2. In general cicatricial contraction of the stomach, due to the swallowing of caustic fluids, in which the stomach has been so far damaged that it no longer performs its functions or even allows of the passage onwards of food.

3. In chronic ulcer of the stomach giving rise to haemorrhage, pain, or vomiting, and to malnutrition; and where the patient is too ill to bear partial gastrectomy, which can, however, be subsequently done if thought needful after the patient's condition had been restored by adequate feeding.

4. In some cases of chronic duodenal ulcer, associated with hyperchlorhydria, in which there may be a fear of jejunal ulcer subsequently developing if gastro-enterostomy be performed.

5. In certain cases of duodenal ulcer in very stout subjects where it is extremely difficult to perform a posterior gastro-enterostomy, and in which violent haemorrhage has only recently occurred and may be again excited by dragging on the stomach.

6. In jejunal or gastro-jejunal ulcer where the patient is thought to be too ill to bear one of the extensive operations previously mentioned; or where, the disease being slight, it is thought that the complete rest to the stomach and upper jejunum that can be given by a jejunostomy will at the same time relieve the hyperchlorhydria and cure the ulcer. Neumann has, in fact, suggested the operation for hyperchlorhydria alone.

7. In recurring haematemesis failing to yield to ordinary treatment, and where on exploration no ulcer or other removable cause can be discovered.

8. In persistent vomiting threatening life, as in the severe and sometimes fatal vomiting of pregnancy, where no food whatever can be retained in the stomach.

URETHRAL CALCULI,

WITH SPECIAL REFERENCE TO ENCYSTED CALCULI
OF THE PROSTATIC URETHRA.

BY

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NOMENCLATURE.

SOME discussion has found a place in the literature of this subject as to the proper application of the term "urethral calculus." The term should be used for all calculi which are lodged in the urethra, whether formed in the urethra itself or elsewhere. A calculus in the bladder is none the less a vesical calculus if there is evidence of its having descended from the kidney, and the same applies to urethral calculi. The question of nomenclature was first raised by Lieblein,¹ who argued that the title "urethral stone" should be used only for stones which are formed primarily in that channel, or stones arrested in the urethra which increase in size after lodgement. The same argument was developed by Kaufmann,² and has been approved by others. It would introduce, however, an entirely new principle into the nomenclature of calculi in the urinary passages, and upon clinical grounds there is much to be said against it. With regard to calculi in general, the qualifying adjective used has always been one which has reference to the site of the stone at the time of description; the adjective is clinical, and has no pathogenetic significance. The adjective "urethral" should be employed in this sense, and the attempt to give it a pathogenetic significance is, in the present writer's opinion, misdirected.

IMPACTED CALCULI.

Urethral calculi are either calculi which have been formed in the urinary passages above and have lodged in the urethra, or calculi which are formed in the urethra itself, or in some cavity or channel communicating with it.

The lodged or impacted calculi of the urethra are vesical or renal in origin. While sufficiently small to engage in the urethra they are too large to pass, and are arrested behind some natural or acquired strait in the passage. In a paper published in 1904 Englisch³ collated the records

of 400 such cases. Among these the sites of impaction were:

In the navicular fossa	...	...	11.2 per cent.
In the pendulous portion	...	...	14.5 "
In the scrotal portion	...	...	13.7 "
In the bulbous portion	...	...	18.6 "
In the membranous portion	...	...	42.0 "

No reference is made in the paper to calculi impacted in the prostatic urethra. That calculi do lodge in the prostatic urethra is well known, either in the bladder neck or where the prostatic joins the membranous portion.

It is a matter for surprise that the proportion of calculi recorded as lodged in the membranous urethra is so large when regard is had to the anatomy of this segment of the urethra. The membranous urethra is about half an inch in length, bounded above and below by the superior and inferior triangular ligaments; it is surrounded by an annular coat of unstriated muscle, and it is further supported by the fibres of the compressor urethrae. It is also a matter for surprise that Englisch should speak of the great distensibility of this portion, and explain on this ground the frequency of acquired urethral diverticula here. It is difficult to avoid the conclusion that many of these so-called membranous urethra diverticula are in reality diverticula of the prostatic urethra where it abuts on the superior triangular ligament, and that many of the calculi recorded as impacted in the membranous urethra have been, in fact, in the terminal part of the prostatic urethra. The prostatic urethra is the most dilatable portion of the channel, and once the superior triangular ligament is pierced the urethra is surrounded and supported by the muscular structures above referred to. A calculus or pouch behind the triangular ligament is of the prostatic and not of the membranous urethra. The term "membranous urethra" has not, in fact, been employed in so strict a sense by surgeons as by anatomists—even so precise a writer as Young speaks of opening the membranous urethra in the course of a dissection behind the triangular ligament.

