the bad prevailing diet of the Christian children.

It is an established fact that males are subject to lithiasis far more often than are females. In the statistics given in Table 1 the males outnumber the females 2 to 1. Bokay's statistics show that only 4 per cent. were girls. Coulson's comparison places the figure at 5 per cent.

Rafin finds urinary stone occurs most frequently on the right side. While we have here in America no regions where lithiasis is essentially endemic, as in Egypt or in Asia, still the condition is known to be fairly evenly distributed over the different parts of this country.

TABLE 1.—SHOWING RECORDED CASES, THE RELATIVE AGES AND SEX PROPORTION AND THE PROPORTION OF AUTOPSY CASES*

Name	Total Cases	Cases at Autopsy	Under 1 Year	1 to 5 Years	Male	Female	Not Stated
Rafin	39	28	0	5	24	11	4
Pitt	3	3	3	...	...	...	3
Charvin	45	10	0	...	...	...	?
Jacobson ...	1	1	0	...	...	...	1
Hance	1	1	1	...	...	...	1
Partridge ...	1	1	1	...	...	1	...
Meigs	1	1	1	...	...	...	1
Langenbeck..	1	1	1	...	...	...	1
Brendel	3	3	3	...	...	...	3
Clubbe	2	0	0	2	2	...	...
Southworth..	1	1	1	...	...	...	1
Aleksinski...	1	0	0	...	1	...	...
Jopson	2	1	0	2	2	...	...
Smythe	4	0	0	4	...	...	4
Sumpter	1	0	0	1	1	...	...
Porter	1	0	0	1	...	1	...
Monsseaux...	77	?	0	9	51	26	...
Comby	48	48	46	2	31	17	...
Joseph	40	40	38	2	27	13	...
Bokay	45	?	45	...	...	...	45
Mandble	1	?	0	1	1	...	...
Dun	1	?	0	...	...	...	1
Jaffrey	1	?	0	...	...	1	...
Drew	1	?	0	1	...	...	1
Nash	1	?	0	1	...	...	1
Totals ...	322	139	140	26	140	70	67

* The males outnumber the females 2 to 1. Of the total number of 322 cases, 139, or over 43 per cent., are post-mortem cases.

ETIOLOGY

The etiology of urinary stone has furnished a subject for much discussion in past times. Heretofore divers theories have been advanced to explain the existence of such calculi. A traditional view holds that the mode of life, diet, and especially nitrogenous diet with wine, beer and little exercise, is conducive to stone. Again, any interference with urinary discharge is regarded as a predisposing factor. English believes a congenital narrowness of the urethra in the second year is a factor in vesicle

calculus in boys. Langstein states that in addition to uric acid infarction, endemic conditions have a decided influence on the formation of a calculus; also, that heredity, especially from gouty parents, and still further, the amount of calcium in the drinking water, are important factors. Phosphatic medication was supposed to have an influence in the occurrence of a stone in an infant case reported by Anozan. Comby states that the cause of stone formation is poor alimentation and inanition.

TABLE 2.—TO SHOW THE AGE DISTRIBUTION OF CASES OF RENAL CALCULUS IN INFANTS AND CHILDREN FIVE YEARS AND UNDER IN ONE HUNDRED SEVEN CASES*

Name	Under 3 Mos.	3 to 6 Months	6 to 12 Months	12 to 24 Months	2 to 3 Years	3 to 4 Years	4 to 5 Years
Comby	11	17	18	2	....	....	....
Pitt	0	0	1	2	....	....	....
Monsseaux...	0	0	1	2	3	2	1
Mandle	0	0	0	0	0	1	....
Joseph	12	15	11	2	....	....	....
Drew	0	0	0	0	0	0	1
Nash	0	0	0	0	0	0	1
Southworth..	1	....	....	....	....	....	....
Meigs	0	0	1	....	....	....	....
Partridge ...	0	0	0	1	....	....	....
Hance	0	0	0	1	....	....	....
Totals	24	32	32	10	3	3	3

* From the above table it will be seen that ninety-eight cases or 91.5 per cent. of the total, are 2 years or under. It will also be found by comparing with Table 1 that practically all of the 91.5 per cent. are post-mortem cases.

