MOVABLE KIDNEY FROM A SURGICAL
STANDPOINT.By WILLIAM BILLINGTON, M.B., M.S.LOND., F.R.C.S.,
SURGEON TO OUT-PATIENTS, QUEEN'S HOSPITAL, BIRMINGHAM.

DURING recent years attention has been called with increasing frequency to the harmful effects of unduly movable kidneys upon the general well-being of the individual. It has long been known that movable kidney may cause local pain and discomfort, and in some cases even the acute attacks known as Dietl's crises. Such a kidney is often very tender, and, according to its position, may simulate renal calculus, an inflamed gall bladder, or appendicitis. Further, the drag of the kidney upon the duodenum and colon not infrequently gives rise to dyspeptic symptoms of a very intractable character. Many cases of dilated stomach without obvious pyloric obstruction appear to be caused by a movable right kidney having produced kinking of the duodenum. In a recent autopsy at the General Hospital, Birmingham, this condition was found, and no cause other than the dropped right kidney was discovered to account for a markedly dilated stomach. The duodenum was sharply kinked just beyond the pylorus. Several times I have fixed the kidney for gastric dilatation of many years' standing, with very satisfactory results. As a rule, in these cases there is little or no vomiting, but great delay in the passage of food through the stomach and much flatulence. No history of preceding ulceration is obtainable, and no pyloric thickening can be felt. In America the association between movable kidney and menstrual disturbances, especially dysmenorrhoea, has been emphasized.

Apart, however, from those symptoms which are more or less readily explicable on mechanical grounds, it is gradually becoming more clearly recognized that movable kidney may produce more general and far-reaching disturbances. The frequent association of profound neurasthenia, persistent headaches, depression, and even insanity, with undue mobility of one or both kidneys, has led to the supposition that there is a close relationship between these symptoms and the renal mobility. Dr. Sackling of Birmingham has insisted upon this relationship for many years, and has advocated the necessity for keeping the kidney in its proper place by means of a suitable belt, and when this fails, by nephropexy. Latterly this view has been strongly supported by many American and Continental writers, and increasing experience tends to prove that very often marked relief and frequently complete cure follows fixation of the kidney when undue mobility of that organ is associated with profound disturbance of the nervous system which medical treatment fails to relieve. The most probable explanation is that renal mobility leads to the accumulation of toxins in the blood by interfering with urinary excretion, and that these toxins act deleteriously upon the nervous system and nutrition generally. Knowing, as we do, how easily the functions of the kidneys are affected by the quantity and quality of the blood flowing through them on the one hand, and by the resistance opposed to the escape of urine on the other hand, it is not difficult to understand how profound disturbance of urinary secretion may be caused when they are unduly mobile. The continual change of position must frequently interfere with their circulation and cause temporary obstruction to the escape of urine.

I do not, however, in this paper intend to discuss the indications for operation when the kidney is movable, or the pathological explanation of the symptoms caused by it, but to confine myself to certain points connected with its operative treatment based upon an experience of nearly 70 cases.

MORBID ANATOMY.

A typical movable kidney, as seen during operation, presents certain well-marked features. The true capsule is thickened and has a mottled appearance, due to the presence of opaque, yellowish-white patches of varying size. These patches indicate areas of greater thickness, and to them are attached adhesions, often of great strength. The perirenal fat is usually scanty, and its place is taken by adhesions which surround the entire kidney. The adhesions are sheet-like in appearance, with denser bands leading to the opaque patches on the true

capsule. They extend between the true capsule and the fascial capsule outside. Usually the adhesions are quite loose and allow the kidney a wide range of movement within its fascial capsule, though the latter is dragged after the kidney in its more extensive excursions. The true capsule is never very adherent to the renal parenchyma, and where adhesion exists it is irregular and generally found beneath the opaque areas. The kidney pedicle is very much elongated, and the kidney can generally be pulled right out on the loin without causing any undue tension upon it. It is unusual to find the pelvis of the kidney dilated, and when this does occur it is apparently due to the kidney having become fixed in an abnormal position and a temporary kinking of the ureter converted into a permanent one. So long as the kidney can move freely, hydronephrosis is not produced. It is rare for the suprarenal capsule to drop with the kidney, and I have only once seen it. On that occasion it was firmly attached to the upper and inner aspect of the kidney, and showed evidences of chronic inflammation. Sometimes the adhesions between the colon and kidney are very dense, and their separation is effected with difficulty.

