two had obstruction of the popliteal vein or above and one had minor calf thrombosis. This latter one was missed on ultrasonic examination.

TABLE I.—*Comparison of Ultrasonic and X-ray or Isotopic Studies in 19 Legs with Clinical Deep-vein Thrombosis. The Two Legs Which Were Normal on Ultrasonic Examination had Very Minor Calf Thrombosis on Venography*

	Ultrasonic Dopplergram	X-ray or Isotope Examination
Positive	8	10
Negative	11	9

TABLE II.—*Comparison of Results of Ultrasonic and X-ray or Isotopic Studies in 19 Clinically Normal Legs. The One Patient Not Diagnosed by Ultrasound had Minor Calf Thrombosis on Venography*

	Ultrasonic Dopplergram	X-ray or Isotope Examination
Positive	2	3
Negative	17	16

By varying the site of the squeeze applied to the leg it was possible to indicate accurately the upper limit of the thrombosis in the affected veins if the occlusion was in the popliteal vein or above. The correlation between Dopplergrams and venograms was accurate. One patient had incomplete occlusion of his popliteal vein on venography, and Dopplergrams again showed the upper limit of the thrombus. In the 25 legs which were normal on venographic or isotopic survey no false positives were obtained by Dopplergrams.

Discussion

In this preliminary report ultrasonic investigation was far superior to clinical examination. Clinical assessment was accurate in only about half of the cases in this series where the diagnosis of deep-vein thrombosis was made. More important possibly was the fact that three legs thought clinically to be normal proved to have thrombosis. In two of these the process was extensive.

Ultrasonic investigation was performed after clinical examination and before the results of the ancillary tests were known. The correlation between ultrasonic and venographic or isotopic

studies in this small series was 92%. On ultrasonic investigation thrombosis was diagnosed in 10 legs whereas with venography or isotopic tests thrombosis was found in 13 of the 38 legs examined. The three legs not diagnosed by ultrasound were found to have thrombosis in one group of calf veins only.

Five per cent. of all hospital deaths result from massive pulmonary embolism, and of these patients just over half would have returned to a normal mode of life but for the fatal incident. As most of the emboli originate from the deep veins of the leg the need for a method which is simple, quick, accurate, easily repeatable, and without discomfort to the patient is obvious. An individual can be rapidly trained to use such a method, and it appears that ultrasound will prove to be a useful test for regular screening of a patient at risk of massive deep-vein thrombosis, especially as Dopplergrams can be performed at the bedside with the minimum of discomfort to the patient.

As tissue penetration with ultrasound is inversely related to the frequency it has been found that, operating at 2 MHz, it is possible to scan the venous system from the calves to the inferior vena cava.

Potential hazards from the ultrasound appear to be negligible as the entry output is 10 milliwatts/sq. cm. Many thousands of obstetrical cases have been monitored for lengthy periods at a similar energy output by means of the same instrument without any reported ill effects.

Further investigations into the problem of diagnosing deep-vein thrombosis are in hand, and the results will be presented in a more extensive future communication.

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Medical Memoranda

Severe Muscle Cramp due to Acute Hypomagnesaemia in Haemodialysis

British Medical Journal, 1969, **2**, 804–805

Attention has recently been drawn to the complications of hypermagnesaemia induced by haemodialysis for chronic renal failure (Govan *et al.*, 1968). We report here a case of severe muscle cramp due to acute hypomagnesaemia occurring in chronic intermittent haemodialysis. Wacker and Parisi (1968) extensively reviewed abnormalities of magnesium metabolism in man; there is no reported evidence for acute hypomagnesaemia related to dialysis.

CASE REPORT

The patient, a 38-year-old white South African with advanced chronic glomerulonephritis, was started on regular twice-weekly haemodialysis early in 1968, a Kolff kidney with twin coil 145 being used for nine hours per dialysis. After about four months he began to develop severe muscle cramps in both legs and to a lesser degree in both arms. These involved the smaller muscles in particular and usually came on about six to seven hours after the start of dialysis, gradually fading in the 12 hours after the end of dialysis. The blood pressure and pulse remained normal throughout, and no excessive loss of weight was noted. Both oral quinine and intravenous saline were given without any effect on the cramp.

Physical examination failed to show any abnormal signs beyond the muscle spasm. Both Chvostek and Trousseau signs were

negative. Plasma calcium and potassium were normal both at the beginning and at the end of dialysis. Predialysis magnesium, however, was 2.5 mg./100 ml. (normal range 1.7–2.1 mg./100 ml.), and this fell to 1.3 mg./100 ml. at the end of dialysis (see Table).