The influence of the infectious diseases on urinary lithiasis cannot be ignored. M. Nove-Josserand is quoted by Rafin as having recorded a case of renal stone discovered by the radiograph and recovered at operation in a child who first had a mouth infection followed by bronchopneumonia and later by a grave osteomyelitis. The renal symptoms appeared at the close of the above series of complaints. He quotes, also, Eynard's case, in which the stone was perhaps the result of a grave impetigo. The association of various infectious diseases with urinary stone is also pointed out in connection with Joseph's cases, as seen in Table 4.

Albarran's classification of renal stones into *primary* and *secondary* stone has been widely used, and is utilized by Charvin in his study of forty-five cases in infants and children. The first form (primary) is considered to be due to or at least associated with gastro-intestinal dis-

orders, deficient alimentation or poor elimination. The second form (secondary) is considered to be due to bacterial activity, chemical modification of urinary constituents and precipitation of urinary salts. The primary is believed to occur in the very young and the secondary in older children, or to put it in another way, the secondary form does not occur in the very young infant.

On this problem of the origin of primary renal calculi, Schade furnishes an explanation based on certain scientific facts. To quote Robert Milne's summary of Schade's work:

We must comprehend what he means by the terms "colloids," "reversible" and "adsorption," as applied to this problem. "Colloids" are substances which appear to dissolve in water (e. g., mucin or fibrinogen), but are probably in a condition of suspension, since the osmotic pressure is not affected by their presence. A "reversible" substance is one which can be redissolved after being deposited from solution, for example, a crystal of magnesium sulphate. Mucin is a reversible colloid. Fibrin is an irreversible colloid. Adsorption is the property colloids have of holding in a solution inorganic substances to an extent greater than could be dissolved in an equal quantity of water. He would suggest that, for example, uric acid in urine is held there in its excess by adsorption, on urochrome and other reversible colloids.

Should the uric acid be in excess of the amount which the colloid can hold by adsorption, we can picture the uric acid being deposited on the colloid. Should the colloid be a reversible one, both colloid and deposit can be removed by more water. If the colloid be irreversible, e. g., if that uric acid be deposited on the surface of fibrin, then no amount of water will redissolve that irreversible colloid—the patient is forming a primary renal calculus which no mineral water or drug ever cured. The colloid is the source of the small amount of organic matter found in every primary aseptic calculus. The tendency of fibrin to form laminae is the reason of the laminations of these primary renal calculi, and lastly, to cure that patient we have only to diet him in the future to prevent excess of the substances which formed the stone; we have not only to tell him to prevent relative excess by drinking abundance of water, but we have to discover the cause of fibrinuria, or fibrin in the urine, which occurs apart from hemorrhage. This problem has still to be solved.

Joseph describes, in connection with his study of forty autopsy cases, a peculiar albuminous substance which he found beneath the kidney capsule and also in the Bowman's capsule, morphologically glairy and homogeneous, sometimes occurring in lumps and appearing like fibrin, much the same as the hyaline casts in the urine. He concludes that calculi are caused by renal changes. He observed in kidneys containing stones, changes which were the same as those in the opposite kidneys without stones.

It would be difficult to believe that infection plays any considerable part in the origin of stone during uterine life or in the very young infant. Morris states that the nucleus of calculi formed in infancy is generally urate of ammonium.

SYMPTOMATOLOGY

To await classical symptoms of calculus as may be encountered in the adult is to waste valuable time. Calculus may exist in the kidney without

giving rise to symptoms of any kind. Beck found that whenever there was a calculus in the bladder he found a renal calculus also. There may be serious paroxysms of pain which are the result of the incarceration of stone. Hematuria is not always to be expected, however, when stone is present. Pitt reports a case of stone found at autopsy in an infant of 15 months, in which case no blood had ever appeared on the napkin. The possibility of microscopic blood is to be considered here. The history merely states that the infant passed more water than the other babies in the family.

In the observation of Monsseaux, who reports some seventy-seven cases, hematuria was a sign in but eight of the cases. He mentions a hereditary disposition in forty-four of the cases. According to Durand and Civiale, nephritic colic is not a rarity. Small children are not, however, capable of indicating the site or the character of the pain. The older the child the less difficulty will usually be found. From the sudden onset of pain the child is apt to cry continuously, and while the pain may at first be in the region of one kidney or the other, later in the attack the pain is usually diffused over the abdomen. Nausea and vomiting may occur with greater or less frequency and present a bilious character. The absence of diarrhea will, however, be noted to remove suspicion from a possible essential gastro-intestinal disorder. The face is pale, and, in the words of Monsseaux, "the expression vividly reflects the pain in the suffering infant." After a few hours the crying and restlessness may cease and more or less small gravel may be found in the urine. Or the picture may be that presented by my case in which the first alarm was sounded by a suppression of urine due to an impacted urethral stone, the finding of which led to the suspicion of other stones in the urinary tract. Blood may be found only on microscopic examination. The tendency to a remission of the symptoms renders the condition very chronic in its course.