The adhesions are not always confined to the immediate proximity of the kidney. On several occasions in which the peritoneum had been accidentally opened from the loin I have seen sheet-like adhesions within the peritoneal cavity closely resembling those surrounding the kidney. Once or twice also, during an abdominal section, I have observed these adhesions, and in every case the kidney was very movable. In one case, where the kidney could almost be pushed into the pelvis, the appendix, ascending colon, gall bladder, and pylorus were involved in thin, sheet-like adhesions for which no other satisfactory cause was discoverable than the mobile kidney. The constant presence of these adhesions furnishes striking proof of the amount of perirenal irritation caused by undue renal mobility.

TREATMENT BY BELTS.

Some years ago Dr. Sackling devised a belt to keep the kidney in position, and its use is attended by great relief in many cases. This belt has since been patented by Messrs. Salt of Birmingham, and is too well known to need description. Frequently, however, the belt fails to cure or even to relieve. This is partly due to the depth of the kidney from the surface, rendering it difficult to provide satisfactory support without the pressure of the pad being irksome. Another reason for failure is discovered when operating. Not infrequently it is found to be impossible to restore the kidney to its normal position until the adhesions to its lower pole have been divided. These adhesions may be so strong and dense as to effectually prevent the kidney from being pushed into place by any external pressure. When it can be readily slipped beneath the ribs a belt may be tried, but many failures are met with.

TREATMENT BY OPERATION.

Very many different operations have been devised for the fixation of a movable kidney, and this in itself is striking testimony to the difficulty experienced. The frequency with which the kidney comes loose again has not unnaturally caused a prejudice against operation in the past, and, more important still, accounts for many of the failures to obtain relief of symptoms. This is unfortunate, because the failure is apt to be regarded as due to an error in attributing the patient's symptoms to the movable kidney rather than as a surgical failure to fix it.

There are several reasons why it has been found difficult to fix movable kidneys successfully and permanently. The renal parenchyma is soft, and sutures passed through it tear out easily, so that the capsule alone can be utilized for purposes of support. The muscles of the back are too yielding, and will not withstand the drag of a kidney fixed to them; further, by their own contraction, they tend to push the kidney away from them, and so strain the supporting stitches. The strain thrown upon the supporting sutures during the retching that is so common after operation is enormous, and is, I believe, the cause of so many kidneys being found loose again so soon as the patient assumes the erect position. I am firmly convinced that no method by which the kidney is sutured to the muscles of the back will give satisfactory results. Another difficulty has been

experienced in connexion with buried sutures; those such as catgut, which are absorbed in the tissues are apt to soften and yield too soon, while the permanent suture materials, such as silk, frequently give rise to troublesome sinuses. To avoid these troubles, the kidney capsule itself has been cut into strips which have been made to serve as sutures, and some of the tendons of the back muscles have been utilized for the same purpose. The results, however, have not been altogether satisfactory.

The operation devised by Goelet was a distinct advance upon former methods. In his operation the kidney is supported by two silkworm-gut sutures passed beneath the kidney capsule, taken through the external arcuate ligament, and brought out through the muscles of the back on to the surface of the loin, where they are tied over a roll of gauze. These stitches are allowed to remain in for three weeks, at the end of which time the new adhesions which form round the kidney become sufficiently firm to keep it in place. The stitches are very strong and prevent the kidney from tearing loose during the early vomiting. As an additional support, Goelet packed the space below the lower pole of the kidney with iodoform gauze, which was left in for several days.

The operation described below is a modification of Goelet's. I have now performed it 70 times, and so far as I can ascertain the kidney has remained in place in every instance. Most of the cases have been examined from time to time after operation by Dr. Suckling, and he informs me that he has never found the kidney down again.

Method of Operating.

