Case Report

The value of computed tomography and magnetic resonance imaging to diagnose rhabdomyolysis in acute renal failure

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Introduction

Rhabdomyolysis results from various clinical conditions such as drug abuse, alcohol, neuroleptic agents, extreme pyrexia, direct trauma, compression, ischaemia, excessive muscular activity, polymyositis, and metabolic/genetic disorders [1]. Clinically it is accompanied by release of creatine kinase, myoglobin, lactate dehydrogenase, phosphate, and potassium from muscles, causing increased serum concentration of these substances. Rhabdomyolysis can be complicated by acute renal failure [2].

Diagnosis of rhabdomyolysis can usually be made easily based on elevated serum creatine kinase level. In some cases the presence of rhabdomyolysis is not immediately evident, e.g. when a patient is admitted several days after the event. In such patients the increase in creatine kinase, if any, is minimal because creatine kinase peaks within 24 h and subsequently decreases by 39% every day [1].

Recently magnetic resonance imaging (MRI) [3,4] and computed tomography (CT) [5] have been introduced to visualize rhabdomyolysis. Russ and Dillingham [5] suggested that CT can be helpful in diagnosing rhabdomyolysis in cases of acute renal failure of unknown aetiology. Here we report such a case where CT and MRI were helpful in documenting a history of rhabdomyolysis as the cause of acute renal failure of unknown origin.

Case

A 57-year-old male was admitted to our hospital for acute renal failure and immobilization. He had a history of depression and had been treated with sulpiride, thioridazine, and biperiden for about 37 years. On 13 June 1998 he complained of progressive weakness and fever. On 4 July his sister found him lying on the floor at home with extreme fatigue and inability to move. There was nobody who witnessed him having seizures. At a nearby hospital he was found to be febrile and was diagnosed as having acute renal failure with blood urea nitrogen of 143 mg/dl and serum creatinine 15.0 mg/dl. Other laboratory data included potassium 5.0 mmol/l, uric acid 14.8 mg/dl, and creatine kinase 295 IU/l (normal, 30–150). Treatment with cefoperazone/sulbactam and intravenous frusemide 60 mg/day was started. He was transferred to our hospital for the management of acute renal failure on 8 July 1998.

The patient had a history of familial adenomatous polyposis (Gardner syndrome) for which he underwent total colectomy in 1967. In 1992 he was found to have rectal cancer, pancreatic cancer, and diabetes mellitus when rectal resection and duodenopancreatectomy were performed. Osteomata of the skull and the mandible were resected in 1992. In 1994 he underwent partial hepatectomy and lipiodolization for multiple hepatic tumours. In 1996 he was diagnosed to have pigmentary degeneration of the retina. The patient had never previously consumed alcohol or tobacco.

On transfer, he was lethargic and mildly obtunded. Blood pressure was 142/78 mmHg, pulse ranging from 60 to 106/min, respiration 16/min, and temperature between 36.3 and 38.6°C. The chest and abdomen were unremarkable apart from the surgical scars. There was 2+ oedema in the upper extremities. Muscular tenderness was noted in the left upper arm and left inner thigh. Neurology showed nystagmus, sluggish speech, asterixis, and continuous rhythmic involuntary movement of the eyelids, head, mouth, and upper extremities, but reflexes were normal.

Laboratory data showed leukocytes 14 290/μl with 88% neutrophils, haemoglobin 9.4 g/dl, haematocrit 27.9%, platelet 192 000/μl, total protein 5.8 g/dl, albumin 3.1 g/dl, blood urea nitrogen 141 mg/dl, creatinine 14.8 mg/dl, uric acid 13.5 mg/dl, sodium 130 mmol/l,
potassium 4.7 mmol/l, chloride 97 mmol/l, bicarbonate 15.6 mmol/l, calcium 7.9 mg/dl, phosphate 6.9 mg/dl, aspartate aminotransferase 30 IU/l, lactate dehydrogenase 776 IU/l (261–483), alkaline phosphatase 825 IU/l (115–359), gamma-glutamyl transpeptidase 136 IU/l (10–47), creatine kinase 159 IU/l (62–287), aldolase 8.8 IU/l/37 °C (1.7–5.7), gamma-globulin 18.7%, and C-reactive protein 5.0 mg/dl. Urinalysis revealed negative protein, 3+ blood, and trace sugar, with microscopic examination showing numerous erythrocytes and 4–6/hpf leukocytes. Urinary sodium was 45 mmol/l and fractional excretion of sodium 6.6%. Serum hepatitis C antibody was positive. Chest X-ray revealed mild, right-sided pleural effusion. Ultrasonography of the abdomen showed mildly enlarged kidney, splenomegaly, intrahepatic bile duct dilatation, and multiple liver cysts.

No evident aetiology of the acute renal failure could be identified initially. The patient was treated with emergent haemodialysis for 3 days. Frusemide was discontinued. Subsequently urine output increased to 1400–2500 ml and azotaemia gradually improved to the levels of blood urea nitrogen 15 mg/dl and creatinine 2.4 mg/dl by 23 July. There was transient hypercalcaemia up to 13.2 mg/dl in the diuretic phase, which was managed with intramuscular calcitonin injection and forced diuresis.