Mention is made of an occasional case in which urinary stone is associated with disturbances of the nervous system. Monsseaux cites one case in which injury to the head at the age of 6 months was followed by gravel in the urine. Aleksinski's case, having "nervous fits" at 2 years, which will be quoted further on, has also a suggestion of this nature in it.

DIAGNOSIS

An analysis of the urine cannot always be relied on to give specific information leading to the diagnosis of urinary stone, though the urine findings are often suggestive. Microscopic examination of the sediment in a suspected case may disclose blood or pus cells, or crystals of oxalate, phosphate or of uric acid. The urinalysis may, however, present certain constant characters in that the urine may be somewhat abundant, the

specific gravity 1.023, 1.025 or 1.030, the acidity often considerable and a fine precipitate of flakes of uric acid crystals, brilliant and orange colored, to be found, the uric acid being greater than normal.

The history of elimination of sand is an important matter to determine, if possible; also, the history of frequent or painful micturition should be recognized as suspicious of stone. Hematuria accompanies nephritic colic, especially with oxalic gravel, less frequently in the interval between crises of colic. Hematuria of bladder origin is thought by Monsseaux to be very rare in the infant.

Palpation of the kidney, ureter and bladder regions may not reveal the site of trouble until late in the attack. It should therefore be tried again. Eliot reports a case in which the kidney was very much hypertrophied, but was misplaced by an accumulation of gravel (presumably in the kidney-pelvis). Murphy's "first-percussion," in a modified form, may be used over the kidney regions at the back, by employing, instead of the fist as a pleximeter, fairly vigorous percussion with one or two fingers of the right (or striking) hand. This method may serve to differentiate between involvement of the right or left kidney early in the attack.

Differentiation must at times be made from affections of the liver (rare in the infant); also lumbago (rare), Pott's disease and appendicitis. In a case of Weill's, the latter was clearly to be considered in the diagnosis. Nephritis is not rare in the infant. Casts should be searched for. Renal tuberculosis in the infant generally runs an acute course. Other organs are involved. Cancer in infants or young children is not accompanied by renal or ureteral pain. Renal tumefaction should be sought and an examination made for symptomatic varicocele, "always pathognomonic to that age," according to Charvin.

Abdominal pain of a spasmodic character accompanied by vomiting, but without diarrhea, the maximum pain traceable to the kidney or along the ureter, dysuria, rapid recovery from the attack and that followed by passing gravel, leaves little else to complete the diagnosis. In infected calculus, pus and very little blood may overshadow symptoms of its presence.

Rectal examination may be useful in the diagnosis of bladder stone, also ureteral stone. Fagge and Robinson are each quoted by Rafin as having made diagnoses of calculus in the ureter by this method.

Ureteral catheterization in the infant is practically impossible. It is difficult to say at what age such instrumental procedures begin to be practicable. Rafin separated the urine in a little girl of 6 months.

If the radiograph is important as an agent in diagnosis on the adult, it is of even greater importance in the diagnostic endeavor on the infant. Here it has served to point out many errors which occurred in diagnosis

before, and it should be advised in all suspected cases. Hartman speaks of a case in which a radiograph was not made and the surprise was great at finding stone at autopsy. In our day the diagnosis should not be considered complete without a good radiograph. It may not always be complete with the radiograph. It is said by Tenney that a positive plate is more dependable, however, than a negative one, although there is a small degree of error in both negative and positive. In ninety-three of Leonard's cases, five failed to find stone. In 233 of his cases with negative diagnoses, a stone was found at operation, or passed, in four. Carl Beck advises radiographing the kidney region in addition to the vesical when vesical calculus is suspected. It is very desirable that a radiograph be obtained which shows clearly all kidney, ureteral and bladder regions, i. e., the total urinary system. In infants and young children two plates should be sufficient and usually one large plate will suffice. In case two are used, one should show both kidney and upper ureteral regions, the other should include the bladder and lower ureteral regions. The necessity of an instantaneous exposure in the case of a crying and wriggling infant needs no elaboration. Immobility of respiration is practically impossible. The dorsal position is found to be the best. The thighs should be flexed, even to a right angle, if necessary, in order to eliminate the "saddle-back" and to permit contact of the back with the plate. A purge is advisable before the radiograph is made. The table should be warm to lessen trembling.