The skin of the loin is prepared in the usual way and rubber gloves are used. The loose fat in the loin has a very low resisting power and unless rigid aseptic precautions are taken suppuration occurs and convalescence is prolonged. The patient is turned on the side so that the loin to be operated upon is uppermost, while the space between the ribs and iliac crest is increased by introducing a sandbag or rubber air-cushion under the lower loin. The incision commences just above and a little behind the tip of the twelfth rib (Fig. 1). It is

Fig. 1.—Diagram to show line of incision.

carried almost vertically downwards to the crest of the ilium and is about 3 in. to 3½ in. in length. This incision runs parallel with the outer border of the erector spinae muscle. The fibres of the latissimus dorsi muscle are identified and separated in the line of cleavage. The lumbar fascia is next divided from the twelfth rib to the iliac crest along the outer border of the erector spinae. The fingers are then inserted into the wound and its margins as widely separated as possible. In the space thus opened up is seen the anterior layer of the lumbar aponeurosis covering the perirenal fat, and internally the outer part of the quadratus lumborum muscle, which extends beyond the outer edge of the erector spinae. At the upper part of the wound the last dorsal nerve and the first lumbar artery running along the lower border of the last rib are identified and protected from injury. The

anterior layer of the lumbar aponeurosis is next divided along the outer edge of the quadratus lumborum between the twelfth rib and the crest of the ilium. When incising the lumbar aponeurosis care must be taken to avoid injuring the ilio-hypogastric nerve, which crosses the line of division in its lower part. The kidney surrounded by its fatty capsule is now exposed. With the margins of the wound widely retracted, the kidney can with a little coaxing be brought out on the loin. It is covered with sheet-like adhesions, often of great density, extending from the true fibrous capsule to the perirenal fascial capsule. It is rarely possible to strip these adhesions and the attempt to do so may cause separation of the true capsule from the kidney cortex. They are better divided with a pair of scissors curved on the flat, the blades of the scissors being kept close to the kidney. It is essential that the kidney should be completely freed from all adhesions and left attached by its pedicle only, otherwise they may exercise a downward drag and militate against the success of the operation.

Two incisions are now made through the kidney capsule. The first extends from the upper pole along the convex border as far as its centre; while the second, commencing at the same point as the first, is carried to the back of the hilum. The triangular area of capsule thus marked out is raised and left attached by its base, which extends from the convex border to the hilum. Use is made of it for purposes of support, as described presently. Two stout strands of silkworm-gut are now passed beneath the capsule in the way described by Goelet. The upper of these enters near the centre of the convex border, passes beneath the capsule for about ½ in., is brought out and re-entered in the same direction a little lower down. It is brought back in the same way a little behind the convex border. By passing the suture beneath the capsule twice in series in this way a very much stronger hold is obtained, and it is less likely to tear through. The second stitch is passed in exactly the same way, but nearer the lower pole (Fig. 2). The free ends of the silkworm-gut sutures and the apex of the loose triangular piece of the capsule are clamped with pressure forceps and the kidney replaced in the loin. The loose fat and fascia covering the anterior surface of the upper part of the quadratus lumborum is stripped off and dragged away, so

Fig. 2.—Diagram to show position of silkworm-gut sutures and the way in which they are passed. The dotted lines mark the incisions in the capsule to form the suspension loop.

that the back of the kidney, when fixed in position, will lie against the muscle itself. This ensures the formation of firmer adhesions between the kidney and muscle.

All is now ready for the final fixation. A pair of closed Spencer Wells forceps is forced through the muscles of the eleventh intercostal space immediately behind the tip of the twelfth rib, and made to project below the rib in the wound. The forceps pass between the rib and the pleura. By using blunt forceps and keeping the points close to the rib there is no risk of wounding the pleura, and this accident has never happened in my hands. The blades of the forceps are now opened, and the apex of the triangular piece of loose capsule, already described, seized. The forceps, with the blades closed, are then withdrawn. The kidney is pushed up from below by

