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[John Murray].**

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A
PROBATIONARY ESSAY
ON THE
FORMATION AND SOLUTION
OF
URINARY CALCULI;

SUBMITTED,
BY AUTHORITY OF THE PRESIDENT AND HIS COUNCIL,
TO THE EXAMINATION OF THE
Royal College of Surgeons of Edinburgh,
WHEN CANDIDATE FOR ADMISSION INTO THEIR BODY, IN
CONFORMITY TO THEIR REGULATIONS RESPECTING THE
ADMISSION OF ORDINARY FELLOWS,

BY
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ON
URINARY CALCULI, &c.

THE formation of Urinary Calculi, in the kidneys or the bladder, constitutes one of the most painful of the diseases which afflict humanity. When these concretions are of such a size that they cannot be expelled with the urine, they necessarily remain in the body, sometimes attaining to an enormous size, and producing sufferings of the severest kind, which embitter, and frequently terminate, the existence of the unfortunate patient. Few departments of Surgery or Medicine have attracted more attention, or been more fully and ably discussed, than the questions relating to the origin and causes of Calculi, and the methods of attempting their removal, whether by surgical operation, or by the administration of remedies. I presume, therefore, that it may be neither useless nor un-

interesting, to present a general view of the various and very opposite opinions on this subject, which have, at different periods, been adopted.

To the justly celebrated Swedish chemist SCHEELE we are indebted for the first, and therefore most difficult, step towards the knowledge of the nature of Calculi. After him various important facts were collected by other chemists; but to Dr WOLLASTON belongs the distinguished honour of giving to our knowledge, on this subject, a precise and definite form, by his numerous discoveries and able classification.

Dr WOLLASTON arranges Calculi into four species; 1. The Uric Acid Calculus; 2. The Fusible Calculus, formed chiefly of phosphate of ammonia and magnesia; 3. The Bone Earth Calculus, composed of phosphate of lime; and, 4. The Mulberry Calculus, or that composed of oxalate and phosphate of lime. He afterwards discovered a fifth, which he named the Cystic Oxide Calculus. To these Dr MARCET has added other two new species, the Xanthic Oxide and the Fibrinous Calculus. Calculi are seldom homogeneous, that is composed of only one ingredient, as uric acid or phosphate of lime. Often the ingredients

form concentric layers round a nucleus, and there is always an animal matter which serves the purpose of a cement.

1st, Uric Acid Calculus.—Concretions composed entirely of this acid are of rare occurrence. Those in which it predominates, however, and to which it gives the characters of the species, form a very considerable proportion, more than one-half, perhaps, of the whole number of urinary concretions. They vary from the size of a bean to that of a large egg. Their shape is generally a flattened oval, and their colour of different shades of yellow and brown. When sawn through they are seen to consist of numerous thin layers, inclosing a central nucleus of uric acid, of more compact texture, and greater hardness and lustre. They are insoluble in cold water, but when reduced to powder, and thrown into boiling water, a solution is obtained, from which small crystals are deposited on cooling. This calculus is soluble in the cold, in solutions of pure potash or soda, and from the solution a precipitate of a fine white powder is thrown down by acids. It is insoluble in the alkaline carbonates. Nitric acid,

when heated, dissolves it, producing the deep red colour characteristic of uric acid.

The urate or lithate of ammonia calculus is generally of a clay colour, with a smooth and somewhat tuberculated surface. It is an uncommon species, and seldom of any considerable magnitude. It is more soluble than the former in water, and in the alkaline carbonates.

2d, The *Ammoniaco-magnesian Phosphate* is scarcely ever found to form a calculus alone ; but is commonly intermixed with some other ingredient, usually with phosphate of lime. It is easily distinguished from the first species by its pure white colour, and the closeness and fineness of its texture. It is smooth, soft, and friable, and when sawn, gives a fine light powder, of a brilliant whiteness, which dissolves partially in the mouth, communicating a sweetish taste. It is insoluble in alkalis, but easily soluble in acids. Mr BRANDE justly observes, that the urine has at all times a tendency to deposit the triple phosphate upon any body over which it passes, hence drains by which urine is carried off are often encrusted with its regular crystals ; and in cases where extraneous bodies have entered the bladder,

they have in a short time become covered with a crust of the same substance.