Impacted calculi, having their origin in the urinary channels above, exhibit the varieties of structure of vesical and renal stones. They are comparatively frequently met with in children; out of 324 cases in Englisch's paper in which the age was known, 127 were under 15 years of age and 66 under 6 years of age.

In children the points of impaction are behind the natural straits of the urethra. In the adult acquired straits, that is, strictures, play the most important part in determining the site of arrest. If they remain in position they set up changes in their surroundings and also undergo changes themselves. Irritation of the urethral wall leads to ulceration, and the obstruction offered by the calculus to the stream of urine causes dilatation behind the site of impaction. The stone itself tends to increase in size by the deposit of phosphates upon its surfaces. Such secondary deposit is always phosphatic. The diagnosis and treatment of impacted urethral calculi are discussed in the textbooks and are well understood.

ENCYSTED CALCULI.

By encysted urethral calculi is here understood calculi which lie in pockets or diverticula communicating with the urethra. It is convenient to consider first diverticula of the anterior urethra in front of the superior triangular ligament (the urethra proper), and secondly, diverticula of the prostatic urethra, which is the representative of the primitive urogenital sinus.

Diverticula of the urethra proper are congenital or acquired. The congenital diverticula are due to imperfections and abnormalities in the union of the genital folds which bound the genital groove. Complete failure of union of these folds results in hypospadias; imperfect union may leave a pouch of greater or less extent, and the dermoids of the median ridge described by Timofeev⁴ owe their origin to the same cause. Such congenital pouches are almost always found on the proximal side of the glandular portion, and from this point extend for a greater or lesser extent towards the scrotal fold. Acquired diverticula are more common, and arise from a variety of causes. They may be retention cysts of urethral glands or blood cysts which burst into the urethra. Other causes are strictures and operation scars, and a urethral fistula may end in the formation of a diverticulum. An impacted

calculus may form a pouch for itself by pressure ulceration of the urethral wall, and it may come to lie entirely outside the urethral channel; the pocket in which it lies is then an acquired diverticulum of the urethra.

The diverticula of the prostatic urethra are also either congenital or acquired. On the floor there is normally a median recess, the sinus pularis, which represents the persistent lower common extremity of the ducts of Müller. In the adult it is a cul-de-sac which runs upwards and backwards for 6 to 12 mm.; its upper extremity lies behind and beneath that part of the prostate which underlies the urethral floor, and in some cases reaches to the posterior surface of the gland. Congenital abnormalities of the sinus pularis are on record, and are referred to below. Possibly some of the congenital diverticula of the prostatic urethra are due to abnormalities of the urogenital sinus where it joins the urethra proper. Acquired diverticula occur in two situations—at the proximal and at the distal extremities. A certain number of those at the proximal end, near the bladder neck, are produced by prostatic calculi; these stones form pockets in the substance of the gland, which pockets tend to establish communications with the urethral channel. According to the observations of Englisch⁵ and Vollemier,⁶ cysts of the prostate underlying the urethra are responsible for another form of acquired diverticulum of the vesical end of the prostatic portion. Chronic abscesses of the prostate may also, by opening into the urethra, create a pocket in which a calculus might lodge or form. Diverticula of the distal end are produced by impacted calculi which lodge in the urethra on the vesical aspect of the triangular ligament, become embedded, and form pressure diverticula.

The composition of encysted stones has been relied on to decide the question of their origin, it having become an accepted doctrine that only phosphatic stones are formed *in situ*, and that urate, uric acid, and calcium oxalate stones found in diverticula must have come down the urethra from above. Tillmanns says stones formed in the urethra are "almost always phosphatic"; others are more dogmatic; Kaufmann, for example, stating that they are always so.

There is no obvious reason why calculi of other composition should not be formed in preformed diverticula, at any rate. Those described by Lieblein⁷ were urate, and he considered them formed *in situ*, on account of the absence of symptoms pointing to their descent. Finsterer⁸ recorded two cases: one of a large urate stone with a delicate coating of phosphate; another a mixed urate and oxalate stone with a small amount of phosphate; he considered both formed *in situ* in diverticula. In 100 cases of diverticulum stone collected in Englisch's paper whose composition was recorded, 22 were urate, 16 oxalate, 27 phosphate, and the remainder of mixed composition. Englisch, however, accepts the view that only the phosphatic stone is formed *in situ*, the others having come down from above. As far as I can ascertain, the doctrine is based on the *a priori* reasoning that urethral stones, including those in diverticula, are formed only as a result of local irritation and inflammation. Given a preformed diverticulum, however, and the urinary constitution which tends to the production of calculi, there does not appear to be any difficulty in the way of assuming that calculi other than the phosphate may form *in situ*.

Primary prostatic concretions may, as has already been stated, establish a communication with the urethra, the pocket in which they lie then forming acquired diverticula of the prostatic urethra. There is agreement amongst authors as to the constitution of these calculi; they are stated to consist of calcium phosphate and carbonate with a small proportion of organic matter.

