has been performed 11 times. Seven patients survived the operation one month; but of these, only 4 lived out the year and only 2 survived three years.

A radical cure may be attempted in several ways. Chavannaz reports 3 cures by dilating the fistula and scraping its rectal extremity. Suprapubic section and suture of the vesical end of the fistula improved 1 case. Inasmuch as fistulæ between the bladder and intestine above the rectum are almost all either tubercular or malignant, they are only susceptible of palliation by colostomy. Vesico-rectal fistulæ may be operated upon by the methods employed in the treatment of urethro-rectal fistulæ (p. 247).

CHAPTER XXVIII

URINARY CALCULUS—VARIETIES—ETIOLOGY—VESICAL CALCULUS—MORBID ANATOMY—SYMPTOMS—DIAGNOSIS—TREATMENT OTHER THAN RADICAL

URINARY CALCULUS

A URINARY stone, or calculus, is a body resembling a stone in its general characteristics, and formed of crystalline urinary salts (exceptionally of other substances) held together by viscid organic matter, and showing, microscopically or to the naked eye, a laminated structure.

FIG. 98.—SECTION OF A PHOSPHATIC STONE, SHOWING EXCENTRIC DEVELOPMENT.

All true calculi are composed of a nucleus, single or multiple, and layers more or less concentric of the same or of another material arranged around it (Figs. 98, 99, 100). This is the case for large as well as for microscopic calculi, even for those requiring a magnifying power of 250 diameters (Beale) to make out their lamination. This fact of lamination alone differentiates calculus from gravel, the latter being crystalline dust or concretions of crystals more or less large, but not possessed of definite structural arrangement.

The *nucleus* of a stone may consist of whatever, among the organized, crystalline, or earthy constituents of normal or pathological urine, is capable of concreting into a more or less solid mass; or it may be a foreign substance either coming from within the body or introduced from without. The nucleus is usually in the centre of the stone (Figs. 99, 101). An unusual excentric development is shown in Fig. 98.

The calculus takes its distinguishing title from the salt or salts

which enter chiefly into its composition. Thus a phosphatic stone is usually accepted as a stone composed apparently of phosphates, though it may have a nucleus of some other salt (Fig. 101). The classification of stones according to the nature of their nuclei would have its advantages, but it is clinically impracticable.

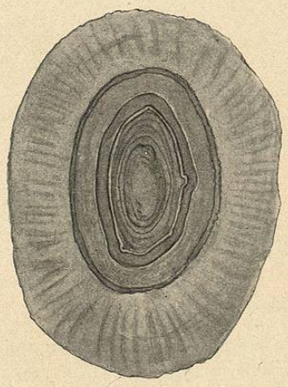

Fig. 99.—Uric-Acid Stone (Section).
The marked central lamination suggests a preponderance of uric acid, while the more amorphous periphery shows an intermixture here of urates.

Varieties

The more refined and obscure points relative to the varieties of stone and their pathogenesis cannot be dwelt upon here. I have considered the subject at length in another place.[1] All stones come under one of the following groups:

Primary stone, which develops in an acid urine without any antecedent inflammation, may consist of uric acid, urate of soda, lime, or potash, oxalate of lime, cystin, xanthin, carbonate of lime, crystalline phosphate of lime, or indigo.

Secondary stone, which develops in an alkaline urine as the result of inflammation, may consist of ammonio-magnesium phosphate (triple phosphate), amorphous phosphate of lime, tricalcic phosphate, urate of ammonia, or urostealith.

Among the primary stones only those composed of uric acid, oxalate of lime, and urates are common; the other varieties are extremely rare. Secondary stones are commonly formed of mixed phosphates, very rarely of urate of ammonia or urostealith. Primary calculi are usually formed of the same substance throughout, while secondary phosphatic calculi are often found about a primary stone as a nucleus. While the proportions vary in different countries, uric acid forms the nucleus of from 50% to 80% of all stones.

Fig. 100.—Oxalate of Lime (Mulberry) Stone.