3d, The *Bone-earth Calculus*, or that composed of phosphate of lime, is generally of a pale brown colour, and so smooth as to appear polished. When sawn through, it appears to be composed of concentric layers; internally its colour is white, but not of the brilliant white which characterises the phosphate of ammonia and magnesia; it is also distinguished by its dry and earthy appearance, and by feeling harsh and gritty to the touch. It is dissolved readily by diluted muriatic acid, from which it is again precipitated unchanged by ammonia.

Though neither this nor the former species are often met with alone, yet mixed together, they form a calculus, which, next to that of uric acid, is the most common. It was first discovered to be different from the uric acid calculus, by its melting into a white vitreous globule, when exposed to the blowpipe, instead of being charred and destroyed. It is a very friable concretion, of a white colour, resembling chalk, sparingly soluble in water, but easily dissolved by acids. Calculi of this kind often acquire a very large size;

and they frequently assume the form of the bladder, even so far as to have their extremity moulded into a kind of peduncle corresponding to its neck.

4th, Mulberry Calculus, or Calculus of Oxalate of Lime.—The former name is given to this calculus, from its resemblance to the fruit of the mulberry. Its surface is uneven, commonly covered with tubercles, more or less rough and pointed; and it is usually of a deep reddish-brown colour, with the density and hardness of ivory. It is rather a common species, either pure, or serving as a nucleus to large calculi of the earthy phosphates. Dr HENRY found 45 out of 187, and Dr MARCET 57 out of 181, to consist principally of oxalate of lime. It is not soluble in the pure alkalis, nor in the acids, unless they are heated and concentrated. It is decomposed with much facility by the alkaline carbonates, which separate the oxalic acid, and replace it with carbonic acid. It contains commonly more than one-third of its weight of lime, and a large quantity of animal matter, which gives it hardness and closeness. Its colour is supposed to be derived from effused blood.

According to Mr BRANDE, persons who have voided this species of calculus are much less liable to a return of the complaint than those patients who have discharged uric acid calculi. The reason of this probably is, that the uric acid diathesis is one much more easily excited than that producing oxalic acid, which is more probably, indeed, an accidental formation, than a product from a settled habit of secretion.

It is a very general opinion that the mulberry calculus is by far the most painful and dangerous species,—an opinion apparently justified by its rough tubercular surface, and great hardness and weight, whence it might be supposed to cause the greatest irritation and injury to the health. This, however, is not the case. While the proportion of deaths, after extraction of uric acid or phosphatic calculi, is about 1 in 6 or 7, in cases of mulberry calculi it is not 1 in 20. It is moreover found, that the phosphatic calculi, which are the lightest and smoothest, are accompanied by pain and general suffering by far the most severe and intolerable. It appears, then, that the sufferings arise not so much from the mechanical irritation of the bladder by the stone, as from the intensity

of the general diathesis. The mulberry calculus is, however, the most refractory in resisting chemical agents; hence it is the least likely to be dissolved or crumbled by any solvent.

5th, The *Cystic Oxide Calculus* was discovered by Dr WOLLASTON in 1805. It appears to be of extremely rare occurrence; Dr HENRY states its comparative frequency as 1 out of 100 calculi. It bears some resemblance to the triple phosphate of magnesia and ammonia, but is more compact and has no distinct structure. It is easily acted on by chemical agents; combines both with alkalis and acids, and these compounds may be obtained crystallized. From these properties, and its not affecting vegetable colours, Dr WOLLASTON named it Cystic Oxide, an appellation not quite correct, as Dr MARCET has since seen instances proving it to be a formation rather in the kidneys than in the bladder.

6th, The *Xanthic Oxide*, and *Fibrinous Calculi*, are rare species discovered by Dr MARCET. They are so uncommon, as not to merit a particular description.

The different component parts of calculi are commonly intermixed, either arranged in concentric layers or blended into one mass. It almost always happens, however, that a calculus, whatever may be the composition of its mass, has a nucleus either of uric acid or of oxalate of lime.

