FAT EMBOLISM

Dr Shahab Sorouri

pulmonologyst

Fat embolism syndrome (FES):

is a rare syndrome

that, when severe, is associated with respiratory failure, neurocognitive deficit, and death.

It remains a diagnostic challenge for clinicians, but prompt recognition is important so that supportive therapy can be instituted early.

DEFINITION

- is defined by the presence of fat globules in the pulmonary circulation.
- The term fat embolism syndrome refers to the clinical syndrome that follows an identifiable insult which releases fat into the circulation, resulting in pulmonary and systemic symptoms.

EPIDEMIOLOGY AND ETIOLOGY

- **Trauma-related**
- Orthopedic (common)
- Long bone fractures (especially femur)
- Pelvic fractures
- Fractures of other marrow-containing bones (eg, ribs)
- Orthopedic procedures
- Intraosseous access or infusions
- Lung transplantation

- **Nonorthopedic (uncommon)**
- Soft tissue injuries
- Chest compressions with or without rib fractures
- Burns
- Liposuction, lipoinjection, fat grafting
- Bone marrow harvesting and transplant

- **Nontrauma-related (rare):**
  - Pancreatitis
  - Diabetes mellitus
  - Osteomyelitis and panniculitis
  - Bone tumor lysis
  - Prolonged steroid therapy
  - Sickle cell hemoglobinopathies
  - Fatty liver disease
  - Lipid infusion
  - Cyclosporine solvent
  - Intraoperative cell salvage
  - Cardiopulmonary bypass
  - Metastases from fatty tumors
  - Osteonecrosis
  - Bone marrow necrosis

- Rates of FES in orthopedic trauma patients vary from **<1 percent to >30 percent**, with the wide range likely reflecting study population heterogeneity and a lack of standardization for diagnostic criteria
- As an example, in a matched case-controlled study of the Japan Trauma Data Bank from 2004 to 2017, the incidence of FES in trauma patients was **0.1 percent.** However, patients who did not survive >48 hours were excluded such that cases could have been missed

- FES is most commonly associated with long bone (especially the femur) and pelvic fractures and less commonly with fractures of other marrow-containing bones (eg, ribs)
- The rate of FES is also higher in those with **multiple** rather than single fractures and in patients with **open fractures** than closed fractures
- A **delay in the time to reduction** of the fracture is also associated with FES
- In another retrospective study, **hypomagnesemia**, **hyperphosphatemia**, **hypoalbuminemia**, and **blunt traumatic** mechanism of injury were identified as risk factors for FES in patients with orthopedic injuries

- FES :
- more common in men than in women and
- its incidence is highest in those between 10 and 40 years, likely reflecting the incidence of trauma in this age group

PATHOGENESIS

- is unknown
- There are two theories:
- **the mechanical theory** where fat emboli may be the result of fat globules entering the bloodstream through tissue (usually bone marrow or adipose tissue) that has been disrupted by trauma,
- **the biochemical theory** where inflammation results from the production of toxic intermediaries of circulating fat (eg, chylomicrons, infused lipids, or bone marrow-derived fat). It is feasible that both mechanisms are at play in many cases.

CLINICAL PRESENTATION

- Fat embolism syndrome typically manifests **24 to 72 hours** after the initial insult
- but may rarely occur as early as 12 hours or as late as two weeks after the inciting event
- Affected patients develop a classic triad: **hypoxemia**, **neurologic abnormalities**, and a **petechial rash**.
- None of these features are specific for FES

RESPIRATORY ABNORMALITIES

- Pulmonary manifestations are the most common presenting features of FES.
- **Hypoxemia, dyspnea, and tachypnea** are the most frequent early findings.
- In one series, hypoxemia was present in **96 percent** of cases
- A syndrome indistinguishable from acute respiratory distress syndrome (ARDS) may develop.
- Approximately one-half of patients with FES caused by long bone fractures develop severe hypoxemia and require mechanical ventilation