Magnesium Concentrations (mg./100 ml.)

	Present Patient		Range of 6 Other Dialysis Patients, MgSO ₄ Not Added
	Before Adding MgSO ₄	After Adding MgSO ₄	
Predialysis Mg	2.5	2.5	1.3–2.2
Postdialysis Mg	1.3	1.8	1.0–1.9
Fall in plasma Mg concentration during dialysis	1.2	0.7	0.1–0.7
Bath-water Mg	0.8	1.8	0.8

No magnesium was added to the dialysing fluid, and the bath magnesium concentration was normally only 0.8 mg./100 ml.

During one of the acute cramps 4 mEq of magnesium in the form of 10% MgSO₄ was administered intravenously. This brought about a sudden and dramatic relief of the cramp, which did not recur during that dialysis. At the beginning of the next dialysis the plasma magnesium was again 2.5 mg./100 ml. Severe cramp recurred during dialysis and was again relieved by a similar dose of magnesium sulphate.

Magnesium sulphate was next added to the bath-water in order to bring the magnesium concentration up to 1.8 mg./100 ml. Since then the patient has had no severe muscle cramp.

COMMENT

Although all of our patients on chronic intermittent haemodialysis are dialysed against a bath-water magnesium concentration of 0.8 mg./100 ml., we have not seen these excruciating cramps in any others. The predialysis plasma magnesium concentrations in six patients ranged from 1.3 to 2.2 mg./100 ml. (see Table). Serial predialysis estimations over several months showed no tendency for hypomagnesaemia to develop. Nevertheless, in none of these patients was the plasma magnesium level as high as 2.5 mg./100 ml. at the beginning of dialysis, but the postdialysis magnesium levels (1.0 to 1.9 mg./100 ml.) are comparable with those found in the above patient.

Cerebral Embolus after Traction Injury to the Arm

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Trauma to the subclavian artery may occasionally be sustained as a result of injury to the neck, upper chest, or shoulder. Injuries include blunt trauma as well as open wounds from gunshot, etc. Apart from acute haemorrhage, a variety of complications may ensue. Thrombosis of the contused vessel has led to brachial artery embolism (Watson-Jones, 1952), and has also resulted in a number of cases of traumatic subclavian steal syndrome (Sweetman, 1965; Rojas *et al.*, 1966; Mandelbaum *et al.*, 1967). Post-traumatic aneurysm of the subclavian artery has been discussed by DeBailey *et al.* (1965), and several cases of subclavian arteriovenous fistulae were described by Pate and Wilson (1964). A case of delayed haemorrhage has also been published (Fisher and Rienhoff, 1966).

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At the time of the onset of severe cramps the patient's plasma magnesium was 1.6 mg./100 ml., which is only just below the normal range. This suggests that the clinical symptoms were not related to the absolute level of plasma magnesium but rather to the rate and extent of fall in plasma magnesium level during dialysis. Symptoms occurred in the only patient with a fall in plasma magnesium concentration exceeding 1 mg./100 ml. during the period of dialysis, and he became symptom-free as soon as this rate of decline was reduced.

This situation may be related to the fact that this patient had a rather higher than normal plasma magnesium level. This is an unusual feature in patients on long-term chronic intermittent dialysis, though hypermagnesaemia has been described in acute renal failure with the use of flame photometry estimation (Wacker and Vallee, 1957).

We have not added magnesium sulphate to the bath-water of our other patients on chronic dialysis, since none of them appear to have had any clinical evidence of magnesium deficiency.

Our plasma magnesium estimations were done by a colorimetric method (Bohuon, 1962). Although objections have been raised to this method, and the atomic absorptiometer is superior, the findings in this case are probably valid because (1) the estimations were repeatable, and (2) the important features in this case were the relative values before, during, and after dialysis rather than the absolute values themselves.

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We report a case of severe traction injury to the arm causing rupture of the subclavian artery. This was complicated by a cerebral embolus passing up the vertebral artery causing severe visual-field defects. Only one previous case of cerebral embolism occurring after subclavian trauma has been found in the literature (Lewin, 1965).

CASE REPORT

A man aged 43 was brought into the casualty department after his left arm had been accidentally drawn into a tire-shredding machine; he had sustained a severe traction injury to his left shoulder.

On examination he was conscious but shocked. There was considerable bruising around his shoulder and left chest below the axilla. A 5-in. (13-cm.) laceration extended across the axilla. No pulses could be felt in the left arm distal to the subclavian artery. The arm was paralysed and limp and was also anaesthetic beyond the C 4 dermatome. A left Horner's syndrome (Fig. 1) confirmed