Calculi vary extremely in their size. Several hundreds have been found in one bladder, but, of course, all very small. They sometimes again increase to a very large size, so as to occupy almost the whole of the cavity of the bladder. It is generally supposed that the nuclei of calculi are formed in the kidneys; and this is proved in many cases by their passage from the kidneys through the ureters to the bladder, being distinctly marked by the extreme pain felt at the time in the region of these ducts. When they happen to be too large to leave the kidneys, they remain and sometimes grow there to so large a size as to fill the pelvis of the kidney, and even distend it till it is converted into a kind of membranous cyst. When a nucleus is once lodged in the bladder, it increases gradually, by deposition on its surface, as long as the urine continues to have a tendency to precipitate calculous matter.

ON THE CAUSES OF THE FORMATION OF
CALCULI.

With regard to these we as yet know very little. The proximate cause in general, it has been remarked, is a superabundance of uric acid in the urine, but whence this originates is not clear. Though it be allowed, that, in many cases, the nuclei are formed in the kidneys, and, on descending into the bladder, become coated with earthy phosphates, in the same manner as if they were extraneous bodies, altogether unconnected with the urine, this is only removing the difficulty a step farther back. Neither is uric acid always the nucleus ; frequently it is oxalate of lime. Out of 187 calculi examined by Dr HENRY, 158 had nuclei of uric acid, 17 of pure oxalate of lime ; the rest were, three nuclei of cystic oxide, four of earthy phosphates, two extraneous bodies, and three calculi had hollow centres, arising probably from the shrinking of animal matter which had formed the nucleus. Dr PROUT computes the number of calculi originating from uric acid nuclei, as nearly $\frac{2}{3}$ ds of the whole number, and the rest to have chiefly nuclei of oxalate of lime. In this case it

is equally difficult to give any reason for the formation of oxalate of lime as of uric acid. It has been supposed, and with some probability, that the oxalic acid which is never detected in any other fluid in the body, may be formed by some chemical change, caused by a morbid secretion, in urée, that peculiar principle so abundant in urine. Sugar, it is known, is converted into oxalic acid by a change in the proportion of its constituent parts; and between urée and sugar there is a considerable analogy. There may, therefore, be some change in the proportion of the elements of urée induced in secretion by the kidneys, which will give rise to oxalic acid. Whenever this acid is formed, from the strength of its attraction to lime, it will immediately combine with it, in whatever state of combination it may be present, and the insoluble oxalate of lime will be precipitated.

As to the uric acid, it has been supposed by MAGENDIE, that it originates from a superabundance of nitrogen in the system, derived from the habitual use of animal food. This opinion is by no means an improbable one, as uric acid does contain in its constitution a very large proportion of nitrogen. Moreover, the urine may be regard-

ed as the chief medium, by which superfluous or hurtful ingredients are removed from the circulation. If, then, an excess of nitrogen did exist in the system, it is highly probable that it would be excreted by the kidneys, and in that state of combination which constitutes uric acid. In conformity with this reasoning, it is found that the urine of herbivorous animals contains none of this acid, while in the urine of carnivorous quadrupeds it is abundant. It is even found, that, if carnivorous animals are deprived of their natural food, and obliged to live on vegetable substances, in which no nitrogen exists, their urine in a short time ceases to contain uric acid. These facts are considerably in favour of MAGENDIE'S theory, and appear indeed clearly to demonstrate an intimate connection between the constant use of animal food, and the consequent production of uric acid. In the application of the theory, however, to the explanation of calculous disorders, so many difficulties present themselves, that even MAGENDIE himself is obliged indirectly to confess its insufficiency.