The following three cases present examples of encysted calculi in diverticula which communicated with the floor of the prostatic urethra near the neck of the bladder.

CASE I.

E. S. H., aged 27, when first seen in 1908.

History.—A vague account was given of a blow in the perineum by a cricket ball in 1891, following which there was slight bleeding from the urethra for about a week. There was no history of venereal infection, and this may be accepted as correct. There were no further urinary symptoms until 1899, when he commenced to have some difficulty in passing urine. The cause of this difficulty was considered to be stricture, and from this time until 1908, when I first saw him, he had had

instruments passed at intervals, and had also been instructed in passing them himself. In 1903 he became acutely ill with pain and tenderness in the left loin. He consulted a surgeon in London, who removed the left kidney; he was told that the organ was destroyed by tuberculosis. A sinus persisted in the loin for about three years, eventually closing after a series of injections of a suspension of iodoform.

During all this time he had varying difficulty in urination, and instruments were passed at frequent intervals with a transient improvement in his symptoms. He never had an attack of renal colic, except just preceding the illness for which the left kidney was removed.

In August, 1908, he presented no signs of disease in any system except the urinary. The complaint was that of pain and difficulty in micturition. The urine contained a copious deposit of phosphates, was alkaline in reaction, contained no albumen and no pus. On examination I found a stricture immediately behind the bulbous portion admitting with difficulty a No. 8 English metal bougie. The passage of the bougie caused a great deal of spasm. I sent him to bed and tied in a No. 5 silk webbing catheter for twenty-four hours. This was not well tolerated; it caused a mild attack of urethritis and cystitis; the stream was, however, much improved. The improvement was only short, and, as further treatment by intermittent dilatation proved unsatisfactory, I advised external urethrotomy, and this was performed on April 16th, 1909. A stricture of moderate dimensions just behind the bulb was cut through. During convalescence from this operation he developed acute arthritis of the right hip-joint, an abscess formed on the pelvic aspect of the acetabulum, and was opened. The lesion gradually subsided, leaving an incomplete ankylosis of the joint. In the following July (1909) when passing a metal bougie along the urethra a grating sensation was felt just before entering the bladder. A radiograph was taken; this showed a fan-shaped shadow behind the symphysis pubis, and extending above and below this, apparently due to a collection of calculi. On rectal examination there was felt a collection of stones in the situation of the prostate which grated on palpation, the mass being about the size of a damson. On August 26th, 1909, the bladder was opened above the pubis, and on passing the finger into the

Fig. 1.

submitted to Professor Benjamin Moore for analysis, and his report was as follows:

Calcium phosphate	...	...	...	61.5 per cent.
Calcium oxalate	...	...	...	30.8 "
Uric acid	...	...	...	3.9 "

The patient made a slow convalescence from this operation; the wound was not finally closed until after seven weeks. A calculus, which must have been dislodged into the urethra at the time of operation and overlooked, was subsequently removed.

The condition remained satisfactory for a period of eighteen months, the urinary stream was good, he had none of the previous pain and difficulty in micturition, and the general health was excellent. On March 5th, 1911, he had an attack of right renal colic while away in France and another attack a month later. There were several minor attacks following this, and on June 10th, 1911, he again came under observation. He was then seriously ill, and on examination I found the right, and only, kidney much enlarged and tender to palpation. A radiograph was taken by Dr. Thurstan Holland, and showed a collection of four calculi lying close together in the right ureter below the brim of the pelvis. It was obviously necessary to remove these without delay, and this was done on June 13th. Suppression of urine supervened, and he died on June 16th.

When this history is considered in the light of the later findings, it is clear that the long-continued difficulty and

⁹ The nature of the renal disease and the reason for the persistence of the sinus were cleared up by the radiograph taken in July, 1909, which showed a calculus still present in the left ureter about the pelvic brim.

pain on micturition are to be ascribed to the presence of the encysted calculi, and that the stricture was of minor importance. The failure to relieve his symptoms by dilatation by myself and others points to this. The encysted calculi caused a condition of spasm which was responsible for the difficulty of micturition and the pain in micturition. Unfortunately I am unable to present an analysis of the calculi removed from the ureter owing to a laboratory misfortune. They were of a brown colour, rough surface, and the naked eye diagnosis was calcium oxalate. The absence of anything in the history pointing to the calculi in the urethral pouch having descended from above inclines to the belief that they were formed *in situ*. They filled the diverticulum and were packed together and faceted. The orifice of the diverticulum was comparatively small, and situated centrally in the floor of the urethra. They had in all probability been present in part for a period of ten years before the projection of one into the urethra revealed their presence, and during these ten years various surgeons had passed bougies along the urethra.

All these facts taken together appear to me to make it certain that they were formed *in situ*.