Uric Acid.—Uric-acid stone is the most common in the human subject. It may be mixed intimately or in layers with urates, oxalate of lime, or phosphates. It does not attain a very great size, and may be single or multiple. In structure it is either laminated or amorphous.

[1] Internat. Encycl. of Surgery (Ashhurst), vol. vi, p. 145.

The laminated uric-acid stone is of a dark reddish-brown colour, very hard and heavy. When cut and polished it resembles an agate,

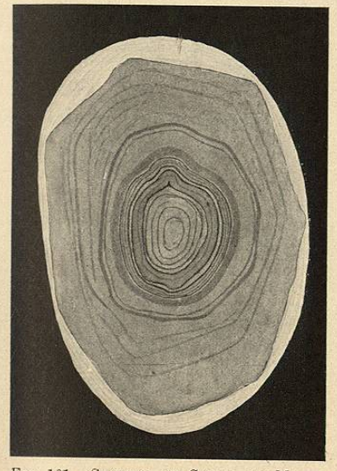

Fig. 101.—Section of Stone of Mixed Uric Acid and Oxalate of Lime, coated with Phosphates.
Such a stone would pass for phosphatic on inspection.

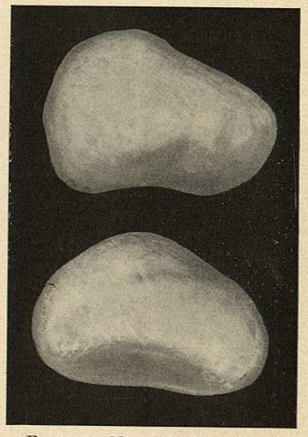

Fig. 102.—Multiple Phosphatic Stones (Natural Size).
The irregular shape is due to friction. (There were 6 similar stones in this case.)

displaying a concentric arrangement of irregularly curved lines of slightly varying colour and thickness (Fig. 99). The amorphous variety is much less common. It is rather soft, gritty looking, and comparatively structureless on section. It is of a reddish-yellow colour and composed chiefly of urates, and hence is commonly known as urate stone.

Oxalate.—Oxalate of limestone is commonly single, blackish-brown in colour, and very hard. It is usually covered with blunted asperities, whence it has acquired the name of mulberry calculus (Fig. 100). Upon section it shows undulating laminæ, which may vary widely in colour, as there is often an admixture of uric acid or phosphates in the composition of this stone (Fig. 101).

Phosphate.—Mixed phosphatic or fusible calculus is the common secondary calculus. It may grow to an enormous size, and may be single or multiple (Figs. 101, 102, 103). It forms around a primary calculus, a blood clot, or a foreign body. It is granular, soft, light in weight, and of a dirty white colour. It may be amorphous or laminated.

The other forms of calculi are so rare as to require no special

mention. Cystinuria has a medical rather than a surgical interest. (*Cf.* Cohn [1] and Moréigne.[2])

Etiology

The causes of stone formation are extremely obscure. Secondary (phosphatic) stones are known to result from the changes in the urine commonly known as alkaline fermentation. Such calculi are frequent in old men suffering from the cystitis of prostatic hypertrophy, and are less frequently met with as the result of other forms of inflammation. But the etiology of primary calculus is most obscure. Primary stones are very uncommon in women. The negro is said to be singularly exempt, and there are two periods of life during which they are most frequently found—viz., in the first two and in the fifth decades of life. But the most notable feature of the occurrence of primary stone is its great frequency in certain localities and its comparative rarity in others. Thus India leads the list with hundreds of operations a year. Egypt, perhaps, comes second, and North America is, as a whole, comparatively exempt. Yet in certain parts of India primary calculus is quite as rare as it is with us, and it has also been observed that the tendency to stone among the inhabitants of a certain district seems to increase or decrease regularly over a long period of years. To explain these vagaries various theories have been adduced. The influence of climate, the soil, the water, the civilization of the inhabitants, as affecting their occupations, the diet, especially the amount of salt habitually taken—all of these and various other factors have been implicated.