The precipitation of uric acid, whence calculi are formed, may arise from two causes, either its

superabundance in the urine, or the predominance of a free acid. This precipitating free acid is usually the phosphoric. The office of this acid, in general, is to retain dissolved the earthy phosphates, along with the mucus of the bladder, while the uric acid passes off in solution in the urine, combined with ammonia. When the phosphoric acid, then, is in excess, it takes the ammonia from the uric acid, which is accordingly precipitated. This explains to us how alkaline remedies which are administered, may, without ever entering the bladder, and without directly acting on the uric acid, prevent its deposition, by neutralizing the excessive phosphoric acid. Dr WILSON PHILIP, who strongly recommended the encouraging of cutaneous perspiration, was of opinion that, in this way, the precipitating acid was diverted to the skin; and though Dr PROUT does not exactly agree with him in the theory, he approves of the practice. It was at one time a general opinion, that cyder, and similar acid vinous fluids, were frequently causes of gravel, from the acid which they contain precipitating the uric acid in the urine. This was rendered more probable by the great solubility of malic acid, the

one which exists in most fruits, except the grape, whence it was likely to pass into the kidneys. It was even affirmed, that in the cyder counties, calculous cases were most abundant ; yet, in opposition to this notion, we have the fact, that Herefordshire, one of the greatest cyder counties in England, seems to be remarkably exempted from this disease, not a single calculous case having occurred in its hospital since its erection nearly fifty years ago. Even if it be granted that cyder is likely to favour the formation of uric acid calculi, it must, on the other hand, by the acidity which it keeps up in the urine, be beneficial, by holding in solution the earthy phosphates, and thus preventing the most distressing form of calculus. One district in England, that around Norwich, in Norfolk, has long been remarkable for the multitude of calculous cases which occur in it. The number of such cases in that small district, is, though it might scarcely be credited, equal to that of calculous patients in the whole of Ireland or Scotland. The cause of this unfortunate pre-eminence is not well understood. There is indeed one theory indirectly given by Dr PROUT, but which is not perhaps perfectly satis-

factory. In a number of passages in his excellent Treatise, he enlarges in a forcible manner on the bad effects produced on the urine, by "hard boiled fat dumplings." Now, it is known that such dumplings are a favourite article of food in Norfolk. Comparing these facts together, he seems to insinuate that there is some connection between them. From his observations, these "hard-boiled fat dumplings" do indeed seem to have much influence in producing a deposition of uric acid, though it is certainly not very obvious how they should.

As to the triple phosphate, it is supposed by FOURCROY and VAUQUELIN to be formed, when ammonia has been produced in the bladder, by a process similar to incipient putrefaction, and in such quantity as to saturate not only the uric acid, but all the phosphoric acid. The excess of phosphate of ammonia produced, is supposed to abstract the magnesia of the sulphate of magnesia, and the insoluble triple phosphate thus to be precipitated.

Dr PROUT proposes another theory, namely, that the primary error is in the kidneys. These organs, he is of opinion, become unable properly to acidify the phosphorus that passes through them in some state of combination, and which,

in the healthy state, they convert wholly into phosphoric acid. Hence, though there is no deficiency of phosphorus, there is a deficiency of the phosphoric acid, which usually retains the bases in solution by its excess, but which, in the diseased urine, is just sufficient to form the insoluble compounds with the earths. The insoluble phosphates are thus deposited, giving rise to the worst species of calculous disease. Dr PROUT is of opinion, that, whatever may be the nature of the original diathesis, the phosphatic is, after a certain period, invariably produced. This, though generally, is not, however, constantly true. Dr MARCET mentions a case, for instance, where the uric acid diathesis lasted for thirty years, and the phosphatic was never induced. It is further affirmed by Dr PROUT, that, when the phosphatic diathesis is fairly established, it will give place to no other; it will neither change of itself, nor be changed by medicines. As it admits neither of cure nor of much palliation, Lithotomy is the only resource whence relief can be expected.

The cementing animal substance of calculi is undoubtedly no other than the mucus of the

bladder, which, being of greater specific gravity than the urine, slowly subsides when the bladder remains long at rest: hence, in persons of sedentary habits, it may often be the origin of calculus. It appears also to be partially retained in solution by phosphoric acid; hence, when this acid is deficient, as in the phosphatic diathesis, mucus is abundantly deposited.

ON THE SOLUTION OF CALCULI.