Their position in relation to the prostate inclines to the view that they were formed in the substance of the prostate itself. The sac as felt per rectum appeared to have replaced the prostate, and the radiograph shows them extending to right and left of the middle line beneath the neck and trigone of the bladder. On the other hand, their chemical composition raises a difficulty in adopting this view. Primary prostatic calculi are composed of calcium carbonate or calcium phosphate or a mixture of the two, there is no record of a prostatic calculus composed of 30 per cent. of calcium oxalate. On the whole it seems most in accordance with the facts to consider that the primary condition was the production of stones in the prostatic tissue underlying the urethra; these led to the formation of a cavity by pressure, which cavity communicated with the urethra at first indirectly through ducts and later directly. The further formation of concretions in the adjacent gland tissue and the increase in size of the original calculi led to a gradual growth of the diverticulum, and the calculi were built up in part from prostatic secretion and in part from the urine in the pouch. It is to be noted that the patient was a determined "stone maker" and that the calculi produced elsewhere were oxalate.

CASE II.

S. A., aged 48, as a boy and youth had been much troubled with incontinence of urine; this continued up to the age of 20. At the age of 18 he had an attack of gonorrhoea, from which he recovered in a few weeks under treatment. At 23 he first had some difficulty in passing water associated with pain. The attacks were occasional, and he noticed they were liable to occur after taking alcohol. He was treated by the passage of soft bougies "for a year or two" from the age of 25 onwards; he then had internal urethrotomy performed, which improved the difficulty in passing water, but the occasional pain in urination continued, especially when he first emptied his bladder in the morning. He had no further treatment until the age of 44, when he went to a hospital on account of increasing pain and difficulty in urination. He was then told that there were some stones about the neck of the bladder, but no operation was performed. In July, 1911, he passed a few small stones. I saw him with Dr. Thomas Clarke, on August 17th, and operated the same day. A metal bougie, which was passed with some difficulty through the bulbous portion, came on calculi just before entering the bladder. The urethra was opened in the perineum, and a stricture of moderate dimensions was cut through at the bulb. The perineal wound was extended backwards, and a finger passed towards the bladder came on a diverticulum of the floor of a prostatic urethra containing calculi. The left forefinger in the rectum felt the collection of stones, and with the aid of this finger, and by means of a spoon passed through the urethral wound, they were removed. They numbered 86 (Fig. 2). The pouch was investigated with the right forefinger. The interior was rough; it measured approximately 2½ in. antero-posteriorly and 2 in. transversely, and extended backwards from its communication with the prostatic urethra behind the base of the bladder. There was no calculus in the bladder. A catheter was fixed in the bladder, and a rubber drainage tube also placed in the diverticulum. Three of the larger calculi were examined by Professor Benjamin Moore, who reported that the composition was as follows:

Calcium phosphate	...	...	94.3 per cent.
Uric acid	...	...	1.5 "
Calcium oxalate	...	...	2.3 "

When seen on October 8th, 1911, the wound had healed; he had no pain on passing water, and the stream was good. There

was, however, a considerable degree of incontinence: between the periodic emptying of his bladder the urine dribbled. The explanation of this dribbling was not clear. However, on November 13th a metal sound was passed into the bladder and a calculus demonstrated. On taking a radiograph a large shadow appeared to occupy the base of the bladder, and to project into its neck. On November 15th the urethra was opened behind the triangular ligament; projecting into the internal meatus was a mass of calculus connected with a stone of very large dimensions in the bladder itself; it was of the consistence of moderately hard mortar; a lithotrite did not crack it, but pulped it. Some similar soft phosphatic material was adherent to the bladder wall here and there. In order to remove the whole of this it was necessary to make a suprapubic opening also. The diverticulum from which the calculi were removed at the previous operation was represented only by a shallow depression in the floor of the prostatic urethra; into this some of the soft phosphatic material projected. The formation of this phosphate was evidently due to a septic cystitis following the operation. Its position in the neck of the bladder was the apparent cause of the dribbling of the urine. At the second operation the bladder was of very small size, and was practically filled with the phosphate mass.

This history shows a striking resemblance to the first. The incontinence which troubled him right up to adolescence may have been due to some congenital structural abnormality about the neck of the bladder, but this can only be surmised; certainly involuntary micturition up to the age of 20 is a very uncommon condition. His pain and difficulty in micturition were ascribed solely to stricture for close on twenty years, and as internal urethrotomy was performed by a competent surgeon, it must be assumed that there was a stricture present. At the time of my operation there was a narrow strait at the bulb, but its dimensions were such that it could have had little influence on his symptoms. No doubt the greater part of his disability was due to the presence of the calculi, unsuspected for many years. Their position and relation to the prostate and chemical composition point to their having been formed primarily in the prostate. The small quantities of uric acid and calcium oxalate present were probably deposited *in situ* from the urine.