The knowledge of the localization of stones simultaneously in different parts of the urinary tract is very important. A direct relationship exists between the multiplicity of localization and gravity of operation. Multiplicity of localization also darkens the prognosis.

PROGNOSIS

Charvin states that lithiasis in the adult may be traced back to infancy. This would lead one to believe that the immediate prognosis is good. Gravel, it is true, is generally of long duration. (See Table 3.)

In Table 3 it will be seen that the interval of time between the date of onset, or at which symptoms pointing to disturbances in the urinary tract occurred, and the date of admission, or such time as the patient presented himself for treatment, varies within wide limits. In the thirty-eight cases tabulated it will be seen that the interval above mentioned ranged from six months or less up to forty-one years. This is in evidence of the tendency to chronicity with respect to urinary stone. And here we return to the principle of "survival of the fittest." H. Joseph has made a very praiseworthy study of forty cases *post mortem*, in which stones were found in the kidneys or elsewhere in the urinary tract. None of these were diagnosed during life. Of this material, 65 per cent. were

TABLE 3.—TO SHOW IN THE CASES OF CHARVIN, MONSSEAUX AND PORTER
THE INTERVAL OF TIME BETWEEN FIRST ONSET AND TIME OF ADMISSION;
ALSO, WHERE STATED, SIZE OF STONE RECOVERED

Case	Age on Admission, Years	Age at Onset, Years	Interval, Years	Remarks
Charvin				
4	3½	?	?	Autopsy: Right kidney crammed with small stones. Largest were 12 x 8 mm. (½" x 3/10").
9	10	8	2	Urate calculi.
11	15	14	1	Stone size small pea.
12	12	9	3	
13	6	3	3	Stone wt. 8 gm.
16	10	?	...	¾" x ¼"; cylindrical.
17	9	4	5	
18	6	¾	5	
19	11	9	2	Stone 8 x 6 x 4 cm. in size.
20	10	2	8	
21	12	11-12	½	
22	5	4½	½	
29	7	4	3	
32	14	12	2	
35	4	4	0	
37	15	15	0	
39	4	3	1	Stone wt. 33 gm.
40	7	?	?	Stone wt. 18 gm.
41	11½	1	10	
42	11½	3	8	
43	9	6	3	
Adult Cases				
46	16	10	6	Stone wt. 25 gm.
47	18	12	6	
48	19	15	4	
49	19	7	12	
50	20	12	8	
51	24	4	20	
52	24	6	18	
53	46	5	41	
Monsseaux				
1	19	5	14	
2	21	12	9	
3	31	10	21	
4	33	15	18	
5	24	12	12	
6	29	7	22	
7	43	8	35	
8	48	13	35	
Porter Case				
..	4	½	3½	Stone wt. 3.9 gm.; size 7/8" x 3/8".

bilateral cases. I have arranged some of his statistics in tabular form, as will be shown in Table 4.

The evident predominance of bilateral involvement, as shown by Table 4, bears out Rafin and Charvin in that the prognosis becomes more somber with multiplicity of involvement. On 76 observations at autopsy Legeu found thirty-six (nearly 50 per cent.) cases of bilateral calculi. Kuster, who bases his study on clinical facts, arrives at the proportion of 11.78 per cent. bilateral stones. Leroy found 22 per cent. of bilateral renal or ureteral stones. Of the cases operated on by Rafin he found four bilateral cases, or 8.8 per cent. A highly important lesson to be drawn from the preceding information, therefore, considering the high mortality of cases of multiple involvement, is that the cases must be discovered and treated earlier, before destruction of kidney substance progresses to cripple the organ or infection becomes a complication.

Cuturi determined from his animal experiments three very potent conclusions: (1) *B. coli* reaching the healthy kidney by way of the bloodstream causes no lesion. It simply causes bacteriuria. (2) *B. coli* in the kidney complicated by calculus provokes pyelonephritis and pyonephrosis. (3) Experimentally, by separation or ligation of the rectum for twenty-four hours, one obtains a pyelonephritis by the passage of *B. coli* to the kidney by way of the blood, after ligation of the ureter. If, therefore, the above conclusions apply to the human, an individual harboring a primary stone runs a greater chance of secondary infection when constipation exists.

