Institute of Science and Technology, for advice and data on the properties of plastics; and to Mr. E. K. Hillard for preparing the illustrations. We gratefully acknowledge the supply of samples of their plastic syringes from Messrs. Becton Dickinson, Gillette, Johnson and Johnson, Sherwood Medical Industries, Smith and Nephew-Southalls, and Steriseal.

References

- Adams, A. P., Morgan-Hughes, J. O., and Sykes, M. K. (1967). *Anaesthesia*, 22, 575.
 Asmussen, E., and Nielsen, M. (1961). *Scandinavian Journal of Clinical and Laboratory Investigation*, 13, 297.
 Berggren, S. M. (1942). *Acta Physiologica Scandinavica*, 4, Suppl. No. 11, p. 51.
 Charlton, G., Read, D., and Read, J. (1963). *Journal of Applied Physiology*, 18, 1247.
 Fletcher, G., and Barber, J. L. (1966). *Journal of Applied Physiology*, 21, 463.
 Hedley-White, J., and Laver, M. B. (1964). *Journal of Applied Physiology*, 19, 901.
 Hilty, H., and Karendal, B. (1969). *Acta Societatis Medicorum Upsaliensis*, 74, 193.
 Kelman, G. R. (1966). *Journal of Applied Physiology*, 21, 1375.
 Kelman, G. R., and Nunn, J. F. (1968). *Computer Produced Physiological Tables*. London, Butterworths.
 Laver, M. B., and Seifen, A. (1965). *Anesthesiology*, 26, 73.
 Le Blanc, A. D., and Johnson, P. C. (1971). *Physics in Medicine and Biology*, 16, 105.
 Major, C. J., and Kammermeyer, K. (1962). *Modern Plastics*, 39, 135.
 Mapleson, W. W., Horton, J. N., Ng, W. S., and Imrie, D. D. (1970). *Medical and Biological Engineering*, 8, 585.
 Selby, J. W. (1961). In *Modern Food Packaging Film Technology*, p. 55. Leatherhead, British Food Manufacturing Industries Research Association.
 Severinghaus, J. W. (1966). *Journal of Applied Physiology*, 21, 1108.
 Wiesinger, K. (1950). *Die Polarographische Messung der Sauerstoffspannung des Blutes*, p. 51. Basel, Benno Schwabe.

¹³¹I Hippuran Renogram in Acute Renal Failure

M. E. MAYO, P. J. HILTON, N. F. JONES, R. W. LLOYD-DAVIES, D. N. CROFT

British Medical Journal, 1971, 3, 516-517

Summary

A hippuran renogram pattern of the type usually interpreted as indicating urinary tract obstruction was seen in acute tubular necrosis and was present both in the oliguric and in the diuretic phase. It seems that in acute renal failure the renogram does not distinguish urinary tract obstruction from intrinsic renal disease.

Introduction

It is sometimes difficult to decide whether oliguric renal failure is due to urinary tract obstruction or to intrinsic renal disease. The hippuran renogram shows a characteristic pattern in urinary obstruction, and Fig. 1 (a) is the renogram of a patient with acute obstruction at the lower end of both ureters. Various reports (Winter, 1961; Trinkle and Kiser, 1964) have indicated that in oliguric renal failure the renogram could distinguish obstruction from intrinsic renal disease, but our experience has shown that it can be misleading.

Case Reports

Case 1.—A man aged 66 developed acute tubular necrosis due to hypotension following rupture of an abdominal aortic aneurysm and subsequent surgery. The renogram (Fig. 2) was obtained on the fourth day after the onset of oliguria and showed an "obstructed" pattern. He died 12 days after admission and urinary tract obstruction was not found at necropsy.

Case 2.—A man of 37 developed acute renal failure complicating pneumonia. Renal biopsy was compatible with acute tubular necrosis and he recovered normal renal function. The first renogram was performed when urine flow had risen to over 2 l./day and also showed an "obstructed" pattern (Fig. 3). Ureterograms obtained the next day were normal. Five weeks later the pattern of the renogram had not changed, and at this time the

blood urea was 47 mg/100 ml and an intravenous pyelogram was normal.

FIG. 1—Hippuran renograms of a woman aged 28 (a) during oliguric renal failure due to bilateral ureteric obstruction following caesarean section; she was receiving peritoneal dialysis at the time; and (b) after reconstructive surgery.