fingers in the wound until the fixed base of the denuded area is on a level with the lower border of the twelfth rib. The loose strip of capsule is then drawn taut, and fixed by means of fine silk to its own base. For additional security a second silk stitch fixes it to the intercostal muscle at the place where it emerges above the twelfth rib. In this way the kidney is suspended by a loop of its own capsule, which passes completely round the rib. This loop gives excellent support, and enables one to fix the kidney accurately in a position as nearly normal as possible.* A long-handled needle is then passed through the skin of the back about 1 in. above the top of the incision, and brought out in the wound. It passes behind the twelfth rib and through the ligamentum arcuatum externum immediately below it. The eye of the needle is threaded with one of the free ends of the upper silkworm-gut suture already passed beneath the capsule of the kidney and the needle withdrawn. The needle is again passed through the skin at the same level, but about $\frac{1}{2}$ in. in front of the first puncture, and the remaining free end of the upper suture withdrawn. The free ends of the lower stitch are drawn to the surface in the same way, but are made to emerge about $\frac{1}{2}$ in. nearer the wound than the upper. The stitches are then pulled tight and

Fig. 3.—Diagram to show arrangement of suspension stitches. K, kidney; C, kidney capsule; P, pleura; M, lung; L, liver; I, intestines within peritoneum; D, silkworm-gut sutures passing through muscles and fasciae of back to surface, where they are tied over a roll of gauze well above the wound; F, fine silk sutures fixing loop of kidney capsule.

tied over a roll of iodoform gauze. The roll of gauze rests on sound skin above the wound. At first I brought the supporting stitches out through the top of the wound, and the gauze pad lay on the upper part of the incision. The pad, however, becoming soaked with serum, and later hard, caused considerable irritation. By placing it altogether above the wound this is avoided (Fig. 3).

The fixation is now complete. As a rule, no vessels require ligature, and drainage is unnecessary. If, however, there is much oozing, a strip of iodoform gauze is placed below the kidney and brought out between the skin sutures. It is removed in forty-eight hours. The wound is closed by through-and-through silkworm-gut sutures, or, if thought desirable, the lumbar aponeurosis and latissimus dorsi may be stitched separately with catgut. In order to diminish as far as possible the large space that is left below the kidney a large pad of wool is laid on the abdomen just internal to the anterior superior spine and fixed by means of a spica bandage.

The skin stitches are removed at the end of a week, but the supporting stitches are left in for three weeks. The patient is kept in bed for a month, and then provided with a light belt or an elastic webbing bandage applied in the form of a spica to be worn for six months.

* I am indebted to Mr. Jordan Lloyd for demonstrating to me the practicability of utilizing the last rib for purposes of support.

CONVALESCENCE.

It is surprising to find how little shock is caused by the operation, considering the extensive manipulations to which the kidney is subjected; it is far less than that caused by exploring a healthy kidney for stone. Clearly the constant change in position of a movable kidney causes its nerves to become much more tolerant of manipulation. Post-anaesthetic retching is frequently troublesome and more prolonged than usual. Flatulence is also a constant trouble, and seems to be aggravated by temporary paralysis of the colon. This is induced by the separation of adhesions between the kidney and colon. I now make a practice of giving a large simple enema on the second night after operation, and this gives the patient marked relief. There is usually some pain at first, and it may be necessary to give morphine the night of the operation. I have, however, found that aspirin, 10 to 15 grains, often affords marked relief, and it is well to try this before resorting to morphine.

In most of my cases recovery has been uneventful. In a few, however, the temperature has risen between the seventh and tenth day, and a little later a quantity of turbid serum has escaped from the wound. Evidently this was an accumulation of fluid in the space below the kidney, which came to the surface after the skin sutures had been removed. The presence of such a collection is indicated by a slight convexity of the loin and an ill-defined fullness just inside the anterior superior spine. Usually but little trouble is caused, and after discharging freely for twenty-four hours the sinus rapidly closes. Only in one case has the discharge persisted for more than two or three weeks, and in this case it ceased about ten weeks after operation. I have had no cases in which a permanent sinus has resulted, or which required subsequent operative interference. In two cases active suppuration occurred. These were evidently infected at the time of operation, but after a more tardy convalescence ultimately did very well.

RESULTS OF OPERATION.

Recovery from the operation has occurred in every case except one. This was a man who was operated on during an attack of acute mania which necessitated his control by two keepers. As he was rapidly wasting and becoming weaker it was decided not to postpone operation. He bore the operation very well, and for three days appeared to be progressing favourably, with a normal temperature and slow pulse. On the third day he vomited bile once or twice, but apart from this and a reluctance to take food there was nothing to cause anxiety. On that day he was sensible for the first time for over a week, and conversed with his wife quite cheerfully. On the fourth day he became collapsed and died without apparent reason. The autopsy showed nothing to account for his death. Of the rest, recovery has been complete, and, so far as can be ascertained, the kidney has never come loose again.