NEUROLOGIC ABNORMALITIES

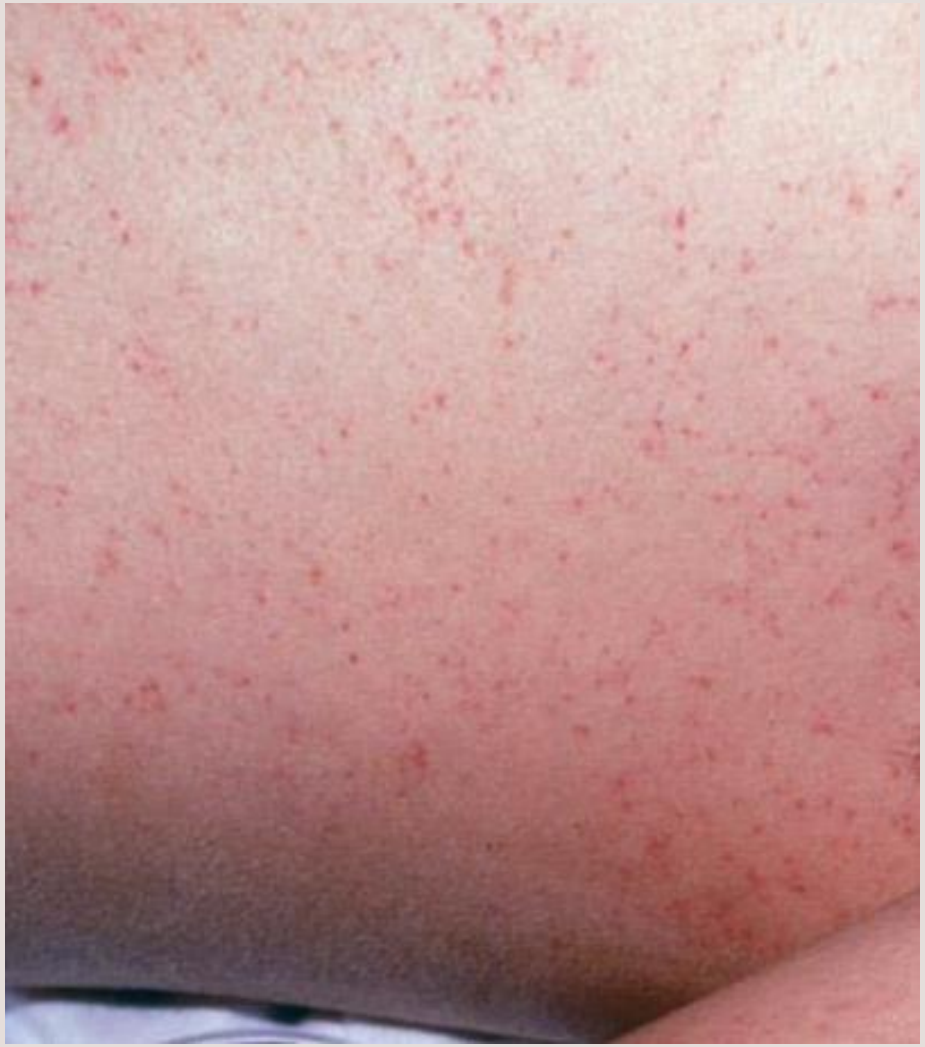
- are also common and typically manifest after respiratory abnormalities, although rare case reports suggest neurological symptoms can occur in isolation
- Neurologic manifestations range from the development of an acute **confusional state** and altered level of consciousness to **seizures** and focal deficits
- One study reported that mental status changes occurred in 59 percent of patients with FES

PETECHIAL RASH

- The characteristic **red-brown petechial** rash may be the last component of the triad to develop and occurs in only **20 to 50 percent** (on average one third) of cases

- It is found most often on the nondependent regions of the body including the head, neck, anterior thorax, axillae, and sub-conjunctiva

PETECHIAL RASH



OTHER CLINICAL AND LABORATORY FINDINGS

- ●Anemia and thrombocytopenia (one-third to two-thirds)
- ●Retinal scotomata (Purtscher's retinopathy)
- ●Lipiduria
- ●Fever
- ●DIC
- ●Myocardial depression
- ●RV dysfunction
- ●Hypotension

IMAGING AND LABORATORY FINDINGS

- **Chest and brain imaging** are frequently performed to investigate the etiology of respiratory and neurologic abnormalities.
- Findings are generally nonspecific.
- ●**Chest radiographs** are normal in the majority of patients
- A minority of chest radiographs reveal **air space disease** due to edema or alveolar hemorrhage, which tends to be most prominent in the periphery and bases

