

LOCAL EXPERIENCE OF REGIONAL ANTICOAGULATION WITH SODIUM CITRATE FOR HAEMODIALYSIS IN PATIENTS AT RISK OF BLEEDING

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Summary

Regional citrate anticoagulation was used in 310 haemodialyses in patients at risk of bleeding. Efficient anticoagulation was achieved on cuprophane or cellulose dialysers without any bleeding complications, without systemic anticoagulation nor any change in clotting or blood parameters. A slight increase in blood calcium was seen. The citrate flow rate during haemodialysis correlated with the pre-haemodialysis blood calcium. We conclude that regional citrate anticoagulation is a safe, easy and efficient technique for haemodialysis in patients at risk of bleeding.

Introduction

As the use of heparin as an anticoagulant for haemodialysis is followed by systemic anticoagulation, its use gives rise to a high rate of complication in acute or chronic haemodialysis patients bleeding or at risk of bleeding. Different techniques have been proposed to avoid or minimize the risks of systemic anticoagulation: limited dose heparinization with close monitoring of the activated whole blood clotting time (aWBCT) [1], neutralization of heparin with protamine after haemodialysis or by regional anticoagulation [2], prostacyclin infusion to increase heparin action or as the sole anticoagulant [3,4], and non-anticoagulant high flow-rate haemodialysis [5].

However, it has been shown that the most commonly used of these techniques, and the limited dose heparinization with monitoring of the aWBCT, is still associated with bleeding complications in nearly 26 per cent of the patients [6].

Citrate is a very powerful anticoagulant as it binds with calcium, the important cation of all steps of the blood coagulation process. It is a normal metabolite of the tricarboxylic acid energy pathway and is rapidly metabolized in subjects with normal liver function. In 1982, Pinnick et al [7] demonstrated the efficacy

of citrate as an anticoagulant in haemodialysis so we have used this technique since February 1, 1983 for haemodialysis in all our patients at risk of bleeding.

Methods

Pinnick et al [7] have shown that the aWBCT of 1ml of blood is increased by 100 to 400 per cent by the presence of 2.5 and 5mM of citrate respectively.

An 0.1M solution of trisodium citrate is infused to the arterial line of the dialysis circuit (Figure 1) and its flow rate (always 200ml/min) adapted to maintain an aWBCT of about 200 seconds at the dialyser. In our experience any existing type of dialyser has been used: cuprophane or cellulose hollow-fibre or multilayer. The dialysate used was always a bicarbonate non-calcium containing dialysate, so that the calcium citrate complex is eliminated through the dialyser. Its clearance has been estimated as 60 per cent of the urea clearance [8]. To avoid hypocalcaemia and to restore coagulation, a five per cent calcium chloride solution is then perfused in the venous line at the bubble trap to lower the aWBCT to about 100 seconds. The flow rate ratio of calcium chloride to citrate was maintained at 1 to 10.

Patients

From February 1, 1983 until December 1, 1984, we used citrate for 310 haemodialyses in 18 patients with acute and 91 patients with chronic renal failure.

Thirty-two patients had active bleeding at the time of haemodialysis (16 gastrointestinal tract haemorrhage; 2 disseminated intravascular coagulation, 5 traumatic wounds, 4 epistaxis, 5 others) and 77 patients were at risk of bleeding (18 pericarditis with or without pericardial effusion; post-operative period: 8 aortic or vascular surgery, 4 cardiac surgery, 6 nephrectomy, 4 cholecystectomy, 4 parathyroidectomy, 16 others; 2 disseminated intravascular coagulation; 2 after renal biopsy).

Results

Bleeding complications No patient developed any bleeding during or immediately after citrate haemodialysis. One patient collapsed one hour after haemodialysis due to bleeding from oesophageal varices; her coagulation parameters had been measured five minutes after haemodialysis and were normal.

Blood calcium and hypocalcaemic symptoms No patient developed any complaint or signs of hypocalcaemia. An increase in blood calcium from 8.5 ± 0.1 mg/dl (mean \pm SEM; n=50) before haemodialysis to $8.8 \pm$ after haemodialysis was observed ($p < 0.02$).

Citrate flow-rate The mean citrate flow rate in the first 50 patients was 521 ± 60 ml/hr or 4.3 per cent of the blood flow rate. In those patients the aWBCT in the arterial line was 290 ± 55 sec and in the venous line 112 ± 36 . The citrate flow-rate at the end of the first hour of haemodialysis correlated with the pre-haemodialysis calcaemia (n=50; $r = 0.533$; $p < 0.001$).