Since admission the patient had been febrile with the highest daily body temperature between 37.4 and 38.6 °C. Intravenous cefoperazone/sulbactam were apparently ineffective. On 16 July a CT of the abdomen and pelvis was performed which incidentally revealed low-density areas in the left gluteus and adductor muscles accompanied by high-density calcifications (Figure 1). An MRI on 5 August showed high signal intensity in the left obturator, pectineus, and adductor muscles on T2-weighted images (Figure 2). Gallium scintigram and 99mTc-hydroxy methylene diphosphonate bone scan demonstrated significant uptake in the right shoulder, right elbow, left upper arm, front chest, and left femoral regions (Figure 3). The patient gradually became alert and less febrile but a low-grade fever persisted for 5 weeks. Blood urea nitrogen, creatinine and leukocyte count on 10 August were decreased to 7 mg/dl, 1.1 mg/dl, and 3800/μl respectively, and a computed tomography on 19 August showed total resolution of the muscle calcification. An MRI on 27 August was normal.

Discussion

Rhabdomyolysis is the cause of acute renal failure in 5–8.6% of all cases of acute renal failure [6–8]. Although the presence of rhabdomyolysis is clinically evident in most cases, it was reported that rhabdomyolysis had not been clinically diagnosed in 27% of the cases [8]. This is due to the fact that (i) because serum creatine kinase is not always significantly elevated in rhabdomyolysis, especially when cases are admitted later, that (ii) a history is difficult to obtain in patients with altered mental status, and that (iii) muscular symptoms may be minimal, particularly in cases with non-traumatic rhabdomyolysis [6,7]. In the study by Koffer et al. [7], only 52% of patients with non-traumatic rhabdomyolysis had muscle swelling. In another study, one-third of patients with non-traumatic rhabdomyolysis had completely normal physical examination, without muscle weakness, swelling, or tenderness [6]. Therefore, non-traumatic rhabdomyolysis is an underdiagnosed cause of acute renal failure [6,9].

Recently it has been reported that CT and MRI are useful in the diagnosis of rhabdomyolysis. Muscle tissue having undergone rhabdomyolysis appears as a low-density area in CT [10,11], but this finding is not specific and can be seen in pyogenic myositis, abscess, and neoplasm [5]. On the other hand, Russ and Dillingham [5] found that on CT, four of eight patients with rhabdomyolysis had high-density areas in the muscles accompanied by high-density calcifications (Figure 1). An MRI on 5 August showed high signal intensity in the left obturator, pectineus, and adductor muscles on T2-weighted images (Figure 2). Gallium scintigram and 99mTc-hydroxy methylene diphosphonate bone scan demonstrated significant uptake in the right shoulder, right elbow, left upper arm, front chest, and left femoral regions (Figure 3). The patient gradually became alert and less febrile but a low-grade fever persisted for 5 weeks. Blood urea nitrogen, creatinine and leukocyte count on 10 August were decreased to 7 mg/dl, 1.1 mg/dl, and 3800/μl respectively, and a computed tomography on 19 August showed total resolution of the muscle calcification. An MRI on 27 August was normal.

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Fig. 2. T2-weighted images of magnetic resonance imaging showing high signal intensity in the left obturator, pectineus, and adductor muscles.

is still considered to be invaluable in the early diagnosis, because its sensitivity is definitely superior to that of CT or ultrasonography [10].

$^{99m}$Technetium pyrophosphate bone scan was able to detect tissue necrosis as early as 18 h after the onset [12] and was also sensitive in detecting muscle injury when physical examinations were negative [13]. While diuretic-phase hypercalcaemia makes physicians suspect the previous presence of rhabdomyolysis [14], the changes in CT, MRI and bone scan should be seen well before hypercalcaemia. It is suggested that CT and MRI should be performed in patients with acute renal failure of unknown aetiology.

Our patient was considered to have rhabdomyolysis, presumably associated with a long-term use of antipsychotic agents. The patient appears to fulfil criteria of neuroleptic malignant syndrome [15] because he had pyrexia, extrapyramidal signs, and consciousness disturbance. However, some of the symptoms could also have been due to uraemia or medications. The reason why our patient experienced rhabdomyolysis after 37 years of chronic antipsychotic treatment remains to be determined. The neuroleptic malignant syndrome may be triggered by infection or dehydration [16], either of which could have been present in our case. Although there is little information regarding preferential involvement of specific muscle groups in the neuroleptic malignant syndrome, muscle lesions in psoas and adductor have also been described in alcoholics and drug abusers [13,17].

Fig. 3. Significant uptake in the right shoulder, right elbow, left upper arm, front chest, and left femoral regions in (A) gallium scintigram, and (B) $^{99m}$Technetium hydroxy methylene diphosphonate bone scan.

that in four cases of rhabdomyolysis of various aetiologies, high-intensity lesions in T2-weighted images were observed as early as 2 days after admission and had disappeared by 17–46 days. Although MRI findings may not be entirely specific and may have represented reversible oedema and inflammation [3,4], MRI

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References
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