The necessity for dealing with the stricture as well as with the calculi influenced the character of the first operation undertaken. The urethra was opened in front of the triangular ligament, and the incision was extended backwards from this, in order to gain access to the pouch. No radiograph was taken of this case before the first operation, so that it is impossible to demonstrate the exact position of the calculi; the diverticulum was, however, central in position, underlying the urethra and neck of the bladder. Of the possible ways of explaining the formation of the calculi, the one which seems best to accord with the facts is that calcium phosphate calculi were first formed in the prostate, and that after the establishment of a communication with the urethra small quantities of uric acid and calcium oxalate were deposited from the urine. It is however, impossible to negative the presence of a pre-formed diverticulum as the first stage of the whole process

Fig. 2.

in view of the records of such preformed pouches in this part of the channel.

CASE III.

A. M., aged 42, patient of Dr. Finny, Ellesmere Port. In this case I had the advantage of a history drawn up by the surgeon under whose care he had been in India, of which the following is an abstract:

In September, 1900, the patient without warning began to suffer from frequent urgent calls to urinate, with pain during and after the act. On passing a sound it was arrested with a grating sensation a short distance in front of the triangular ligament. After returning home the same day he passed a stone consisting of several "hemp-seed" calculi, agglomerated together and separable from each other with great ease. On subsequent examination "only a small sound enters the bladder, and that with much pain"; his symptoms continued, but with less intensity. On December 4th, 1900, a stone was located in the urethra "close up at the back of the scrotum." The urethra was opened, but no stone was found there or elsewhere. On December 8th, however, a stone was removed by urethral forceps. At the end of January, 1901, he had a return of his old symptoms; on March 22nd, 1901, a small stone was located "½ in. in front of membranous portion of urethra," and removed with a scoop. His symptoms continued off and on, pain on micturition and frequency being constant, but it was not until August, 1902, that he had another acute attack. On August 9th, 1902, a stone was located, "apparently embedded in the prostate," but an attempt to remove it was unsuccessful. However, a further attempt with a scoop was successful on August 16th, and another minute stone was washed from the bladder. A week or two later he had very severe lumbar pain (renal colic); this recurred from time to time, and he also had a return of pain and difficulty in micturition.

In 1904 he was under the care of a surgeon in London, who performed an external urethrotomy and stated that a stricture was present; he removed two minute spherical stones, which he stated were prostatic concretions. This operation did not relieve him, pain and difficulty in urination continued, and he also noticed that whenever he passed a constipated motion he had a sharp cutting sensation in the perineum.

When I examined him a large calculus was felt with the finger in the rectum in the situation of the prostate, grating was felt on moving it. A radiograph showed a large dense shadow to the right side of the middle line and two minute separate shadows close to its outer edge. Both kidneys and ureters were examined and showed nothing abnormal. No instrument was passed along the urethra.

Operation on October 27th, 1911.

An inverted V incision was made in front of the anus, the bulb exposed and the wound deepened by blunt dissection; the fibres of the external sphincter inserted into the central point of the perineum were cut, and the space between the rectum and the prostate was opened up. There was much old cicatricial tissue around the urethra behind the bulb. The prostatic urethra was opened behind the triangular ligament, and on inserting the finger the orifice of the pouch was immediately come upon. It was emptied of its three calculi without difficulty (Fig. 3), the opening was largely dilated, and a sharp spoon was freely used in the cavity. The interior of the pouch had a rough irregular wall. A rubber catheter was passed into the bladder and fixed by a catgut stitch through the margins of the urethral wound. The wound of the overlying parts was closed with deep and superficial sutures of catgut. The catheter was removed from the bladder on the fourth day; urine ceased to come from the perineal wound on the sixteenth day.

The chemical composition of the large calculus was reported by Professor Moore to be:

Calcium phosphate	...	...	60.91 per cent.
Calcium oxalate	...	...	13.36 "
Calcium carbonate	...	...	5.96 "
No uric acid.

Fig. 3.

This case differs from the other two in that soon after the onset of symptoms the true nature of his affection was discovered by the passage of a calculus. His first symptoms were evidently produced by the projection of a calculus out of the prostatic pouch into the urethra, and before this time there were no urinary symptoms of any kind. Subsequently other calculi, projecting and escaping into the urethra, were removed, but the pouch was not opened up and exposed. The calculi which I removed were situated well to the right of the middle line and firmly fixed. The large calculus presents a number of projections which suggest the irregularity of the bed in which it lay. On section it has an amorphous soft white centre, and around this are laid down concentric layers of a harder material of pale fawn colour, between the layers of which there is more of the softer whitish material. The position of this large calculus points to its having formed in the right lobe of the prostate. No prostatic tissue could be made out with a finger outside and another within the pouch—the gland appeared to have been destroyed by pressure. In this case I think there can be no doubt that the calculi were true prostatic calculi formed in the gland. There is nothing in the history which throws any light on the condition which led up to their formation.

Fig. 4.

CHEMISTRY OF THE CALCULI.

It is necessary to say something on the composition of the calculi found.