IMAGING AND LABORATORY FINDINGS

- CT of the lung may also be normal but bilateral well-demarcated **ground glass opacities** or ill-defined **centrilobular nodules** may be present Less common findings include **lobular consolidations**, **septal** or **bronchial wall thickening**, and **areas of crazy paving**
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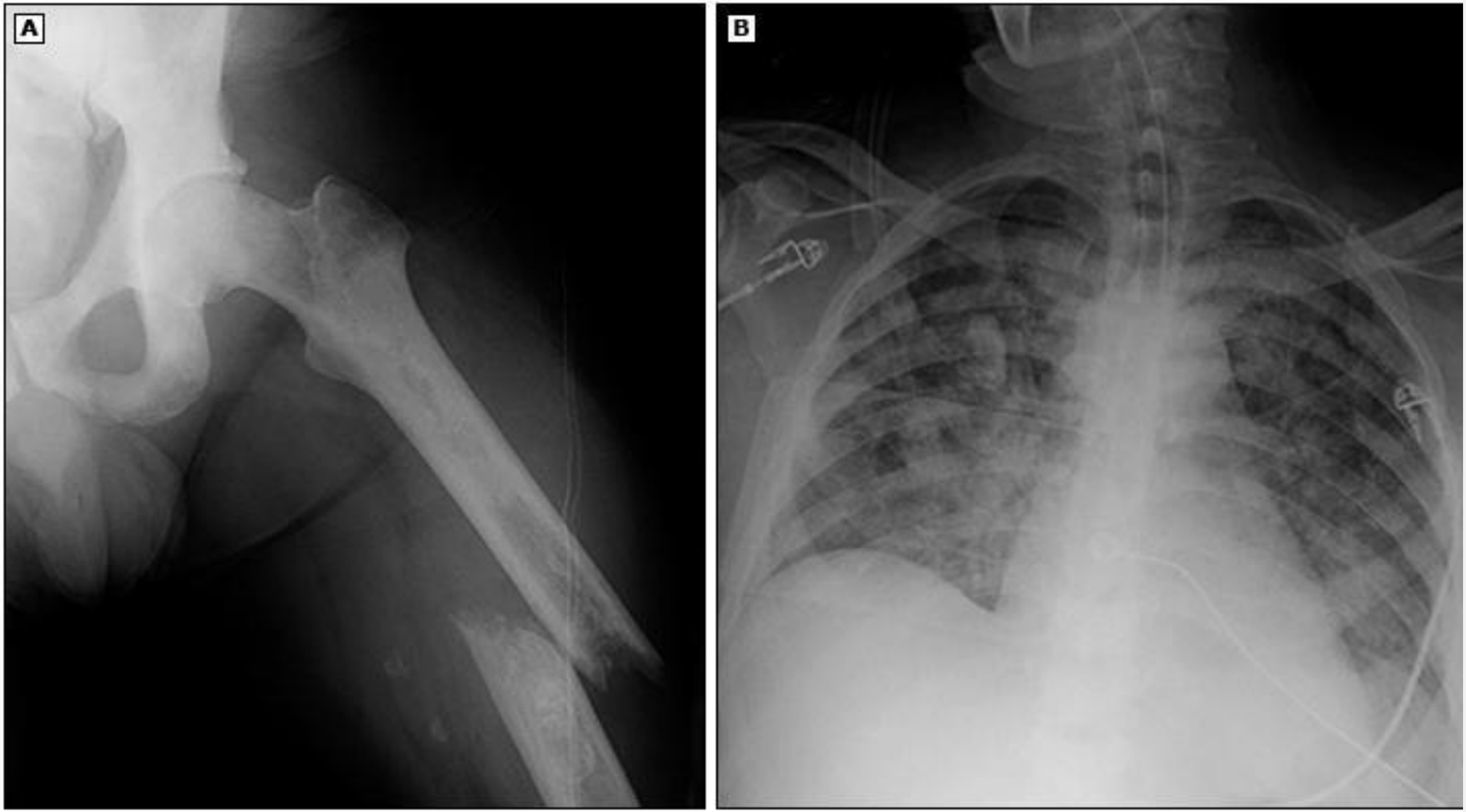
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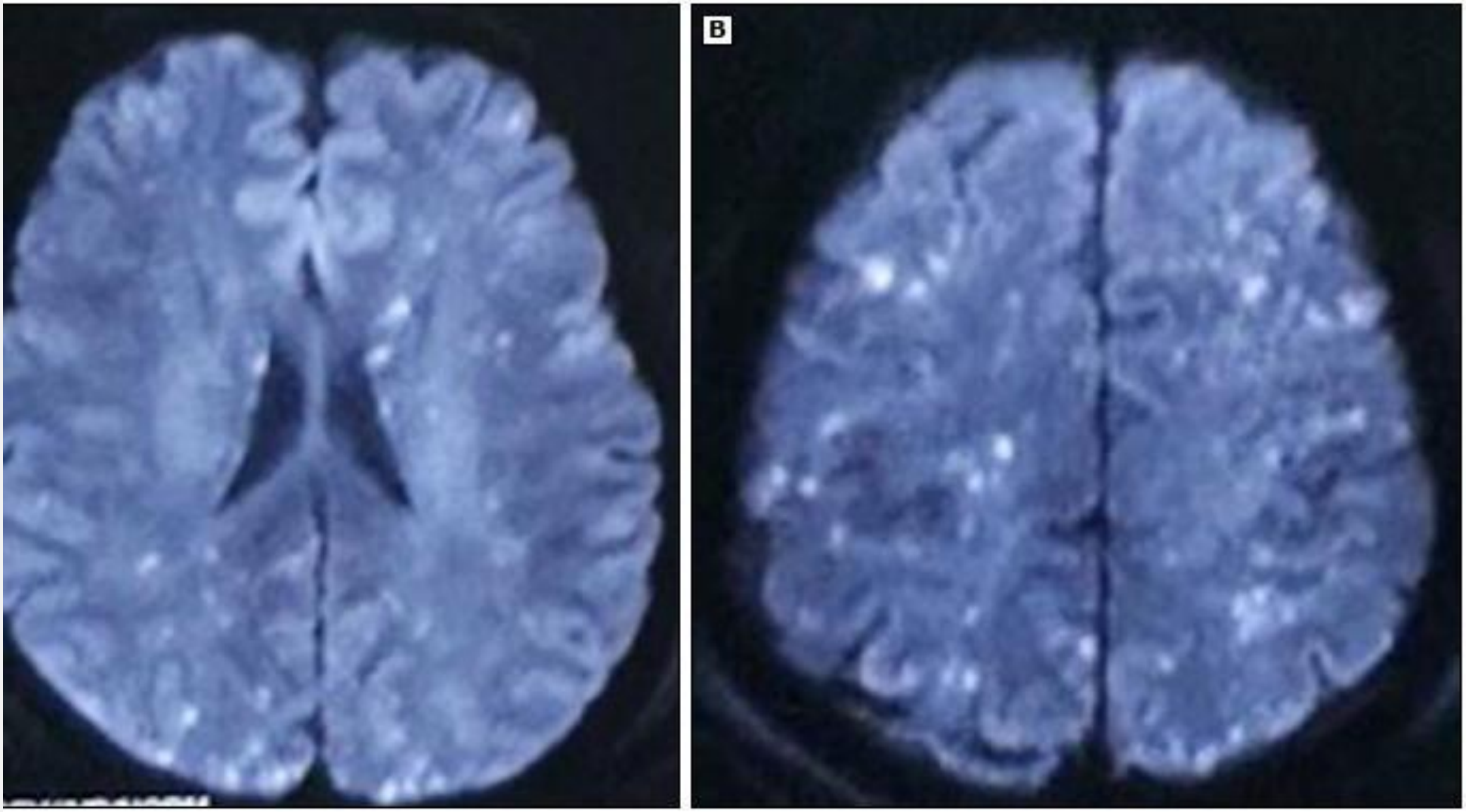
- **V/Q Scan:**
- is not helpful
- but if performed to investigate for the presence of venous thromboembolism, it may demonstrate a mottled pattern of subsegmental perfusion defects with a normal ventilatory pattern