I have rarely operated upon both kidneys at the same time, for the reasons that it adds to the risk and that fixation of one kidney is usually sufficient to cure the symptoms. Where both kidneys are movable the worst one is dealt with and the effect of this observed. In one or two instances only, where relief of symptoms has only been partial, does a second operation on the other kidney appear necessary.

The benefit resulting to the patients from fixation of the kidney has been highly gratifying, many of them stating that they have not felt so well for years. When it is remembered that in most of them the symptoms had extended over years, in spite of all ordinary treatment, and that they were mental and physical wrecks, these results are all the more striking. That it was not the rest alone that produced the improvement is proved by the fact that in several the Weir Mitchell treatment had previously been tried and failed, and that they are now leading an active life without relapse. Headaches, depression, intractable dyspeptic troubles, and neuroses of various kinds have disappeared; further, in almost every case the weight has increased. Of course, time is essential to effect all this, and I am accustomed to point out beforehand that it is unfair to judge of the effects of the nephropexy for six months. From my experience of these 70 cases I am convinced that where persistent functional disturbances of the kind referred to are found in com-

paratively young people in association with movable kidney, the latter should be fixed.

The anatomy of the operation described has been revised by Professor Arthur Robinson, and to him my best thanks are due for his valuable assistance.

A NOTE ON CRYOSCOPY OF URINE.

By W. R. GELSTON ATKINS, B.A.,

DEMONSTRATOR OF CHEMISTRY, TRINITY COLLEGE, DUBLIN.

WHEN an appreciable quantity of any pathological product is present in urine the depression of its freezing point below that of pure water does not give a correct indication of the functional activity of the kidney excreting it with relation to the elimination of the normal products of metabolism.

The depression of freezing point of water is proportional to the number of gram-molecules of dissolved substances in it, and is independent of the nature of those substances for non-electrolytes. It is for this reason that it is legitimate to use the depression as an indication of the work done by the kidney in eliminating the dissolved substances against the osmotic pressure produced by them, for this pressure is also proportional to the number of gram-molecules in solution.

V. Koryani and others have shown that the value of the depressing of freezing point Δ , does not fall below 0.9°C . unless an unusual quantity of fluid has been taken. From this we conclude that a kidney producing urine which freezes at -1.27°C ., for example, is functioning sufficiently to maintain health. But this conclusion may be quite wrong if it happens that a large quantity of a pathological product is present.

Sugar (glucose) is the substance most commonly met with in quantity, so it alone will be considered here. Suppose that in the above specimen of urine freezing at -1.27°C ., 5 per cent. of glucose be found. This amount of glucose, if dissolved in pure water, would lower its freezing point by a definite amount, and the presence of the other substances in no way interferes with this. Accordingly, if we wish to determine whether the kidney is excreting waste products efficiently, we must find out the depression produced by the normal waste products alone: in other words, it is necessary to subtract from the depression as determined the depression produced by the quantity of glucose.

This was found by experiment originally, but can now be easily calculated from the following equation:

$$M = \frac{s}{L} \times \frac{K}{\Delta}$$

In this M represents the molecular weight of the dissolved substance, and s the weight of it in L grams of solvent; Δ is the depression of freezing point of the solution below that of the pure solvent, while K is a constant depending upon the solvent. A full explanation of the equation would be out of place here, but may be found in any book on physical chemistry, such as Walker, Lehfeldt, Ostwald, or Reychler. Now for moderate concentrations for $\frac{s}{L}$ we may, without serious error substitute

$\frac{n}{100}$ the fractional amount of s present, then

$$M = \frac{p}{100} \times \frac{K}{\Delta}$$

For water, $K = 1870$, and the molecular weight of glucose $\text{C}_6\text{H}_{12}\text{O}_6$ is 180; accordingly the depression produced by 5 per cent. of glucose dissolved in water can be calculated.

$$180 = \frac{5}{100} \times \frac{1870}{\Delta} \therefore \Delta = 0.56^\circ\text{C}.$$

That is, 0.112°C . for every 1 per cent. of glucose, which agrees well with the value 0.104°C ., the mean of several concordant experimental determinations.

