

tions, included embarrassment during airport check-in, slight interference caused to some magnetic electronic equipment, and the inadvertent attraction of small ferrous objects. A major snag was the slightly bulky appearance of the present cap as seen through clothes, particularly if the weight of cap and ring tended to tilt the device forwards.

Discussion

The percentage of complications, continence, and patient satisfaction in this series is almost identical with the early experience reported from Germany.^{1 2} The major difference among the series was that more of the German failures were due to obesity and more of the British failures to colostomy siting or size of skin hole.

It must be emphasised that our results are of the early experience in eight centres. Although we all have a special interest and considerable experience in colonic surgery and the creation of stomas, we still encountered problems with our early cases while learning the correct technique, siting, and indications. Some of the most recent results from Germany and Scandinavia indicate that with careful patient selection and modification of technique the success rate can be raised from 50% to 75%.

Clearly the implantable magnetic continent colostomy device is not a panacea that is about to solve all the problems of colostomy management for patients having to have their rectum removed. It is suitable only for mentally and physically active patients who are not too fat and who have a good prognosis after abdominoperineal resection of the rectum. Attention to technical detail and the prevention of infection is essential. Details of technique and an instructional film have been prepared by some of us and are available from Coloplast International. Most surgeons must expect that in their early experience with this device there will be some difficulties and much less than total patient satisfaction. Nevertheless, the gratitude

of the patients successfully managing their colostomy by this method encourages us to use it in selected patients, particularly as the consequences of failure appear to be small. The morbidity of the removal of the ring is small, and most of the patients not using the magnetic device still keep their ring in situ without any disadvantages. We believe that the lessons learned from our collective early experience will permit us and others to be able to offer this technique to three out of four patients.

What has not yet been decided is how the use of the magnetic device compares with other methods of colostomy management, for there are many patients with a regular predictable colostomy action who have so little trouble with conventional management that they would not wish for anything else. There are many patients successfully managing a colostomy lavage technique once every 24 to 48 hours who need to wear nothing apart from the smallest of dressings over their stoma.

Once the magnetic device can be made to work in a reasonably high proportion of patients, surgeons have to decide for which group of patients it is the best form of management; then to decide whether it is possible to predict this group of patients before operation or whether they should usually first have a conventional colostomy and be offered the magnetic device as a secondary implantation if they need or wish it.

We would like to thank Mr Halskov and the staff of Coloplast International for their encouragement and help in collecting this series.

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Today's Treatment

Diseases of the urinary system

Advances in the treatment of kidney diseases: An introduction

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Considerable advances have been made in treating kidney diseases since 1960. Undoubtedly the most dramatic has been maintenance haemodialysis and renal transplantation for terminal irreversible renal failure. Not only can many patients now be treated who would otherwise die from uraemia but, in addition, these treatments have added tremendous impetus to

research into the nature of the biochemical and hormonal abnormalities that occur in chronic renal failure, basic renal physiology, and also the nature of the underlying renal diseases that may result in terminal renal failure—principally the various forms of glomerulonephritis.

I want to give a brief introduction to the present state of maintenance haemodialysis and renal transplantation and also to mention a few of the areas of renal pathophysiology where advances have and are being made. Some of these areas will be explored in greater detail in future articles in this series.

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Maintenance haemodialysis and renal transplantation

Haemodialysis was introduced by Kolff in the management of acute renal failure in 1943. Its use was limited to this until 1960

because of the few sites available for arterial and venous cannulation. Quinton, Dillard, and Scribner announced a major technical advance in 1960, when they introduced a semi-permanent teflon-silastic arteriovenous shunt that allowed repeated easy access to the patient's circulation for haemodialysis. For the first time, therefore, it became possible to treat patients with terminal chronic renal failure by repeated haemodialysis two or three times a week for long periods. In 1965 it was reported that it was possible to train patients to carry out repeated haemodialysis by themselves and in their own homes.