- Acute neurologic abnormalities on **MRI** may be associated with a **"starfield" pattern** of diffuse, punctate, hyperintense lesions on diffusion-weighted imaging, which correlates with the degree of clinical neurologic impairment

- Findings on CT brain are also nonspecific and may be normal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DIAGNOSTIC EVALUATION

- When suspected, chest imaging, typically CXR and/or CT, should be performed.
- CT or MRI of the brain should be performed in those with neurologic symptoms.
- Routine laboratory studies should be drawn including CBC and coagulation studies.
- Measuring free fatty acid or CRP levels and examining urine or sputum for the presence of fat are not routinely performed since their diagnostic utility is unclear

DIAGNOSTIC EVALUATION

- **CT angiography** is not routinely performed for diagnosis but may help exclude pulmonary thromboembolism as an etiology for hypoxemia.
- Similarly, **microbiology studies** and **echocardiography** may help to R/O competing diagnoses such as pneumonia and heart failure.

- Since most experts consider FES a clinical diagnosis, further testing is not usually performed.
- In most cases, this noninvasive approach is considered appropriate since the only therapy that is available for FES is supportive

INVASIVE TESTING

- Diagnostic invasive testing is **not** routinely performed in most patients with suspected FES since there are no definitive therapies for FES and the diagnosis is typically a clinical one.
- **Pulmonary artery catheter**
- **Bronchoscopy**

PULMONARY ARTERY CATHETER

- PAC is not routinely placed for fat analysis from a wedged sample of pulmonary arterial blood since this is neither a sensitive nor specific way to diagnose FES

BRONCHOSCOPY

- Similarly, bronchoscopy is not routinely performed.
- There is some evidence that suggests **BAL** can detect fat droplets within alveolar macrophages, as a means of diagnosing fat embolism, but their absence does not rule out FES and the presence of fat globules within pulmonary macrophages is non-specific and can be present in the setting of **multi-organ failure** and **sepsis**.

DIFFERENTIAL DIAGNOSIS

- Pulmonary embolism
- Tumor embolism and air embolism
- Alveolar filling disorders (ARDS)
- Vasculitic disorders (SLE)

DIAGNOSIS

- FES is a **clinical diagnosis** that can be made when the classic triad of **hypoxemia**, **neurologic abnormalities**, and the **petechial rash** occurs in an appropriate clinical setting
- presenting manifestations are nonspecific and the rash occurs in fewer than half of cases’
- Several diagnostic criteria, such as Gurd's, Schonfeld's, and Lindeque, have been proposed but none has been validated or compared and in general, they are not widely used in practice

TREATMENT

- **no definitive** treatments for FES, with the exception of individuals with sickle cell disease, who require urgent

RBC exchange transfusion

Therapy is largely supportive while FES resolves spontaneously

- **treatment of the cause** : While early correction of fractures may **prevent** FES, it is unknown whether or not this strategy works as a treatment for those with **established** FES

- **RBC exchange transfusion in sickle cell disease** : FES with pulmonary fat embolism can cause ACS and multiorgan failure syndrome with a high mortality rate.
- Consultation with the transfusion medicine service and hematologist for urgent RBC exchange transfusion is essential

SUPPORTIVE CARE

- With the exception of exchange transfusion for individuals with sickle cell disease, supportive care is the mainstay of therapy for clinically symptomatic FES, while recovery is ongoing.
- This involves **fluid resuscitation**, **oxygenation**, and when indicated, **NIV** or **invasive MV**.
- Rarely, patients require **ICP monitoring** for massive cerebral involvement, or **vasopressors**, **mechanical cardiac support devices**, or **ECMO** for refractory shock
- Supportive therapy is continued until FES resolves or death occurs.

- he administration of **systemic corticosteroids** is controversial.
- most experts do not administer steroids routinely

- Rarely, for those patients with life-threatening cases of FES, a limited trial (eg, 1 to 5 days) of systemic corticosteroids (eg, **hydrocortisone 100 mg three time daily** intravenously or **methylprednisolone 1 to 1.5 mg/kg/day**) is appropriate.

- Its administration should be weighed against the increased risk of steroid-associated infections.

PROGNOSIS

- Most patients with FES fully recover spontaneously.
- findings are transient and fully reversible, often within a few days, although features may persist beyond one week when FES is severe
- Individual studies have reported mortality rates ranging from **5 to 15 percent**

PREVENTION

- Early immobilization of fractures
- Intraosseous pressure limitation
- Prophylactic corticosteroids

THANKS FOR YOUR ATTENTION