So it is clear that the depression produced by the normal products of metabolism contained in the urine is 1.27°C ., -0.56°C ., $= 0.71^\circ\text{C}$., a value which is much too low. Thus this kidney, which would have been able to eliminate the quantities of solids occurring in ordinary metabolism, is unable to eliminate them in addition to the glucose. The difference must be accumulating in the blood, namely, solids sufficient to depress the freezing point from -0.71°C . to -0.90°C . or more, and in

addition probably some sugar, for there is no reason why all the sugar should be excreted while all the urea and other normal products are not. This accumulation will cause the blood to freeze below its normal point -0.56°C ., gradually lowering it to -0.60°C . and beyond, till death ensues. Such a conclusion could not be drawn from one determination alone, but requires the weighing of any other facts that may be known, such as whether the other kidney is badly diseased, not developed, or has been removed by operation.

For example, a specimen sent for examination contained 1.87 per cent of glucose, and froze at 1.17°C . Calculation showed the depression produced by the glucose alone to be -0.19°C ., so the freezing point of the specimen, as far as the amount of normal products eliminated was concerned, was $-(1.17^\circ\text{C} - 0.19^\circ\text{C}) = -0.98^\circ\text{C}$. This value, though low, is above the limit, and, taking into consideration the large volume of urine eliminated by diabetic patients, it would probably be safe to conclude that the kidney was functioning well.

Another specimen contained 7 per cent. glucose, and froze at -2.11°C . The depression produced by the glucose was calculated to be -0.73°C ., so the "corrected" value of the freezing point was -1.38°C . What has been said of glucose holds equally well for any other pathological product.

For convenience a table is added showing the depression of freezing point of water by various quantities of glucose, given to the nearest hundredth of a degree, and based on the value $\Delta = 0.104^\circ\text{C}$. for a 1 per cent. solution. The figures in the region of 10 per cent. are slightly too high, as for great concentrations the law is not strictly correct; these deviations amount to only 0.02°C . at 6 per cent., and increase slightly with the concentration.

Table showing Depression of Freezing Point by Various Quantities of Glucose.

Glucose per Cent.	Δ	Glucose per Cent.	Δ
	$^\circ\text{C}$.		$^\circ\text{C}$.
$\frac{1}{2}$	-0.05	$5\frac{1}{2}$	-0.57
1	-0.10	6	-0.62
$1\frac{1}{2}$	-0.16	$6\frac{1}{2}$	-0.68
2	-0.21	7	-0.73
$2\frac{1}{2}$	-0.26	$7\frac{1}{2}$	-0.78
3	-0.31	8	-0.83
$3\frac{1}{2}$	-0.36	$8\frac{1}{2}$	-0.88
4	-0.42	9	-0.94
$4\frac{1}{2}$	-0.47	$9\frac{1}{2}$	-0.99
5	-0.52	10	-1.04

With regard to the technique of freezing-point determinations of urine and blood, those who claim to make these measurements in twenty minutes are liable to encounter an error, not very serious where urine is concerned, but of relatively great magnitude when blood is being examined. When, in order to determine the scale-reading corresponding to 0.00°C ., the bulb of the Beckmann thermometer is placed in a well-stirred mixture of ice and water, the mercury quickly contracts and comes to rest at, say, 1.35 after a few minutes. But this is not the true zero, for on allowing the thermometer to stand for some time, with constant stirring, the zero will be found to have risen to 1.37 or thereabouts. This occurs because the large and very thin glass bulb contracts appreciably, but more slowly than the mercury; accordingly the mercury thread is gradually forced up. This rise was observed to be 0.02°C . in three Beckmann thermometers examined, and ceased to be appreciable after, roughly, one hour. These thermometers had only been exposed to the ordinary air temperatures of the laboratory for some months previously; but in the case of thermometers which have been exposed to any considerable temperature the error would be much more serious.

The effect is, of course, to cause the freezing point of the blood, δ , to have too low a numerical value, if the zero rises in the interval between its determination and the