CASE I.—The calculi were all of a fawn colour; practically all were faceted—some appeared to be compounded of several fused together. Chemically they consisted of two-thirds calcium phosphate, one-third calcium oxalate. On section they appear to the naked eye to be composed of two substances, the one of white and the other of a brown colour. (Fig. 4, a.) These have been laid down for the most part in layers, but there is a good deal of irregular deposit.

The innermost part of each of the two calculi cut is composed of the whitish material. It is much less hard than the brown. Probably the white is calcium phosphate, the brown calcium oxalate. The arrangement in the calculi shows that during their growth both these substances were deposited in part intermittently, in part simultaneously, the initial deposit being phosphate.

CASE II.—The chemical analysis of the calculi in this case was somewhat of a surprise. Concentric layers are more definite than in the last case, a whitish and dark brown substance alternating, the white material being more friable (Fig. 4, b). The analysis gives the proportion of oxalate as being very small. The dark-coloured

material probably represents a mixture with some organic substance. The centre of one of the smallest seed calculi is composed of this, and is surrounded by the whitish phosphate. In this case the evidence points to the formation of the calculi in the prostate by the deposition of phosphate, a small proportion of oxalate being added from the urine, together with traces of uric acid.

CASE III.—In this case the large stone removed is composed of two substances—centrally a friable white substance, and peripherally a harder yellowish-brown substance (Fig. 4, c). The latter is laid down concentrically, the central part is amorphous. This is a calculus, primarily pure phosphate, on which oxalate has subsequently deposited, no doubt from the urine, after the formation of a definite communication between pouch and urethra.

In all three cases the clinical symptoms, the anatomy of the pouch in which the calculi lay, and the arrangement and number of the calculi, point to their having formed *in situ* primarily in the prostate gland, eventually in pockets communicating with the urethra. The chemical analyses make it necessary to revise the statements in the textbooks as to the composition of urethral calculi formed *in situ*. Evidently, the presence of calcium oxalate in a calculus cannot be accepted as evidence that it had descended from the urinary channel above.

ANATOMY OF THE DIVERTICULA.

In all three cases the pouches in which the calculi lay appear to belong to the acquired diverticula, whose formation is secondary to that of the calculi themselves, and directly due to their presence. This is the most common origin of pouches in the prostatic urethra according to the cases on record, although there are cases in which it is impossible to avoid the assumption of a pre-formed diverticulum antedating the formation of the contained calculi, in particular a diverticulum resulting from cyst formation in the gland.

Englisch⁹ describes a preparation derived from a man aged 40. A cyst was present immediately under the mucous membrane of the posterior wall of the prostatic urethra. It was lined by a many layered flat epithelium, and presented numerous depressions and pockets corresponding to dilated prostatic ducts and acini. The contents consisted of an albumen-like fluid, containing epithelial masses, cells, and prostatic concretions. The same author also describes specimens which show that abnormalities in size of the sinus peculiaris are met with, and that it may attain considerable dimensions. He quotes the following cases recorded by Burkhardt:

A man aged 59, who in life had had no urinary symptoms, presented a fluctuating cyst underlying the internal urethral meatus to the right of the middle line.

A man aged 51. Six months previously sudden dysuria and retention for two days. Return of the same symptoms two weeks before record. With the cystoscope close to the bladder neck was seen a greyish-red translucent swelling the size of a nut. Removal by suprapubic incision. The cyst was single, and showed the characteristics of a prostatic retention cyst.

A third case concerned a man of 22, dead from tuberculosis. Behind the posterior border of the inner meatus there was present a small soft swelling; a sound in the sinus peculiaris led into this tumour, and it was, in fact, a dilatation of this channel.

Michailow¹⁰ has recorded a retention cyst of the sinus peculiaris causing urinary obstruction. Large diverticula connected with the prostatic urethra have been placed on record by Escat, Thistle, Ferraton, and Kapsammer.

Escat¹¹ found and removed by perineal dissection a congenital diverticulum from a youth aged 18. This presented in the perineum behind the scrotum, and was traced to an opening in the pars prostatica. It was considered by Escat a dilatation of the Müllerian ducts. It contained no calculi. The same author described the case of a man of 31 with congenital inversion of the penis, congenital and acquired urethral strictures, and a diverticulum in the pars prostatica which gave rise to great difficulty in catheterization. In Thistle's¹² case a fluctuating swelling presented in the perineum; this was a urethral pouch extending backwards behind the neck of the bladder—it contained three uric acid stones.

Ferraton¹³ recorded a "voluminous calculus of the urethra enclosed in a juxta-vesical pouch, a small prostatic pseudo-bladder." The patient was aged 24. At the age of 4 he had pain on micturition, and ever since a slight

discomfort had persisted. For five years before admission the urinary symptoms had been more pronounced. Radiography showed a circular shadow behind the pubis. The bladder was opened above; the forefinger, introduced into the internal meatus, came at once on a cavity opening out of the floor of the urethra containing a calculus, the cavity being considerably larger than the contained calculus. Analysis showed a centre of urate surrounded by phosphate of lime. Ferraton considered the cavity pre-existing.