Early attempts at renal transplantation occurred around 1956, and the basic surgical techniques were established at that time. The results, however, were poor because of the phenomenon of immunological rejection of the grafted organ. In 1960 there was another major advance, when it was shown that 6-mercaptopurine administration resulted in prolongation of skin allografts in rabbits. Calne reported similar effects in renal transplants in dogs. The basic immunosuppressive treatment to combat rejection of transplanted kidneys was soon established, and a combination of azathioprine (a derivative of 6-mercaptopurine) and prednisone has been used in most renal transplant units ever since. Other supplementary immunosuppressive techniques have been introduced over the years and tissue-typing techniques have advanced.

Both maintenance haemodialysis and renal transplantation have passed through the experimental stage and are now acceptable treatments for terminal chronic renal failure. At first they were sometimes regarded as rival forms of treatment. It is now appreciated that both must be available for optimum treatment. Maintenance haemodialysis is essential for the adequate preparation of patients for renal transplantation and must be available for those transplanted patients in whom irreversible graft rejection occurs.

What is the extent and what are the results of these treatments? The European experience as of December 1975 was as follows: over 900 centres were performing dialysis or transplantation, or both. Out of a total estimated population of 491.4 millions, more than 18 000 patients were undergoing hospital haemodialysis, more than 4000 were on home dialysis, and just over 5000 patients had functioning renal transplants. The results of treatment varied from centre to centre and from country to country, but the overall European experience was that the percentage patient survival at three years for hospital dialysis, home dialysis, and after the first cadaveric transplant was 65%, 81%, and 61%, respectively. Graft survival after the first cadaveric renal transplant was 39% at three years.

With regard to rehabilitation, the percentage of patients in Europe considered medically fit for work and actually working full time or part time was 59% (hospital dialysis), 80% (home dialysis), 85% (living donor transplants), and 79% (cadaveric renal transplants). About 10% of hospital dialysis patients and 6% of home dialysis patients were considered medically fit for work but did not return to work because their earning capacity was less than their social security benefits. In addition, about 11% of hospital dialysis patients and 7% of home dialysis patients were considered medically fit for work but there was no work available.

The choice of treatment for an individual patient will depend on many factors including medical factors, local facilities, and patient preference.

Control of urinary sodium excretion in chronic renal failure

In patients with renal failure, as in normal people, the amount of sodium excreted must equal the amount taken if oedema or salt depletion are to be avoided. The implication of this truism is that as the glomerular filtration rate falls with increasing renal failure, the proportion of filtered sodium that is excreted must increase to maintain sodium balance.

The mechanism of this adaptive process is now attributed to

a circulating natriuretic substance, and the presence of this substance in uraemic plasma is thought to depend on the need to try to maintain sodium balance and not to the retention of a non-specific toxin. It is also thought that this natriuretic substance may be the same substance that increases urinary sodium excretion during volume expansion in animals with normal renal function (third factor or natriuretic hormone).

Hypertension and chronic renal failure

Sodium retention is of major importance in causing hypertension in anephric patients on maintenance haemodialysis and in other dialysis patients with retained kidney remnants. These patients commonly have excess extracellular fluid, and the associated hypertension is readily controlled in many, but not all, by progressive removal of excess extracellular fluid during regular dialysis. These patients tend to have an increase in exchangeable sodium, and plasma renin activity is normal or low. This form of hypertension has come to be known as "salt and water dependent" hypertension.

In occasional patients on maintenance haemodialysis severe hypertension is not controlled by reducing the extracellular fluid volume by dialysis even when this has produced severe sodium depletion. These patients have high levels of plasma renin activity and their hypertension is referred to as "renin dependent" hypertension. In some of these patients bilateral nephrectomy has been used successfully to control severe hypertension, although salt and water dependent hypertension may recur if such patients are allowed to overexpand the extracellular fluid volume. The reason for the "inappropriately" high renin levels in these patients is not clear.