THE next is the most important part of the subject,—Whether it is possible to effect the solution of calculi in the bladder by chemical agents introduced into the urine? Two methods have been proposed by which the solution may be attempted, either by substances, as acids or alkalis, received into the stomach, from which they often pass into the urine; or by direct injection, by the urethra, into the bladder.

The materials of calculus, as they appear in a comminuted form in gravel, or are deposited from the urine, have been stated to be of three kinds. *1st*, Uric Acid; *2d*, Earthy Phosphates; *3d*, Oxa-

late of Lime. A calculus, it has been well observed, may be considered as a substance placed in a solution of various principles in water, a superabundance of any of which will be immediately deposited upon its surface. If we pour into urine a little of any alkali, a white cloud appears, and a sediment falls of triple phosphate, mixed with phosphate of lime. If, on the other hand, a portion of acid, even a weak one, as vinegar, be added, red crystals of uric acid will soon be deposited. It is on these two facts that all attempts at solution or palliation by chemical agents are founded, as they shew that, when a superabundance of uric acid exists in the urine, acids must be hurtful, and alkalis beneficial; while, when the sediment from the urine is white, proving the presence of phosphates, the reverse happens; acids ought to be used, and alkalis to be avoided.

1st, then, As to the solution of Calculi of Uric Acid.—When this is found to be the nature of the calculus, alkaline remedies are of course the only ones that can be employed. These may saturate the superabundant uric acid in the urine, and perhaps also dissolve that already deposited; and this is not a theoretical prescription, for the advantage and relief afford-

ed by the use of alkaline remedies have been proved by experience. It was at one time doubted if the alkalis could reach the bladder through the circulation ; it has been clearly proved, however, that they really are secreted by the kidneys, and pass into the urine. If the alkalis could be used in large quantity, they would speedily dissolve the calculus ; but, when diluted, as much as they must be by passing through the circulation, it is in vain to expect from them any real solvent power. Even when combined with carbonic acid, nay, supersaturated with it, they pass into the kidneys, and, in some measure, retain dissolved the uric acid. Bi-carbonate of potash and of soda have thus been often given with advantage. Beneficial effects have even been produced by the alkaline earth, lime, when administered in solution in water. Magnesia, also, when the system has been much disordered by long and liberal use of alkaline remedies, has been found to afford much relief. Though these remedies have a power of saturating uric acid, and thus preventing the deposition of this substance ; yet it has been proved, that, on the other hand, they are extremely liable to produce a precipitate of earthy

phosphates. These phosphates are held in solution chiefly by the acidity of the urine, and when this is neutralized, they of course are precipitated.

By the use, then, of alkaline remedies, as much or more evil may be done as is corrected: hence it may again be repeated, that it is chiefly as palliatives these medicines are intended to act, as there is little or no hope that they can ever be given to the extent of solution. "The idea," says **BRANDE**, "of dissolving a calculus of uric acid by the internal use of caustic alkalis, appears too absurd to merit serious refutation."

Dr HENRY also says, that the cases which he had seen, "tend to discourage all attempts to dissolve a stone supposed to consist of uric acid. After it has attained a considerable size in the bladder, all that can be effected under such circumstances by alkaline remedies, appears, as **Mr BRANDE** has remarked, to be the precipitating upon it a coating of the earthy phosphates from the urine, a sort of concretion which, as has been observed by various practical writers, increases much more rapidly than that consisting of uric acid alone."

With this view of correcting the acid diathesis, **MAGENDIE** advises, in conformity with his theory, that animal food should be abstained from,

and that the diet should be vegetable, with an abundance of diluents ; and this plan of treatment will probably have a good effect. Wines, and all acid fermented liquors, should be avoided, not only by those labouring under this disease, but also by all in whom the uric acid diathesis exists, as shewn by the plentiful red sediment from the urine when discharged, or on cooling.