Kapsammer¹⁴ has related the removal of a stone the size of a goose's egg from "a vaginal sac" in a male. The patient was aged 29; from youth he had passed blood by the urethra occasionally. At the age of 26 a fluctuating swelling was found between the perineum and prostate which could be emptied into the urethra by pressure. Three years later the stone was removed by perineal incision, and at a second operation the sac was extirpated. The sac had all the appearance of a vagina, communicated with the pars prostatica, and its wall had the structure of epidermis except for glands and follicles. It was surrounded by a layer of unstriated muscle.

These cases illustrate the manner in which preformed saccules of the prostatic urethra may arise. The writer is not aware of any record of a saccule whose origin was definitely traceable to the bursting of a prostatic cyst into the urethra, and such a sequence of events is not likely to be capable of demonstration; but the fact that such cysts do occur, and the likelihood of their establishing a communication with the urethra, make it probable that some of the prostatic urethral pouches arise in this way. The large pouches described by Escat, Ferraton, Thistle, and Kapsammer probably owed their origin to an abnormal development in connexion with the urogenital sinus and its junction with the urethra, or, as Ferraton supposed, to a dilatation of the sinus peculiaris.

The following two cases of diverticula, although described as of the membranous urethra, may be noted as illustrating the lodgement of urinary calculi in preformed diverticula.

Finsterer¹⁵ in an article on urethral stones, relates a case of diverticulum of the membranous urethra. The patient was aged 35, and a calculus was easily palpable on rectal examination above the sphincter ani. Extraction was difficult owing to its firm enclosure in the pouch, which resembled a forebladder (Vorblase). The stone was compound, four articulating with one another; around a small porous nucleus of ammonium urate phosphate was deposited in concentric layers. From the description given it seems very doubtful whether the diverticulum was actually of the membranous urethra.

Schapiro¹⁶ writes of a man, aged 37, from whom he had removed a urate calculus, weighing 5.8 grains, from a congenital diverticulum of the membranous urethra. He considered the diverticulum congenital because no pathological cause for its development could be discovered.

The pouches which form in the prostate around a primary prostatic calculus are more frequently met with than the congenital type, but they are not common.

Young¹⁷ states that he has met with eleven cases of prostatic calculi, in eight of which they were embedded in prostatic tissue, and removed with enlarged prostates. In one case a calculus was removed from the left lobe of the prostate of a child. In another, a patient aged 36, three calculi almost completely filled the prostatic capsule; the third was a case of multiple seed calculi in a *post-mortem* specimen.

Morton¹⁸ has described three cases:

1. A patient aged 35; difficulty in micturition for fifteen years; a pouch present in the prostatic urethra in which there were seven calculi and three minute concretions. One stone was also present in the bulbous urethra and one in the bladder. All were phosphatic. There was a stricture of the scrotal urethra. Later several stones were found in an extension of the pouch backwards under the bladder.

2. A patient aged 34. History of urinary retention when a boy. From this time suffered from incontinence. Nine months before admission had retention, and a month later two stones were removed from the scrotal part of the urethra. On examination stones were felt per rectum grating upon each other, and were removed from the "dilated" prostatic urethra.

3. A patient aged 63. External urethrotomy many years before. Stricture. Stones were felt by sound in prostatic urethra and palpable per rectum. Fragments of stone were removed from a "greatly dilated prostatic portion," partly composed of

calcium oxalate; the prostate seemed to have disappeared, the floor of the pouch being apparently formed of the urethral and rectal walls only.

Morton remarks that in none of the cases was the stricture just in front of the prostatic urethra nor was it so tight as one would expect it to be if it had been the cause of the marked dilatation. He says "as far as I know only phosphatic stones are formed in the urethra."

Fenwick¹⁹ has related the case of a man of 28 years, who had had urinary symptoms for five years. The prostate per rectum felt a mere capsular shell spread over a bag of stones. The stones were five in number and one projected into the prostatic urethra.

De Keersmaecker²³ writes of two cases. A man of 69 years gave a history of fifteen to twenty years' pain in urination. The bladder was opened above the pubis, and immediately within the internal meatus a pouch was found containing calculi. A man, aged 27, had had internal urethrotomy several years before without improvement. A metal bougie felt a stone in the deep urethra. The bladder was opened above the pubis and the finger in the internal urethral opening came on a pouch containing three stones.

DIAGNOSIS.

Encysted calculus of the prostatic urethra is a condition which, though rare, is met with from time to time and gives rise to symptoms of a characteristic kind. There is pain and difficulty in urination, the stream varies greatly without any obvious reason. The passage of an instrument gives rise to an extraordinary muscular spasm which simulates a true stricture. The passage of bougies, however, affects the stream but little and the improvement in urination is very transient.

