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Pulmonary cement embolism in haemodialysis

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ABSTRACT

Chronic care in haemodialysis patients usually requires a multi-system approach. Metabolic bone disorders in chronic kidney disease often cause physical disabilities and require new therapeutic strategies to maintain a good quality of life. Percutaneous cement vertebroplasty and balloon kyphoplasty are widely used to treat compressive vertebral fractures but higher rate of comorbidities in renal patients often cause some complications.

We present an unusual case of late pulmonary cement embolism in an elderly haemodialysis patient.

Curiously, in spite of a large number of vertebral augmentation procedures performed in the world, this is the first report of pulmonary cement embolism in a dialysis patient.

Key-Words: Haemodialysis; balloon kyphoplasty; pulmonary cement embolism; vertebral augmentation procedures; vertebral compressive fractures

BACKGROUND

Chronic care for haemodialysis (HD) patients requires a multi-system approach managing wide range of pathologies frequently unrelated to the kidneys or cardiovascular system. Metabolic bone disorders (MBD) usually present in chronic kidney disease (CKD) and a growing life expectancy in the population under renal replacement therapy (RRT) often cause physical disabilities requiring new strategies to maintain a good quality of life. The combination of multiple diseases and aggressive treatments in this population also increases the complications frequency that can be found.

We present an unusual case of pulmonary cement embolism (PCE) diagnosed in an elderly HD patient.

CASE PRESENTATION

A 76-year-old man undergoing HD was admitted to hospital because of biliary origin sepsis. His summarized medical history includes:

- Orthotopic heart transplantation due to severe coronary heart disease at age 56, complicated with deep vein thrombosis and pulmonary thromboembolism 50 days after surgery. His usual long-term immunosuppressive treatment includes Prednisone, Cyclosporine and Sirolimus. Currently he has cardiac graft dysfunction with NYHA class III chronic heart failure (CHF).
- End stage renal disease (ESRD) due to Cyclosporine toxicity, having begun HD at age 69. Kidney transplantation performed at 70 with early

graft loss due to chronic allograft nephropathy, rebooting HD at age 71.

- Superior vena cava thrombosis due to repeated central dialysis line insertion for HD, diagnosed 18 months before the current admission, resulting in continued treatment with acenocoumarol. His vascular access history includes 1 arteriovenous fistula, 2 PTFE grafts and at least 6 long-term central vein catheters (CVC) in jugular and subclavian veins.
- MBD linked to ESRD and steroid-induced osteoporosis with symptomatic vertebral compression fractures (VCFs) in D12- L4 section. To treat the chronic back pain, two-stage percutaneous balloon kyphoplasty (BKP) was performed. First, L1 and L2 cementation, 8 months before the current admission, and second, D12 and L4 vertebroplasty 7 months before current admission as fractures had extended to adjacent vertebrae (Fig. 1).
- Other medical antecedents are: high blood pressure, gastrointestinal bleeding due to antral gastritis and oligosymptomatic biliary lithiasis.

Diagnosis of cholecystitis and biliary sepsis was based on typical clinical and radiological findings. Blood cultures performed by CVC dismiss the possibility of its infection. Empiric piperacillin-tazobactam antibiotic treatment was started at admission with consequent improvement in few days.

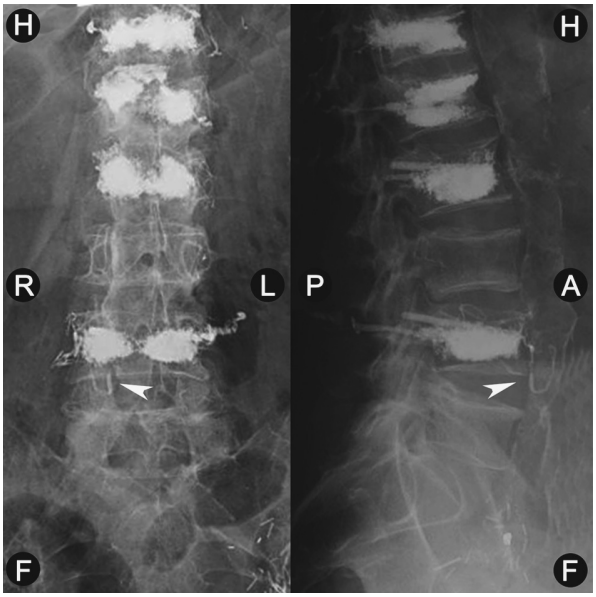
During the 2 weeks were detected peripheral oedema, pleural effusion, asthenia and minimal effort dyspnoea related to stage III CHF. NYHA functional class had not changed compared with previous weeks.