Case 3.—A man of 76 developed Gram-negative septicaemia secondary to urinary tract infection and bladder neck obstruction. He was oliguric for a week but recovered without dialysis. Serial renograms were obtained, the first during the oliguric phase, the second and third (Fig. 4) during recovery of renal function, and all three showed an "obstructed" pattern. An intravenous pyelogram three weeks after admission showed no upper urinary tract obstruction, and the third segment of the renogram had returned to normal by the fifth week. It should be noted that the bladder neck obstruction was not sufficient to produce secondary changes in the upper urinary tract.

Case 4.—A man of 59 was admitted to hospital with a swollen, hard, and tender left calf. Despite the presence of distal pulses it was thought that he had acute ischaemia of the calf muscles and this leg was explored. When the deep fascia was released oedematous pale muscle bulged out and regained its normal colour in five minutes. The next day he was found to be

St. Thomas's Hospital, London S.E.1

M. E. MAYO, M.B., F.R.C.S., Senior Surgical Registrar
 P. J. HILTON, M.B., M.R.C.P., Senior Medical Registrar
 N. F. JONES, M.D., F.R.C.P., Consultant Physician
 R. W. LLOYD-DAVIES, M.S., F.R.C.S., Consultant Urologist
 D. N. CROFT, D.M., M.R.C.P., Consultant Physician

FIG. 2—Renogram in Case 1. Acute tubular necrosis in the oliguric phase.

FIG. 3—Renogram in Case 2. Acute tubular necrosis. This renogram was obtained when the urine output had risen to 2 l./day.

FIG. 4—Renogram in Case 3. Acute tubular necrosis. Urine output on this day exceeded 2 l.

FIG. 5—Renogram in Case 4. Acute oliguric renal failure due to myoglobinuria.

oliguric. The urine contained red cells and fragmented red cell casts. The blood urea was 122 mg/100 ml and serum potassium 7.8 mEq/l. The renogram (Fig. 5) showed steep and steadily rising curves, and on the strength of this, after treatment of the hyperkalaemia, cystoscopy was performed and bilateral ureterograms were obtained. These showed no evidence of obstructive uropathy. He died soon afterwards and at necropsy was found to have extensive myoglobin casts in the renal tubules. The calf muscles of the left leg were necrotic.

Discussion

The "obstructed" renogram curve depicts no more than delayed transit time of the isotope from the renal artery to the bladder. Though this pattern is produced by urinary tract obstruction there are many other situations in which it is seen. Perhaps the commonest is where there is reduction in urine flow, together with sufficient tubular function to show definite uptake. Wax and McDonald (1966) showed that dehydration, shock, and severe renal artery stenosis may all produce this.

In the four cases described here the initial renograms were obtained after correction of fluid imbalance and hypotension. In all of them the renogram pattern was indistinguishable from that produced by acute obstruction (Fig. 1 a); however, there was no evidence of extrarenal urinary tract obstruction at necropsy in Cases 1 and 4 or on pyelography in Cases 2 and 3. It is possible that the pattern of the renogram in Case 4 was produced by intrarenal obstruction due to widespread myoglobin casts, but this cannot account for the pattern found in the other three cases. In the two patients whose renal function recovered the "obstructed" pattern persisted during the diuretic phase for at least five weeks. It should be noted that when uraemia is due to chronic renal disease the renogram does not show an "obstructed" pattern, little or no radioactivity accumulating in the kidneys (a "flat" pattern). In a patient presenting with unexplained uraemia it is not always easy to distinguish acute from chronic renal failure, and the renogram may then be helpful, for a "flat" curve suggests chronic renal disease. However, with this exception, the renogram in acute renal failure is of limited value and the results should be interpreted with caution.

Whether more sophisticated renographic techniques, such as the computer-assisted blood background subtraction method, will prove more discriminatory in this situation remains uncertain.

We are grateful to the physicians and surgeons of St. Thomas's Hospital for allowing us to report cases under their care.

References

- Trinkle, J. K., and Kiser, W. S. (1964). *Journal of Urology*, **91**, 199.
- Wax, S. H., and McDonald, D. F. (1966). *Journal of Urology*, **96**, 816.
- Winter, C. C. (1961). *Journal of Urology*, **85**, 683.