2d, With regard to the Earthy Phosphates.—

The formation of a calculus of this kind is often preceded and accompanied by a white sediment from the urine on cooling, as the uric acid diathesis is marked by a red sediment : When this is observed, it will shew that acids are the medicines proper to be used. When poured upon earthy phosphates, acids even in a weak solution dissolve them, and that not only the mineral acids, but even the weak vegetable ones. The usual acid that has been given is the muriatic, about twenty or thirty drops, properly diluted, being given at a time. The super-tartrate of potash or tartaric acid has been prescribed, but citric acid is now preferred, which, in many cases, greatly alleviates the pain. An effervescing draught is often used of bi-carbonate of potash

and citric acid; the carbonic acid enters the circulation, and retains the earthy phosphates in solution in the urine. When the bladder is in a state of great irritation, the carbonic acid thus administered often gives relief. As in exhibiting alkaline remedies for uric acid depositions, we run the risk of precipitating the earthy phosphates, so in giving acids for the latter, we may precipitate the uric acid. Great caution, then, is requisite to push neither to any extent, but to endeavour to use both, merely with a view to relieve pain, to prevent the sediment, and correct the general diathesis.

ON SOLUTION OF CALCULI BY INJECTIONS.

THE other method which has been proposed for effecting the solution of calculi in the bladder, is by the use of injections of lithontriptic medicines by the urethra. This can be easily performed, and appears a method very likely to afford success. It was first proposed and attempted on scientific principles, by FOURCROY and VAUQUELIN, has been the subject of much con-

troversy, but has now in a great measure fallen into neglect and oblivion. Nevertheless, it is possible that surgeons, alarmed at the very idea of throwing any acrid substance, however diluted, into an organ so very tender and irritable as the bladder, may have been too hasty in their decision.

It is obvious that the bladder will be able to bear lixivium of chemical agents, as strong as what reach it through the circulation, when the medicines are exhibited by the mouth. There is, then, the great advantage, that the application of the solvent is far more under the command of the surgeon. It may be thrown in and again ejected at pleasure, and in any known and certain state of strength that may be thought suitable to the irritability of the bladder. It will have no long and circuitous passage to perform, by which it may be modified and altered in any degree; may reach the bladder in too high a state of concentration, and may materially injure that delicate organ; or, which is more likely, may be so changed and diluted as to exert not the slightest action on the concretion.

The strength of the solvent employed, also, may

be diminished and varied at pleasure ; so that it may be gradually and daily increased, as the patient can bear it ; and, if any unpleasant symptoms supervene, it can at once be withdrawn.

It is a strong objection, as has been stated, to lithontriptic medicines, that they commonly do as much harm as good, by causing the precipitation of other calculous deposits. This has also been objected to the mode of injection by the urethra, but with little truth, since, in fact, it is one of its greatest advantages that it is not attended with this danger : For, before the injection is administered, nothing is more easy than to draw off all the urine from the bladder ; to wash that viscus with tepid water ; and, when the injected solvent has remained in it for some time, so that some fluid may have descended from the kidneys, it may be withdrawn, and the bladder again washed ; and these operations not being, in any great degree, painful or troublesome, may be repeated as often as may be wished. It has been proved also by FOURCROY and VAUQUELIN, that the urine varies much at certain times of the day ; that the proper urine, in its state of concentration, and containing the principles and salts

liable to be deposited, is only voided seven or eight hours after a meal ; but that what they call the crude urine, discharged soon after taking food, contains very little of these dangerous ingredients. Hence, by injecting the solvent leys, soon after this crude urine is discharged, there is little danger of any fluid descending from the kidneys at all highly charged with calculous matter ; while, when taken by the mouth, the agents must of course be secreted as much, or more, with the concentrated, as with the weak urine.

Nevertheless, though this mode of administering lithontriptics appears to have many advantages, the opinions of physicians are, in general, decidedly against it. Mr BRANDE considers the futility clearly proved, “ of attempting the solution of a stone in the bladder, by injections of acid and alkaline remedies.”—“ It appears to me,” he adds, “ that FOURCROY and VAUQUELIN, and others who have advised the plan of injection, have thought little of all the obstacles to success, and have regarded the bladder as a lifeless receptacle, into which, as into an Indian rubber bottle, almost any solvent may be injected with impunity.”