The thoraco-abdominal computed tomography (CT) performed for diagnosis revealed an unexpected presence of high-density deposits diffusely distributed in the pulmonary arteries (Fig. 2).

Despite the initial confusion due to the suspected relation between these radiological findings and pre-existing low-grade respiratory insufficiency, other finds did unlikely the embolism as leading cause of dyspnoea. Arterial blood gas analysis showed low pH (7.32), low PaO2 (64 mmHg), high PaCO2 (52 mmHg), and normal HCO3 levels (26 mEq/L) diagnostic for hypoxemia with combined chronic respiratory and metabolic acidosis partially corrected by bicarbonate supply in dialysis. Progressive “dry weight” decrease led to better respiratory status at discharge without any other therapeutic actions. Presence of the same high-dense material in the paravertebral veins put in evidence the pathway of polymethyl methacrylate

Figure 1

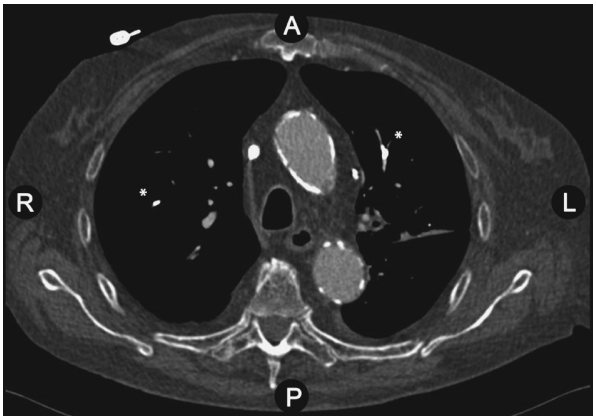
Anteroposterior and lateral lumbar spine radiography



Asterisk – hyperdense deposits in pulmonary arteries; Long arrow – hyperdense deposits in inferior vena cava; Short arrow – hyperdense deposits in paravertebral veins. A – anterior; P – posterior; H – head; F – foot; R – right; L – left.

Figure 2

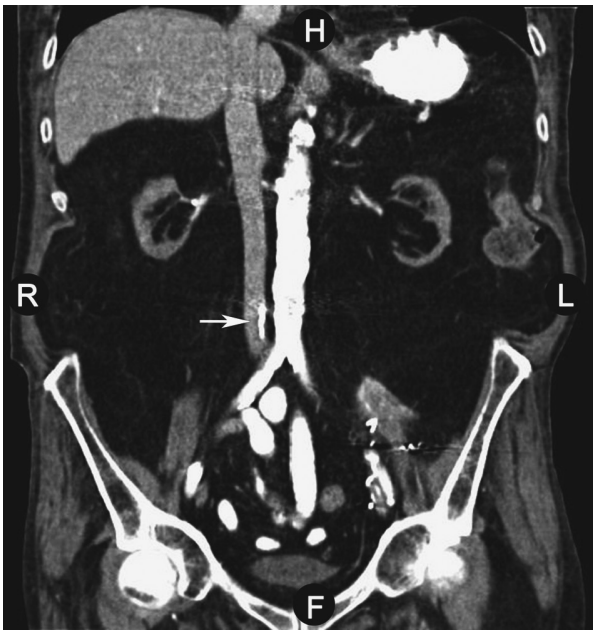
Transverse thoracic CT



Asterisk – hyperdense deposits in pulmonary arteries; Long arrow – hyperdense deposits in inferior vena cava; Short arrow – hyperdense deposits in paravertebral veins. A – anterior; P – posterior; H – head; F – foot; R – right; L – left.