Unless a rectal examination is made or a calculus projects into the urethra, the true cause of these symptoms will probably remain long unsuspected and the patient be treated for stricture. In two of the cases recorded here a stricture masked the chief cause of the symptoms for many years, in the third the escape of a stone into the urethra revealed the state of affairs at an early stage. These calculi are evidently liable to be formed at a comparatively early age, and in young adults who present the symptoms of difficult and painful micturition, if the urethral examination does not satisfactorily account for these symptoms, it will be well to bear in mind the possibility of such a condition as described here.

A point to note also is the intolerance of instrumentation which these patients present; the passage of an instrument along the urethra gave rise to great pain in each case when the posterior urethra was reached. In Cases I and III a catheter was fixed in the urethra while stones were still present, and in each case a urethritis was set up.

These calculi are felt at once on rectal examination, the prostate is more or less replaced by a mass of intense hardness, and when there are several stones present there is grating on palpation.

The passage of an instrument is attended by certain characteristic symptoms—the muscles of the membranous urethra are on guard and the instrument meets with difficulty here owing to their spasm; just before entering the bladder there is complaint of great pain. Of course if the bougie finds a grating surface in the posterior urethra the diagnosis is plain—at any rate, it is clear that a calculus is there.

TREATMENT.

The old methods of removing encysted calculi such as these by means of scoops and forceps when they project or escape into the urethra do not furnish a proper remedy for the condition. It is absolutely necessary that free access should be obtained to the pouch. Calculi are extremely likely to be overlooked unless the pouch is dealt with in the most thorough manner possible, and for this reason also the suprapubic route is inferior to the perineal. I do not think that calculi can be searched for in outlying pockets, as they must be, by the suprapubic route.

The procedure adopted in the third case offers the best means of dealing with the pouch thoroughly. The most obvious suggestion is the total removal of prostate, pouch, and calculi. In the class of case illustrated by these three histories I do not consider the suggestion feasible. The enucleation of a hypertrophied prostate is one thing, the removal of a mass consisting of remains of prostatic tissue

with calculi together with prostatic sheath is quite another, and anatomically impossible, and unless the prostatic sheath were removed with the scissors the wall of the pouch in such cases would not be taken away.

The best method is to open the prostatic urethra behind the triangular ligament. The operation is begun as for a perineal prostatectomy. After freeing and retracting the rectum, the distal part of the prostatic urethra is exposed and opened on a staff. The incision will be within 1 in. to 1½ in. of the pouch, and the finger is thrust into it. The opening into the pouch is forcibly stretched. The calculi are then removed with a spoon or with forceps, the forefinger of the left hand outside the pouch being used as an aid. The most careful exploration is necessary to avoid leaving small calculi behind, and it is necessary to use the spoon vigorously within the cavity, and frequently to explore with the finger.

The second operation in Case II gave an opportunity of examining what was a pouch of considerable size three months previously; all that was present was a shallow depression in the urethral floor. If therefore the pouch is thoroughly cleared and curetted, it may be expected to practically obliterate itself, provided that the pouch is freely thrown open into the urethra by forcible dilatation of the aperture of communication.

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A CASE OF CALCULI OF THE PROSTATIC URETHRA.

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IMPACTION of calculi in the urethra is an occurrence more frequent in children than in adults, the usual place to find them being the fossa navicularis, because the meatus is the narrowest part of the urethra. Such impaction is probably the most frequent cause of retention of urine in children, but usually the urethra is not completely blocked and the urine dribbles away.

In adults a calculus may lodge behind a stricture, cause ulceration and perineal abscess, which bursts and establishes a fistula, through which sometimes the stone escapes.

Prostatic calculi may be divided into two classes:

1. Calculi which lodge in the posterior urethra, escaping from the kidney, bladder, or seminal vesicles; and a small group of cases in which the stone is primarily formed in the posterior urethra.

2. Calculi formed in the substance of the prostate gland—the true prostatic calculi—entirely distinct in origin and nature from urinary calculi.

I report the following case as being of interest, owing to the comparatively large size of the stones and their perfect adaptation to the prostatic urethra; also because I believe the cases to belong to the somewhat rare class in which the stones are formed primarily in the prostatic urethra.

CASE.

P., a highly neurotic Cingalese, aged 20, was admitted into the General Hospital complaining of the following symptoms: Frequency of micturition (about ten times during the day and about fifteen times at night, giving him little sleep). Micturition was accompanied by a burning sensation, especially towards the end of the act, when he experienced a scraping sensation, beginning at the anus and ending at the meatus. In spite of severe straining the stream was thin and weak, and the last few drops contained a thick white precipitate—phosphates. Micturition was most easily accomplished when he lay on his side, but was almost impossible when standing, owing to sudden blockage and interruption of flow. This effect was no doubt contributed to by the loose stone I subsequently