This opinion is strongly expressed ; the method, however, does not appear to all equally absurd. Besides the high character of FOURCROY and VAUQUELIN, who first proposed it, and tried it with advantage in several cases, we have the opinions of various celebrated men, of Dr THOMSON, COOPER, MARCET, &c. in favour of its practicability, and the probable benefits that would be derived from it.

A number of experiments were made by FOURCROY and VAUQUELIN, with the view of determining the strength of solvent leys that would act upon calculi, and, at the same time, could be with safety administered ; the results which they obtained were extremely favourable. They found that the ley of pure potash, diluted to such a degree that it could be held with ease in the mouth, and even be swallowed, melted and dissolved, in a few days, concretions either of uric acid or of urate of ammonia.

The nitric acid or muriatic, on the other hand, sufficiently weakened to be no sourer than lemonade, and to be hardly more acrid than the urine itself, softened and dissolved with even more rapidity, the calcareous ammoniacal and

magnesian phosphates, leaving only some flakes like those of the mucus of the bladder. Even the oxalate of lime, the most refractory calculus, was dissolved both by nitric acid and by carbonate of potash, though, of course, much more slowly.

FOURCROY recommends, that, at the same time that solvent injections are used, lithontriptics, adapted to the nature of the case, should be taken in the usual way. The calculous diathesis may in this manner be corrected ; and the probability of the depositions from the urine interfering with the injections diminished.

In the cases in which the method thus proposed by the French chemists was applied to practice, the results appear to have been by no means unfavourable. In several instances the weak leys, which have been mentioned, were injected and retained for some time without pain being felt, or any bad consequence ensuing. FOURCROY states, that he had seen five persons use alkaline injections, without appearing at all to suffer inconvenience, or even to feel that any fluid was in the bladder different from the urine. The acid injections, indeed, though as weak as lemonade, were more acutely felt, exciting irritation

and spasms, but fortunately they were of use, when in a much more diluted state than the alkalis.

In these cases, nitric and muriatic acids were chiefly used: perhaps an acid more likely to succeed would be the phosphoric. The advantage of it would be, that, as an excess of phosphoric acid very frequently exists in the urine, and, indeed, is the chief cause which keeps the calculous sediments dissolved, the bladder must be thoroughly accustomed to its presence. Hence, that organ would probably be little, if at all, injured by an injection of this acid, much more acrid than what would be safe of any other. There is another advantage which phosphoric acid would possess. The mucus of the bladder is retained in solution in the urine, principally by this acid; and this mucus is the chief cementing matter which binds together the particles of the phosphatic calculi. We have reason, then, to infer that the phosphoric acid would dissolve the mucus, and thus crumble the calculus into sand,—a mode of action perhaps more likely than any other to succeed against these concretions. When the calculus, then, is such as to require acids, this would

perhaps be the best. The only objection to it might be, that its action would be weak or slow; but this can only be ascertained by experiment.

The method of injecting lithontriptics has, since the time of FOURCROY, seldom been put to the test of practice; medical men, in general, being satisfied with condemning or ridiculing it. It may be stated, however, in its defence, and in opposition to the authority of BRANDE and others, that Dr MARCET, whose fame justly stands so high, seems to have entertained an extremely favourable opinion of it. While expressing his belief of the total insufficiency of lithontriptics taken by the mouth, to the solution of calculi, he mentions the method of Fourcroy, as one more likely to be efficacious, stating his opinion, that it has by no means been sufficiently tried to justify its being laid aside. In several cases in which he made trial of it, both acid and alkaline solvents were injected without injury to the bladder, and, as he thought, with favourable results. He first ascertained the nature of the calculus in the bladder, either by examination of the gravel or fragments evacuated, or by an ingenious mode proposed by FOURCROY, of throwing very dilute alka-

line or acid leys into the bladder, and examining them by delicate chemical tests, when withdrawn. Then, according to the results which they gave, a weak solution of one class or the other of lithontriptics, was injected by a syringe through a catheter, the bladder being of course previously carefully emptied of urine. Sometimes half a drachm of pure opium was added to the injected solvent. In general, the alkalis, he remarked, excited less irritation than the acids, but both could be used and retained for some time in the bladder with little or no difficulty, when so much diluted that they might be swallowed without inconvenience, *a state in which they could still act on the concretions.*