Figure 3

Frontal abdominal CT



Asterisk – hyperdense deposits in pulmonary arteries; Long arrow – hyperdense deposits in inferior vena cava; Short arrow – hyperdense deposits in paravertebral veins. A – anterior; P – posterior; H – head; F – foot; R – right; L – left.

(PMMA) cement leakage to the pulmonary arteries (Fig. 3).

Diagnosis of late oligo-symptomatic PCE secondary to BKP was added.

Curiously, in spite of a large number of vertebral augmentation procedures (VAPs) annually performed in the world, this is the first report of PCE in a dialysis patient.

DISCUSSION

Vertebral fractures are an important health policy problem because they provoke kyphosis, chronic pain, impaired physical function, reduced quality of life, higher in-hospital attention rate and greater mortality risk[1,2,3,4] Two large European studies describe about 12% incidence of VCFs in the general population[5,6]. Furthermore, this prevalence is higher in some groups with metabolic illness, bone specific disorders or extended neoplasms. There is little evidence about their epidemiology in ESRD and only one publication of BKP in dialysis[7]. The recent Italian study EVERCRAFT appreciates a higher prevalence of VCFs in HD (55.3%) compared to the osteoporotic control group (51%), being in both, much greater than in the general population[8].

This chronic degenerative disorder usually associates progressive, poorly controlled invalidating pain, which encourages an increased use of surgical interventions as vertebral cementation. Percutaneous vertebroplasty (PVP) using PMMA was first performed by Galibert *et al*., in 1984, to treat a painful, giant haemangioma[9]. Percutaneous BKP, applied since 1998, implies introduction of inflatable balloon into the fractured vertebral body for elevation of the endplates prior to bone cement fixation, thus allowing a lowest pressure injection of greater viscosity cement, with better results and potential decrease of post-procedure complications[10,11]. A recent small, randomized, controlled trial (RCT) compares a new self-expanding implant cement directed kyphoplasty (CDK) to conventional PVP with promising reduction of extravertebral cement leak[12].

The VAP's effectiveness has been strongly discussed after two RCTs published, in 2009, by Buchbinder *et al*.[13] and Kallmes *et al*.[14], but additional research upholds their plausibility[3,4,15-18]. Considering different points of view, the National Institute for Health and Clinical Excellence (NICE) issued, in April 2013, its appraisal guidance based on one of the most complete systematic reviews until now[3,4]. The NICE guidelines recommend VAPs like therapeutic option in patients with recent, unhealed, well confirmed VCFs, who suffer uncontrolled pain despite optimal pain management[3].

Potential mortality benefit in favour of VAPs remains controversial, although some sponsored studies suggest greater survival associated to better biomechanical stability[16,19]. Thereby, a powerful large observational study of 1,038,956 VCFs patients, where 141,343 BKP and 75,364 PVP were performed in 100% of US Medicare data set, showed 55% and 25% higher adjusted risk of mortality in a non-operated cohort compared to balloon kyphoplasty and percutaneous vertebroplasty cohorts, respectively (in both, $p < 0.001$). In this study, the BKP cohort had a 19% lower adjusted risk of mortality than the PVP cohort ($p < 0.001$)[19].

Another controversial point is the cost-effectiveness of VAPs on account of small heterogeneous evidence concerning variable main objectives in all studies until now[4,17].

Pain control is a primary goal in both modalities owing to accomplishment of a better quality of life. One large clinical case series includes 868 VAPs performed during 12 years and shows successful results in 83% of vertebral tumours, 78% of osteoporotic VCFs and 73% of haemangiomas treated. Analgesic effect usually occurs within 6 to 48 hours after the procedure, with surprisingly low cement volume (average 2.8 ml)[20]. The factors involved in the analgesic mechanism of vertebral cementation are not clear. Initial suspicion of nerve-endings damage secondary to thermal and cytotoxic injury due to PMMA, reported by Deramond *et al*. after small *in-vitro* performed study, has not been confirmed uniformly later[20-22].