Some patients on dialysis have a combination of these two mechanisms—that is, salt and water dependent and renin dependent hypertension. Bilateral nephrectomy is not an ideal solution for those with severe renin dependent hypertension, and more recently control of hypertension in patients on dialysis has been achieved by correcting the salt and water dependent moiety reducing extracellular fluid volume during dialysis and by correcting the renin dependent moiety by beta-adrenergic blockade with propranolol to inhibit renin secretion.

Renal osteodystrophy

Renal osteodystrophy includes all forms of bone disease that may be associated with chronic renal failure. There are no bone changes that are specific to renal failure but histologically they include the changes of hyperparathyroidism, osteomalacia, and osteoporosis either singly or in various combinations.

The plasma concentration of parathyroid hormone rises early in the evolution of chronic renal failure and can be detected at glomerular filtration rates of below about 50 ml/min. The cause of the rise in plasma parathyroid hormone concentration is thought to be due to phosphate retention as the glomerular filtration rate falls. This may be thought of as occurring in a series of steps. A fall in glomerular filtration rate leads to phosphate retention with a rise in plasma phosphate concentration. The raised plasma phosphate concentration results in a fall in plasma calcium concentration, which in turn stimulates the increased secretion of parathyroid hormone. The excess parathyroid hormone increases urinary phosphate excretion and results in a tendency for the plasma phosphate concentration to fall back towards normal. The hyperparathyroidism may therefore be regarded as a homeostatic mechanism to control phosphate balance. In severe chronic renal failure, however, a vicious circle may be established. Increased parathyroid hormone concentrations also result in an increased release of phosphate from bones, and urinary excretion of phosphate may have reached a maximum level. Thus there will be a secondary increase in plasma phosphate concentration due to the excess of para-

thyroid hormone, which will in turn stimulate the parathyroid glands even more.

Studies of renal osteodystrophy have also increased our understanding of vitamin D metabolism. It is now clear that vitamin D (cholecalciferol) is converted in the liver to a metabolite, 25-hydroxycholecalciferol (25-HCC). Another metabolite 1,25-dihydroxycholecalciferol (1,25-DHCC) is produced from 25-HCC, and this metabolic step occurs only in the kidney. Some consider that 1,25-DHCC is the active form of vitamin D, and certainly its action on intestinal calcium absorption is greater than that of 25-HCC. Deficiency of 1,25-DHCC may be responsible for the defect in mineralisation (osteomalacia) that may occur in renal osteodystrophy. Others have pointed out, however, that mineralisation of bone can occur in anephric subjects—that is, in the absence of 1,25-DHCC.

More recently it has emerged that those patients with chronic renal failure and osteomalacia tend to have the lowest levels of 25-HCC, and that it is the low concentration of 25-HCC that is responsible for the defect in mineralisation. It is suggested that the low levels of 25-HCC occur in those with long-standing chronic renal failure and well-established hyperparathyroidism who may have a diminished intake of vitamin D, an increased consumption of vitamin D due to the hyperparathyroidism, and induction of liver enzymes by substances retained in chronic renal failure.

Erythropoiesis and the kidney

Anaemia is invariably present in severe chronic renal failure, but there is only a rough correlation between the degree of anaemia and the severity of the renal failure. Many factors may contribute to the anaemia in any individual patient. The peripheral blood is characterised by a normochromic normocytic anaemia, and burr cells are commonly seen.

Quantitative studies of red blood cell production in uraemia indicate that there is a definite suppression of red blood cell production for the degree of anaemia present, and it is now thought that a major factor leading to reduction in erythropoiesis in chronic renal failure is probably a reduced production of renal erythropoietic factor. This factor is produced in normal subjects by the kidney in response to a low oxygen tension—for instance, due to anaemia—and acts on a precursor protein molecule in the blood to produce erythropoietin that in turn stimulates red blood cell precursors in the bone marrow resulting in an increase in red cell mass and haemoglobin concentration.

