

Death following accidental intravenous infusion of an Aluminium irrigation solution

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Abstract

Objective: Bladder irrigation with potassium aluminium sulphate (alum) is an effective and generally safe treatment of hemorrhagic cystitis. It works by protein precipitation over the bleeding surface. Experience with accidental intravenous Aluminium is very limited.

Case Report: A 70 year old woman with hematuria (secondary to bladder amyloidosis) accidentally received about 200 mL of 1% alum bladder irrigation solution intravenously. The patient was immediately transferred to the intensive care unit, treated with deferoxamine as a chelating agent, hemofiltration and plasmapheresis. Shortly afterwards, the general condition deteriorated, the woman became somnolent and developed a disseminated intravascular coagulation. The patient died of multi-organ failure on day 5 after the incident.

Material and Methods: Post-mortem determination of Aluminium concentration in blood, tissues and bone was performed with electrothermal graphite furnace atomic absorption spectrometry.

Results and Discussion: The patient had obtained about 2 g alum and thus approx. 110 mg Aluminium. Aluminum analysis revealed markedly elevated levels in blood (3500 µg/L, normal value 1 µg/L) and tissues, mainly in liver (81 µg/g, controls 0,43 µg/g) and kidney (3,3 µg/g, controls 0,24 µg/g). Concentration in the brain was comparatively low elevated (0,97 µg/g, controls 0,31 µg/g) and apparently no distribution to the bones had yet occurred.

Conclusion: Chelation therapy, hemofiltration and plasmapheresis eliminated only very little of the aluminium obtained.

1. Introduction

Aluminium (Al), one of the most abundant elements in the environment, is naturally not found in the free elemental state, but only in form of Al-containing compounds, which are poorly soluble and consequently hardly available for living organisms. For that reason Al content of plants and animals as well as human beings is small compared to Al content of the soil. Gastro-intestinal absorption of Al is minimal, it is rapidly excreted via the kidneys. Therefore, toxicity occurs mainly if delivered by parenteral routes and/or an impaired renal function. Target organs for Al toxicity are the central nervous system, the skeleton and the blood-building system.

Alum (potassium aluminium sulfate) is known for its astringent properties and acts by protein precipitation over the bleeding surface. Bladder irrigation with 1% alum solution was considered a safe and effective method to control vesical haemorrhage [1].

Case Report

A 70 year old woman with haematuria (secondary to bladder amyloidosis) accidentally received about 200 mL of 1% alum bladder irrigation solution intravenously. The patient was

immediately transferred to the intensive care unit. At first she was awake and responsive. To remove the Aluminium which had been infused, the patient was treated with deferoxamine as a chelating agent and repeated hemofiltrations and plasmapheresis were performed. Nevertheless the condition of the woman deteriorated and she became somnolent. Moreover, the patient developed a disseminated intravascular coagulation with bleedings and multiple hematomas. Although coagulation factors were administered, the patient's condition further deteriorated, she had to be intubated and ventilated. The woman died of multi-organ failure on the fifth day after the incident.

2. Material and Methods

Different samples (blood, tissues and bone) were obtained from the autopsy and analyzed by electrothermal graphite furnace atomic absorption spectrometry with Zeeman underground compensation (AAS 3030, Perkin Elmer). Pyrolytically coated graphite tubes and L'vov platforms were used.

The main problem of quantitative determination of Aluminium is contamination of the samples with Al, which is ubiquitous in the laboratory, especially in glassware and dust. To minimize contamination, minimal sample preparation and the use of plastic vessels is essential. All vessels were rinsed with diluted nitric acid and distilled water before use.

Detailed sample preparation and AAS conditions for Al determination are described in [2].

Controls (data age-matched) are taken from a study where Al concentrations in different tissues from a large non-occupationally or iatrogenic population group were determined [2].

3. Results and Discussion

Alum (potassium aluminium sulfate) has astringent properties, due to which it is commonly used after shaving as a styptic pencil. For preparation as an irrigation fluid, it is sterile filtered, filled in a glass bottle and autoclaved. The appearance of the solution is clear and colorless and probably therefore it was mistaken as an intravenous infusion. The pH of the 1% solution is 3.5.

Data about toxicity following parenteral application of alum are not available. On the one side toxicity is determined by the astringent properties and the acidic pH of the solution resulting in irritation of vascular walls. On the other side toxicity is caused by Al. Al in high amounts is acutely and chronically toxic, mainly neurotoxic. Due to Al-contaminated dialysis solutions, patients on dialysis formerly developed a severe neurological syndrome called "dialysis encephalopathy" [3]. Neurotoxicity of Al can explain the patient's somnolence. The woman developed a disseminated intravascular coagulation with bleedings and multiple hematomas which can be explained by the irritating effect of alum on the vascular walls leading to activation of the coagulation system.

Tab. 1. Aluminium concentrations in different organs of the patient and from controls.

	This case	Controls, Mean (geom)	Factor (approx)
Blood	3500 µg/L	< 1 µg/L	3500
Liver	81 µg/g	0.43 µg/g	180
Kidney	3.3 µg/g	0.24 µg/g	13
Lung	34 µg/g	4.7 µg/g	7
Brain (av)	0.97 µg/g	0.31 µg/g	3
Femur	1.7 µg/g	2.7 µg/g	-

Post-mortem determination of Al showed a strongly increased Al concentration in blood. Although the woman was treated with deferoxamine as a chelating agent and repeated haemofiltrations and plasmapheresis were performed, Al concentration in blood was 3500-fold increased compared to the normal value. Al concentration in liver was elevated compared to controls by the factor 180. The patient had obtained about 2 g alum and thus approximately 110 mg Aluminium. The biggest part of this, about 80 mg, were still found in the liver, which emphasises the essential part of liver in Al metabolism. Concentrations in lung and kidneys were not as strongly elevated.

Concentration in the brain (average from 5 different regions: grey matter, white matter, nucleus lentiformis, brain stem, cerebellum) were 3-fold increased compared to controls, which shows that the brain is (via the blood-brain-barrier) relatively well protected from Al uptake. Nevertheless, it is very susceptible to Al toxicity, and toxic responses are produced when concentrations reach two to four times control levels. Al is not evenly distributed in the brain. Of the 5 different regions of the brain which were analyzed in controls and in this case, Al content is highest in the grey matter of cerebrum, where Al concentration is about twice as high as in white matter. This can be explained by the high affinity of Al to phosphate-rich structures, which appear mostly in the nuclei of cells. Al levels in the other parts of the brain (nucleus lentiformis, brain stem and cerebellum) are in between the levels in grey and white matter.

Distribution to the bones had apparently not yet occurred, since the level in femur was low compared to controls.

4. Conclusion

To summarize, through the measures taken, only very little of the infused Al was removed from the body and the biggest part had remained in the tissues.

5. References

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