Even in a very aggravated case, in which the bladder, the kidney, and other parts, were greatly diseased, he injected a ley, containing a considerable proportion of the most acrid solvent, the muriatic acid. He began with only two drops of acid in four ounces of water, and gradually increased the acid to twenty-three drops, without producing any inconvenience, though the solution was often retained in the bladder as long as an hour. This, of itself, is a very strong fact. The acid used to

be given, even by the mouth, only in doses of 20 or 30 drops, of which a very small portion only could reach the bladder. Here, on the contrary, 23 drops of acid were at once brought to act on the calculus for an hour, without pain or injury, in a case also of peculiarly severe disease. If, in such an instance, Dr MARCET found reason to approve of the effects of the injection, what might not be expected in milder cases, when the method has been developed and improved, by experience and observation.

It is obvious that the method of FOURCROY, which I have thus described, ought to be employed with the greatest caution. It must not be concealed, that fatal accidents have happened to the bladder, from the use of too concentrated leys; and it is possible that such accidents may have excited a prejudice against the plan. Nothing can be more groundless, however, than such a prejudice. Is it not in the power of every operator to inject solutions of any degree of strength that he may think proper, and increase their power as slowly and as gradually as he pleases? Was the safety of the patient, who bore 23 drops of muriatic acid without inconvenience, at all en-

dangered by the first injection, in which there were only two drops ; and if the slightest pain had been felt, was it not easy at once to withdraw the solvent ? As to the attendant danger, then, it seems to be sufficiently proved, that where there is caution on the part of the surgeon, this method cannot be more hazardous than the usual mode of administering lithontriptics.

I have thus considered the more general questions respecting Urinary Calculi apart from the strictly surgical part of the subject. I have, in the first part of the Essay, described rather fully the different species of calculi, and the action of chemical solvents upon them, that the modes of operating of the different lithontriptics might be more easily explained and discussed. I have, in the latter division, ventured to express a rather favourable opinion of the practicability of a method of administering these remedies which has long been neglected, and by many ridiculed : Yet this method was proposed, and has been practised by men of high reputation ; nor, as I have shewn, is it, if conducted with caution, attended with in-

convenience or danger. It is a method, certainly, which has rather an alarming aspect ; but the disease is one that cannot be removed by timid measures, and lithotomy, though the high state of perfection of Surgery has rendered it an operation admirable both in its principles and its practice, is still, from its very nature, painful and hazardous. As I have stated in the Essay, no strictly medical attempts at cure by solution have ever completely succeeded, nor can indeed be expected to succeed ; remedies prescribed by the physician, and exhibited in the usual manner, may palliate, though even then it is doubtful if they are really beneficial, but, at any rate, cannot cure.

On the whole, then, I cannot help thinking, on taking a general view of the subject, that, if any serious attempts at chemical solution of a calculus, already formed in the bladder, are ever really contemplated, it must be in the mode of injection. The physician has failed : it remains to be decided, and it has not yet been decided, whether chemical remedies in the hands of the Surgeon may not be more successful ; whether administered in a more direct manner, though with equal caution, they may not be more efficacious.

convenience or danger. It is a matter of convenience which has rather an alarming aspect; but the disease is one that cannot be removed by simple measures, and although the high state of perfection of surgery has rendered it an operation admissible both in its principles and its practice, is still, from its very nature, painful and hazardous. As I have stated in the Essay on actively medical attempts at cure by solution, have ever extremely succeeded, nor considered as a part to undergo; whether prescribed by the physician, and exhibited in the usual manner, may palliate, though even then it is doubtful if there are really cured. I repeat any cure cannot cure. On the whole, I cannot help thinking on taking a general view of the subject, that if any serious attempt at chemical solution of a calculus already formed in the bladder are ever really contemplated, it must be in the mode of injection. The physician has failed: it remains to be decided, and it has not yet been decided, whether chemical remedies in the hands of the Surgeon may not be very successful; whether administered in a more direct manner, though with equal caution, they may not be more efficacious.

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