Erythropoietin has usually been undetected or present in reduced amounts in patients undergoing maintenance haemodialysis.

Peripheral neuropathy and chronic renal failure

Peripheral neuropathy as a complication of chronic renal failure was largely unrecognised before the introduction of maintenance haemodialysis. The incidence varies, but in a recent review about 20% of patients had symptoms of neuropathy at the beginning of dialysis treatment.

Sensory symptoms predominate and usually start in the feet. Isolated peripheral nerve lesions may occur in addition to a more generalised symmetrical sensorimotor polyneuropathy. Conservative management of severe chronic renal failure such as strict low protein diets does not arrest the progress of a neuropathy, but adequate periodic haemodialysis will do so. Thus the onset of a peripheral neuropathy should serve as an urgent indication to start maintenance haemodialysis, and most would agree that uraemic polyneuropathy is largely preventable given adequate treatment by haemodialysis or renal transplantation.

The cause of uraemic polyneuropathy remains obscure. Initial suggestions that vitamin deficiencies, abnormalities of transketolase activity, or abnormalities of magnesium metabolism might be important have not been substantiated. The improvement of the neuropathy with adequate dialysis suggests that a retained metabolite is responsible. Inositol nicotinate has recently attracted attention, but conflicting reports on its relevance have appeared.

Retained substances with a molecular weight in the range of roughly 300-1500, the so-called "middle molecules," may be responsible for neuropathy. This idea comes from the fact that these middle molecules cross currently available dialysis membranes much more slowly than smaller molecular-weight substances such as urea and creatinine and that control or prevention of uraemic polyneuropathy depends on increasing the hours of dialysis beyond those necessary to control adequately the concentration of the smaller molecular weight substances such as urea and creatinine.

Further reading and sources

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ONE HUNDRED YEARS AGO The fact that three persons have lost their lives while bathing at Hastings within ten days of one another calls for some comment. The first case was that of a gentleman twenty-four years of age. He was bathing from a machine in the early morning; about five minutes after entering the sea, he was seen to fall with his head under water, where the depth was only three feet. He was quickly removed to the machine by the attendant in charge, who "rubbed him, and poured a little brandy down his throat." Dr Cooke was called in, but found him dead. On *post mortem* examination, extensive disease of the heart was found, probably of long duration. He appears to have been in delicate health for some time, and to have known that he had heart-disease. The second case was that of a lad aged 16. He had been bathing from the shore with another lad, and appears to have been able to swim a little. After he had been in the water five to ten minutes, and being about ten yards from the shore, he was seen to kick a little, and those who saw him thought he was diving; he did not, however, come to the surface again. After a delay of eight minutes, he was brought to land, and the endeavour was made to restore him, but without effect. It appears, he had been liable to fainting attacks. The Royal Humane Society keep an attendant at the spot where the accident occurred, but at the time of the accident he was away. In this case, there was no *post mortem*

examination, and the exact cause of death was not ascertained. In both these cases, although the body was quickly recovered, the attendants appear to have been totally ignorant as to how to proceed to restore animation. It is much to be regretted that all attendants on bathing are not instructed in the methods of artificial respiration, and supplied with the admirable illustrated directions of the Royal Humane Society. In the third case, a boy, who had been previously warned never to bathe alone, ventured into the sea when it was rough: the current proved too strong for him, and he was carried away to sea. The quick succession of fatal bathing accidents at one of the favourite watering-places clearly indicates the necessity of a careful and vigilant attendance at the spots most usually selected for bathing; and the juries at the respective inquests drew the attention of the Royal Humane Society to the question. It appears to us that the local authorities should carefully consider the best means of preventing such accidents by a due regulation and superintendence of the bathing. The danger and folly of persons, the known subjects of heart-disease, rashly bathing by themselves is very manifest, and needs to be strongly impressed upon the public. If boys were more commonly taught swimming in their early years, something would be done to render sea-bathing a more safe as well as a healthful recreation. (*British Medical Journal*, 1877.)