A recent prospective *in vivo* study in 22 women with VCF does not observe statistically significant differences in their outcomes in spite of achievement of relevant temperature differences between the groups (average of 86.7° ± 10.7 °C in the highest group, 60.5° ± 3.7 °C in the medium and 44.8° ± 2.6 °C in the lowest). Additionally, none of the eleven tested cements had maintained temperature superior to 45 ºC for more than 30 minutes (a minimal period of time needed to thermal injury of sensory nerves), with author's conclusion that back-pain improves only by mechanical consolidation[22].

There are few contraindications as haemorrhagic diathesis, infection or epidural extended spine lesions, which may limit VAPs performance[3,10]. However, numerous local or systemic adverse reactions linked to percutaneous vertebroplasty techniques may arise immediately or late in time (Table I)[10,23-27].

The presentation of PCE ranges widely from asymptomatic radiologic findings to sudden death, even also respiratory distress, permanent pulmonary hypertension, severe lung failure, supraventricular arrhythmia or right heart failure[23,28]. Atypical and/or late clinical presentation of some symptoms, up to several years after the procedure, often makes difficult the diagnosis. Typical radiological findings are several, radiodense, tubular opacities distributed diffusely in the branches of the pulmonary arteries, as well as shown in our patient.

The rate of PCE secondary to VAPs varies from 0% to 26% in published series with different follow-up periods and depends on cumulative risk of general, local and/or iatrogenic factors[24-29]. Like general risk factors are remarkable:

- Chronic obstructive pulmonary disease
- Pulmonary hypertension
- Prior deep venous thrombosis.
- Prior pulmonary embolism

The group of local risk factors includes:

- Hypervascular tumoural VCFs
- Numerous vertebroplasty procedures
- Vertebral body wall incompetence

In last place, iatrogenic factors from PCE development are:

- Low viscosity cement
- Large volume of injected cement

Table I

Adverse reactions related to vertebral augmentation rocedures

Effect Cause	Local	Systemic
Needle insertion	Infections (osteomyelitis, spondilitis), Neural damage, bleeding, haematoma, neighbour structures damage	Sepsis, pain
Cement leakage or displacement of bone marrow, bone fragments or fat	Leakage in vertebral discs, epidural space or paravertebral veins	Venous embolism in lung, heart, brain or other territories
Systemic reactions or related to anaesthesia	–	Allergy, hypotension, dyspnoea, arrhythmia death
Related to positioning	Rib or sternum fractures	Back pain, muscle cramping
Other	Balloon's fragments retention if ruptures within vertebral body	Anaemia, psychiatric disorders

- Operator experience, and
- Surgical technique performed (PVP vs. BKP)

Now, true delayed incidence of oligo- or asymptomatic PCE is difficult to know. Cement leakage incidence is more than 50% in some series (up to 90% in PVP and up to 37.5% in BKP) with estimated loss of injected volume around 22.9% in 10 years[18,23,25,27,29].

The PCE treatment requires an individual approach and comprises from simple observation without any treatment to aggressive cardiovascular surgery, depending on the severity. Asymptomatic patients require only clinical and radiological observation but symptomatic cases usually need respiratory support, corticosteroids and standard anticoagulation for at least 6 months, according current guidelines[23,28]. Few severe cases with cardiopulmonary failure may require invasive respiratory support, removal of emboli by venous catheterization or cardiovascular surgery, or inferior vena cava filter implantation.

Our patient presented several risk factors, such as superior vena cava syndrome, prior pulmonary embolism and chronic heart failure due to heart transplant dysfunction. Six months after the diagnosis, his respiratory status remained stable, without need of additional treatment.

In our opinion, BKP is an excellent therapeutic option in selected dialysis patients, according to available recommendations.

Disclosure of Potential Conflicts of Interest: None declared.

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