When, after much trouble, the kidney ceases the struggle and there occurs a complete disappearance of symptoms, the relief affords a sense of false security, for in the words of Rafin: "*Ce silence sera le signe de la mort de l'organe*" — the silence will be the sign of the death of the organ.

Ureteral stone as well may occasionally take on a serious aspect if it becomes incarcerated. Guisy reports the case of a little girl of 12 in whom a mixed urate and phosphate stone became lodged in the ureter and caused a lumbar abscess, necessitating incision and removal of the stone.

A large number of Monsseaux's patients, many of them older children, were subjects of migraine headache, eczema, epistaxis and conjunctivitis; some were asthmatic, some had urticaria at intervals, others had transient articular manifestations without fever or swelling, but some pain. In his opinion, if the infant is without hereditary taint, the calculus of an accidental sort, due to alimentary disorders and poor hygiene, etc., the prognosis is not too severe and the patient's chances are good under better conditions. If, on the contrary, the infant is an inveterate arthritic subject, with bad heredity, presenting at the same

TABLE 4.—COMPILED FROM JOSEPH'S FORTY AUTOPSY CASES IN INFANTS TWO YEARS OR UNDER, TO SHOW THE RELATIVE FREQUENCY WITH WHICH URINARY STONE AND COMPLICATING HYDRONEPHROSIS ARE ASSOCIATED WITH INTERCURRENT DISEASES IN OTHER REGIONS OF THE BODY

Post-Mortem Findings	Nephrolithiasis			Hydronephrosis				
	Left Kidney	Right Kidney	Bilat.	Left	Right	Bilat.	Bladder Stone	Totals
Atrophy	1	2	2	1	...	...	...	6
Tracheitis	...	...	1	...	...	...	...	1
Enteritis	2	4	8	2	1	...	...	17
Otitis media	1	1	2	...	...	...	2	6
Gastro-enteritis	...	...	2	...	...	...	...	2
Abscess submax. gland...	...	...	1	1	...	...	...	2
Cardiac dilatation.....	1	1	4	1	...	...	...	7
Bronchitis	1	...	1	1	...	...	...	3
Edema pia mater.....	...	...	1	...	...	...	...	1
Hyper. mes. lymph-nodes	...	1	3	...	...	1	...	5
Rachitis	...	2	4	...	...	...	...	6
Hemorr. pia mater.....	...	...	1	...	...	...	...	1
Hydrothorax	...	1	...	...	1	...	...	2
Lobar pneumonia	...	2	5	1	1	...	...	9
Ascites	...	1	...	...	1	...	...	2
Bronchopneumonia	1	2	7	...	...	1	...	11
Meningitis	...	...	2	...	...	...	...	2
Hydrocephalus	...	2	2	1	...	...	...	5
Colitis	...	1	2	1	...	...	...	4
Cystitis	...	...	1	...	...	...	...	1
Abscess mult. cutaneous..	...	...	1	...	...	...	...	1
Osteochondritis	...	...	1	...	...	...	...	1
Miliary tuberculosis.....	...	...	1	...	...	...	...	1
Intestinal tuberculosis...	...	...	1	...	...	...	...	1
Pulmonary tuberculosis..	1	...	1	...	...	...	1	3
Meningeal hemorrhage...	...	1	1	...	...	...	...	2
Diphtheria	...	1	1	...	...	...	...	2
Carbuncle and furunculosis	1	...	1	...	...	...	...	2
Pararectal abscess	...	...	1	...	...	...	...	1
Totals	9	22	58	9	4	2	3	107

It will be seen from this table that diseases of an infectious nature occur in association with calculus and hydronephrosis 70 times out of 107, or 65 per cent. Enteritis and gastro-enteritis are associated with urinary stone and hydronephrosis 19 times; rachitis 6 times; lobar and bronchopneumonia 20 times.

Respiratory tract associated with stone or hydronephrosis 29 times.

Alimentary tract associated with stone or hydronephrosis 25 times.

Systemic diseases associated with stone or hydronephrosis 15 times.

Nervous system associated with stone or hydronephrosis 11 times.

Glandular system associated with stone or hydronephrosis 7 times.

time habitual manifestations of the diathesis, is subject to migraines, epistaxis, gastro-intestinal trouble or joint-pains, tends to obesity, in a word, is not uremic or arthritic on occasion, but by temperament, and is rebellious to treatment and subject to recurrences, the outlook is not so good.