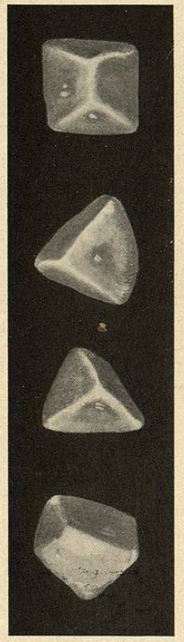

Fig. 103. — Multiple Small Phosphatic Stones (Natural Size).

These stones are selected from a group of 33 similar ones. These small stones show sharp faceting from friction.

There is some evidence of a hereditary tendency to stone formation closely allied to the uric-acid diathesis. Indeed, the predisposing cause of primary stone is undoubtedly the presence of crystals in the urine. Without crystals there can be no calculus, yet the urine may contain crystals for years and no stone form.

[1] Berl. klin. Woch., 1899, xxxvi, 503.

[2] Guyon's Annales, 1899, xvii, 803, 910.

A notable example is the phosphaturia so common in the young. It may continue for years, and the urine may be so thick with phosphates that the terminal drops, if they fall upon the patient's shoe, give the effect of a splash of mortar. Yet phosphatic stone is never due to this phosphaturia. In point of fact, the microscope reveals that a urinary calculus is made up, not of the sharp-pointed crystals so commonly seen in the urine, but of rounded masses, showing neither angles nor polarity, and consisting of an amorphous collection of granules of a urinary salt embedded in a structureless, albuminous substance. If true crystals appear, they occur simply as foreign bodies entrapped in the stone. Rainey and Ord have conclusively shown that the determining cause of calculus is the increased density of the urine and the presence of colloid substances in solution, in conjunction with an excess of urinary salts; for "a crystalloid is deposited from solution in the presence of a colloid," and crystals introduced into a colloidal solution are disintegrated and re-formed by simple, molecular coalescence. Thus the nucleus of a stone is always laid down in an albuminous substance. A blood clot, a foreign body surrounded by the muco-pus which it stirs up by its presence, are common examples—and once the nucleus has formed, it is always in such a foreign body surrounded by albuminous matter that new layers of stone are constantly being formed.

The rate of growth of a stone must vary greatly, and although it would be most interesting to be able to estimate by the size of a calculus how long it had existed, such an estimate cannot be made with any accuracy. Thus it is known that phosphatic stones grow, as a rule, much faster than primary ones, and yet I have removed a uric-acid calculus weighing 2 ounces from a boy nine years old, and a hair-pin from a girl's bladder (in which it had remained for more than a year), which was encrusted with less than a dram of phosphates.

VESICAL CALCULUS

Number and Shape.—Single calculi are generally rounded or ovoidal in shape (Figs. 98, 99, 100, 101). When a calculus is unusually elongated it is suggestive of the presence of several nuclei or of a foreign body. Calculi formed about foreign bodies are always phosphatic (Fig. 122).

Multiple calculi are usually phosphatic, less frequently urates. In general, their number bears an inverse relation to their size. When few in number they influence one another's shape and grow to be many-sided rather than rounded (Figs. 102, 103). Hence when a stone passed spontaneously presents one or more flat sides or

facets, the presence of other stones in the bladder (or kidney) may be inferred.

Fantastic dumb-bell and other shapes are assumed by encysted calculi (Fig. 104), part of the stone taking the shape of the pocket which contains it, while the remainder protrudes irregularly into the vesical cavity.

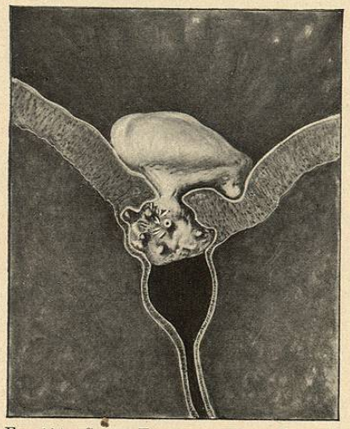

Fig. 104.—Stone Encysted in the Orifice of the Ureter.