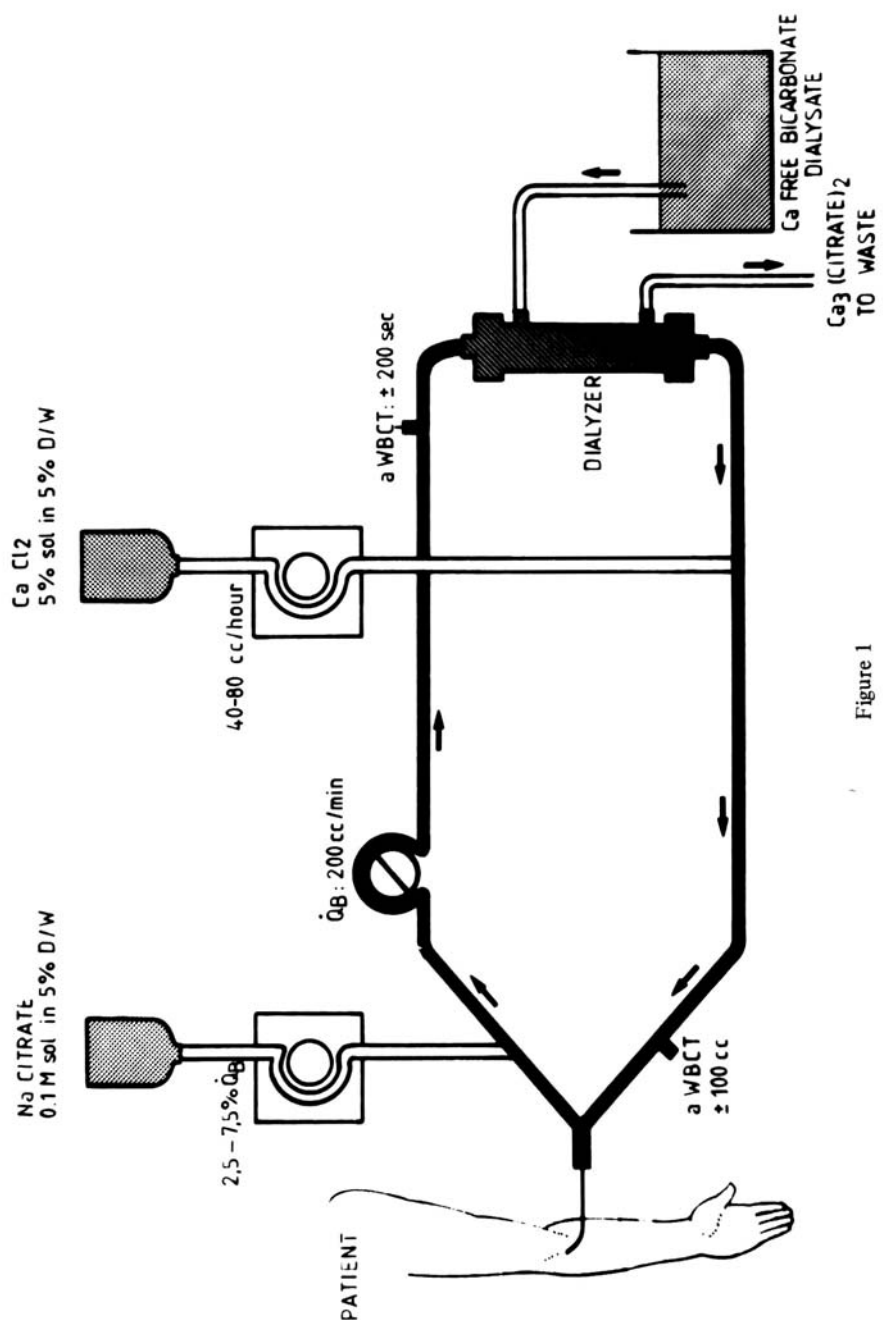


Figure 1

Clotting parameters Coagulation parameters have been studied in 25 patients before and five minutes after haemodialysis to evaluate the possibility of systemic anticoagulation: no change was seen in prothrombin time: from 72.9 ± 3.0 seconds (mean \pm SEM) to 71.3 ± 2.6 , nor in activated partial thromboplastin time: from 27.9 ± 1.5 seconds to 28.6 ± 1.7 , nor in aWBCT: from 335 ± 28 seconds to 286 ± 26 .

Blood parameters No change was seen in haematocrit, leucocyte or platelet count immediately after haemodialysis.

Technical complications Clotting of the venous line was observed four times: twice during haemodialysis on a polyacrylonitrile membrane and twice rapidly after the onset of blood transfusion.

Discussion

Regional citrate anticoagulation using the protocol proposed by Pinnick et al [7] is an easy and safe technique. An efficient anticoagulation of the haemodialysis circuitry without any residual systemic anticoagulation is achieved. No hypocalcaemia nor hypocalcaemic symptoms were seen in our patients and a positive calcium balance during haemodialysis was observed. Moreover, we have shown that the citrate flow rate during haemodialysis correlates with the prehaemodialysis blood calcium so that we were able to propose citrate haemodialysis even for patients with profound hypocalcaemia (e.g. after parathyroidectomy).

The volume of citrate solution should be taken into account concerning the choice of the dialyser to be used and the ultrafiltration rate to be performed. The possibility of using citrate with polyacrylonitrile membranes remains to be evaluated as it was, in our hands, associated with clotting in the venous line, perhaps due to a higher clearance of the calcium citrate complex.

As it is not known if there is any citrate toxicity other than hypocalcaemia and as citrate is mainly metabolized in the liver, the safety of its use in patients with liver failure remains to be assessed.

References

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