TREATMENT

One is confronted in the older literature with the various methods of dietary and medical treatment. In the more recent literature the surgical treatment of urinary stone finds more frequent discussion. Unless the calculi are discovered earlier and removed promptly the mortality will remain high. Calculi in the infant kidney or ureter should be expelled or relieved surgically. The destruction of kidney substance, the blocking of a ureter, the danger of infection, are matters for grave consideration when a calculus is the impeding object. Delay, as suggested by Charvin, enhances the operative risk in that nephrectomy may be necessary in the late stage, where nephrotomy would have sufficed in the early stage. Statistics favor operative relief. Jeanbrau believes the danger of the presence of stone in infants is greater than surgical interference. Sumpter reports a case of bladder calculus in a boy baby 22 months old, removed suprapubically with good result and no recurrence. Porter reports the case of a baby girl first seen at the age of 6 months. She had had colic for two years or more, passing fully a drachm of calculi of small size. Operation was done at 3 years 10 months, and a 60-gram calculus recovered suprapubically. Good recovery followed.

The very instructive case recorded by Aleksinski is worthy of citation here:

The boy was first seen at 7 years, his complaint being painful micturition. At two he had "nervous fits" which were never accurately diagnosed; at five pleurisy with effusion; at 6 he began to have painful micturition, a thin stream and frequently interrupted. The urine contained pus and blood. The temperature ran as high as 104 F. A diagnosis of vesical calculus was followed by suprapubic removal of the stone. A month later his old symptoms reappeared. Urine 1.007, daily quantity 1,500 c.c., acid, turbid, pus and blood cells, oxalates and mucus. Albumin present. Bacteriological examination showed *B. coli*. Radiograph showed shadows in both kidney regions. Nephrectomy on the right side brought forth three stones the size of walnuts. The urine presented no improvement and three weeks afterward at operation the left kidney yielded four stones. Following this last operation he sat up on the eighth day and was discharged on the seventeenth day. Seven months afterward he was well and the urine was normal.

As in the case just cited, where extensive involvement exists it is an accredited procedure to operate in successive stages. Attention to the bladder stones with neglect of the kidney condition is generally a grave injustice to the patient. The wisdom of finding out beforehand, if possible, the localization of stones simultaneously in different parts of

the urinary tract is therefore very important. In eleven operations done by Rafin on infants and children, five were for aseptic stone; six infected. Two had multiple operations. Ten were nephrotomies. Three were nephrectomies. A pyelotomy was done in one case. Recovery occurred in all of the cases.

Such information as it is possible to obtain by means of the cystoscope and the ureteral catheter in adult cases is seldom if ever possible in the child or infant, and this augments the responsibility of doing a nephrectomy. When dealing with the adult, part of the responsibility is shared by the cystoscopist, who has decided before operation, the adequacy of the other kidney. With the infant or small child the weight of responsibility of removing a diseased kidney rests almost entirely on the operator. Examination of both kidneys through lumbar incisions before deciding the operative procedure may save an occasional fatality.

CONCLUSIONS

1. In the past, urinary lithiasis, especially renal, has been accompanied by a high mortality.

2. Of the cases of renal calculus in children 5 years or under, more than 90 per cent. were 2 years or under, and practically all of those were *post mortem* cases.

3. There is a paucity of case reports of renal stone in infants discovered and treated surgically during life.

4. Calculi discovered in older children or in adult life frequently originate in infancy or childhood.

5. The finding of sand or gravel in the infant urine is sufficient reason for advising radiographic examination of the urinary tract.

6. Gravel may be of long duration, ranging from six months or less up to forty-one years.

7. Diseases of an infectious nature occur in association with calculus and hydronephrosis 70 times out of 107, or 65 per cent.

8. Diseases of the respiratory tract are associated with urinary stone or hydronephrosis most often.

9. Bilateral or multiple calculi in the urinary tract offers a condition with an unfavorable prognosis.

10. To better the prognosis, cases must be discovered and patients treated earlier, before destruction of kidney substance progresses to cripple the organ, or infection becomes a complication.

11. Surgical interference is an accredited procedure. When multiple involvement exists, operation in successive stages may be done.

12. Greater responsibility is attached to nephrectomy in the infant by reason of the difficulty of ascertaining the functional capacity of the opposite kidney.

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