Size.—Partly on account of the infrequency of stone, partly on account of the surgeon's omnipresence, large stones are rarely seen in this day and in this country. The largest stone in my collection weighs 5 ounces. Dr. Thomas Smith[1] removed a stone weighing 24½ ounces, and Lieutenant-Colonel Bamker[2] one weighing 25 ounces. Both were phosphatic.

Morbid Anatomy

The changes which the calculus itself undergoes have been noted above, except the rare phenomenon of spontaneous fracture. Spontaneous fracture is apparently due to long-continued dilution of the urine, which weakens the colloidal framework of the stone sufficiently to permit it to break into pieces. This rare phenomenon has been taken advantage of by the purveyors of various lithia waters. The claim that any water or drug will infallibly, or even probably, cause spontaneous fracture of stone is not based on any very good theory, and is not supported by experience. Moreover, when the calculus does break it is not to be expected that all the fragments will be expelled. One or more will remain in the bladder, and around these as nuclei new stones will form.

The changes in the bladder caused by the presence of stone are primarily congestion, secondarily inflammation. The little hard calculus rolling about over the mucous membrane of the bladder keeps that tissue in a constant state of irritation and congestion, which manifests itself in hemorrhage and pain—the early symptoms of stone. Sooner or later infection occurs upon the *locus minoris resistentiæ* and the cystitis of stone adds its pyuria and dysuria to the signs of irritation.

[1] Lancet, 1886, ii, 244.

[2] Med. Record, 1900, lviii, 637.

As the stone grows larger it tends more and more to settle in one particular spot, which it ulcerates and gradually distends as a niche or pocket into which the stone fits quite accurately. Hence it is very useful in the operation of litholapaxy to determine the exact spot in which the stone is first found, for the broken fragments usually show a decided tendency to gravitate to that spot in preference to any other. The favourite position for a stone in the bladder is in the *bas fond* immediately behind the neck of the bladder. Exceptionally, the stone rests in a diverticulum of the bladder or sends out prolongations into the ureter or the urethra.

Rupture of the bladder or the urethra containing a stone is exceptional, and is usually due to the abscess formation which itself is rare.

Symptoms

There is no symptom, no set of symptoms, absolutely and invariably pathognomonic of stone in the bladder, except the physical signs elicited by the surgeon's examination. Yet there is a certain group of symptoms which is very suggestive of stone. Chief among these are frequency of urination, pain, and hematuria, occurring by day and increased by exercise.

Frequency of Urination and Pain.—The pollakiuria and dysuria of stone are usually intense. They appear early in the disease and are the patient's chief complaint from beginning to end. The characteristic distress is absent during the night while the patient lies quietly on his back, and during the day so long as he is still. But every jolt induces spasm. When walking the patient moves slowly and gingerly, almost on tip-toes. Riding over a rough road or in a railroad train, or even walking downstairs, is misery. The pains are situated chiefly in the glans penis, along the pendulous urethra, and in the perineum. The desire to urinate is quite irresistible. Such is the distress, sometimes mild, sometimes severe, caused by the mere presence of the stone. As a result of some extra exertion or an acute infection, the patient, from time to time, has what is known as a *fit of the stone*. During this time his pains are greatly intensified. He may have to urinate as often as every ten or fifteen minutes day and night, so that he spends his time in one long spasm.

As the stone grows larger and the cystitis more intense these paroxysms become more and more frequent. They exhaust the patient's strength, and during them he resembles a woman in the second stage of labour. In children, prolapse of the rectum and involuntary defecation are common results of this straining; while adults complain of hemorrhoids, pass blood by the rectum, and during the paroxysms suffer from unavoidable escape of intestinal flatus and often

of feces. When there is considerable prostatic hypertrophy or the stone is encysted, there is less tendency to dysuria, so that even with intense cystitis the paroxysms may be neither frequent nor severe.

Hematuria.—Hematuria, like the characteristic dysuria, is traumatic in origin, and is, during the first stages of the disease, only aroused by some jolt. It is usually associated with dysuria, and the hemorrhage, though profuse, is usually short-lived. Later in the disease the perpetual straining due to cystitis may make the hematuria quite continuous.

Stoppage.—Sudden stoppage of the urinary stream is a symptom of stone which is peculiarly characteristic though not very common. It is caused by the stone rolling into the vesical orifice and plugging it like a ball-valve. Striking cases, like that of Sir Henry Thompson, whose patient could urinate only while lying on his back, are most uncommon. Prostatics with stone do not show this symptom, and it may be caused by prostatic or vesical tumour.

In children certain special symptoms are associated with stone, notably priapism and a tendency to pull at the prepuce, with a resultant lengthening of that tissue.

Certain reflex pains in the back, testicle, eye, and sole of the foot (pododynia) are among the infrequent symptoms of stone in the bladder.

Course of the Disease.—Although a stone may lie quiescent in the bladder for many months, it usually begins to set up irritation before long. There may be a history of renal colic or of the introduction of some foreign substance into the bladder; there may be a long history of chronic cystitis, or there may be no suggestion of how the stone began. Then, after a longer or shorter time, appear the characteristic dysuria and hematuria, more or less clearly marked. Later, if there is no cystitis already, infection occurs, and leads gradually, by repeated attacks of greater frequency and intensity, to the perpetual spasm described above.

Diagnosis

Every case of painful or hemorrhagic cystitis should be searched for stone. Although the subjective symptoms just described may be absolutely characteristic, in most cases they are confused and ill-described by the patient, so that the only means of making the diagnosis clear is to search.

Sounding or Searching for Stone.—Many different ways have been suggested to prove the existence of stone in the bladder. Among these the cystoscope and the X-ray have grown in favour of late. The cystoscope is fallacious even in the hands of the most expert.

Stones, as seen through it, have been mistaken for tumours and prostatic outgrowths, and its use is often difficult as well as painful, on account of the bleeding and the excessive sensitiveness of the neck of the bladder. The X-rays are even less accurate. In contrast with these methods by which the surgeon endeavours to see the stone, are the old proved methods of touch. Nothing is so characteristic, so entirely unmistakable as the click of a stone against a searcher. It is alleged that the stone may be so covered with mucus as not to click, and that a stone in a saccule of the bladder or behind a hypertrophied prostate cannot be touched by the searcher. I can only say that, in a lifelong experience, I know of several cases whose stones I have overlooked; but in every one of these I either did not make the attempt or was unable to introduce a searcher. Once only have I found a small, untouched stone behind a large prostate a few weeks after a supposedly successful litholapaxy. Yet I have often touched stone after others had failed to do so, and must believe that the searcher is a no more accurate means of diagnosis than any other instrument, unless guided by a practised hand. I have been able to identify a stone by its impact against a soft-rubber catheter, and I have often employed in the final search, after litholapaxy, a Bigelow aspirator

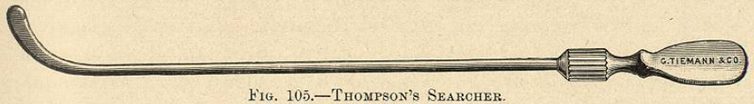

Fig. 105.—Thompson's Searcher.

(p. 449) in the hope of obtaining a click from a very small fragment. But for routine use there is no instrument so well borne by the patient, so easily and quickly manipulated by the surgeon, and so accurate in its results as the Thompson searcher (Fig. 105). The addition of a sounding-board, a stethoscope, a microphone, or a wax covering only detracts from the simplicity of the operation.

To *sound for stone*, the patient is placed upon a table or a firm couch, lying upon his back, with the shoulders low and the pelvis raised upon a hair cushion or some other solid support, so that it may be several inches higher than the shoulders.[1] The thighs and legs are extended and lie flat. The bladder should, when possible, contain about 100 c. c. of fluid, either the patient's urine or a warm boric-acid solution. The difficulty is not to recognise the stone when it is touched, but to touch it at all if the bladder is capacious; for it

[1] If the stone is movable and the bladder contains fluid, when the pelvis is raised higher than the shoulders the stone will roll away from the tender neck of the bladder and rest at the fundus behind the trigone, where it is most easily found.