Bone cement embolism attached to central venous catheter

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Vertebroplasty is a fairly common, invasive procedure for the treatment of osteoporotic vertebral compression fractures. Although relatively safe, the procedure is not without risks. When poly(methyl methacrylate) (PMMA) leaks into the surrounding venous circulation, serious complications can occur, including cement embolization into the venous system with consecutive pulmonary embolism and spinal cord compression.1,2 The true incidence of systemic embolization is likely to be underestimated as clinical presentations range from dramatic (e.g. massive pulmonary embolism resulting in death) to incidental findings on imaging, to asymptomatic.3 Optimal treatment for leaks is controversial and depends on the location of the cement and the severity of symptoms. Exactly how the body reacts to undetected, non-massing leaks is unknown.

Case report

The indication for spondylodesis and vertebroplasty in this 64-yr-old female was osteoporosis with compression fractures and severe pain lasting several years. She consented to publication of the report.

During surgery on the thoracic spine, the pedicle screw holes of vertebral bodies 10 and 12 were filled with PMMA. This was done under continuous fluoroscopy. When leakage into vertebral veins was noted, the application was stopped. In total, ~4 ml PMMA (1 ml per screw hole) had been released. Although PMMA application normally requires high pressure, surgical records in this case indicate that higher than normal pressure was exerted.

After operation, the patient was transferred to the intensive care unit. Although the patient remained asymptomatic, according to our standards we performed a chest radiograph. This image (Fig. 1), as well as the computed tomography (CT) images (Figs 2 and 3) which were subsequently performed, revealed a mass at the confluence of the azygous vein and superior vena cava (SVC). Although we had never seen anything like this previously, we assumed that the mass was likely to be PMMA which had embolized into the systemic circulation. The mass appeared to be attached to the central venous pressure (CVP) catheter and we were uncertain whether the SVC was involved as well.

Although the team discussed several options to remove the central venous catheter (CVC) and the mass, all options included a risk of mass embolism, with either consecutive obstruction of blood inflow into the heart or pulmonary embolism. We decided that the safest option was to transfer the patient to a cardiovascular surgery department with cardiopulmonary bypass availability.

In cardiovascular surgery, the SVC was partially clamped and then incised to immobilize the CVC. Fortunately, the mass was not attached to the vessel wall. The CVC was then cut above the mass, and both the CVC and the attached mass were retrieved completely (Fig. 4). A bypass was not necessary and the patient made an uneventful recovery.

Discussion

PMMA, when used as a cementing agent in arthroplasty for hip and knee replacement, has been associated with hypotension, hypoxia, and intraoperative cardiac arrest in 0.6–1.0% of patients.4,5

PMMA has also been used for vertebroplasty, which is a relatively safe, simple, and commonly performed procedure for the management of vertebral compression fractures. The procedure involves injection of acrylic cement (PMMA) into a partially collapsed vertebral body. This provides mechanical stability.
The procedure is typically performed under CT or fluoroscopic guidance.

Paravertebral venous leakage and pulmonary embolization of PMMA occurs frequently, but is clinically silent in most cases.\textsuperscript{2}

On rare occasions, extravasation of PMMA cement into the vertebral venous circulation may result in devastating complications such as spinal cord compression resulting in paraplegia, cerebral embolism, penetration of the right ventricle, renal artery embolism, and acute respiratory distress syndrome.\textsuperscript{2-8}

In our case, it appears that cement passed from vertebral venous plexuses via paravertebral veins, into the azygous system. At the junction of the SVC and the azygous system, the cement started to solidify and the majority attached to the catheter. Presumably, some cement also passed into the right atrium and pulmonary circulation, although the CT scans did not show any evidence of this.

In order to prevent embolization into the central circulation, it is first important to understand the basic requirements for PMMA use.

Three mechanisms responsible for cement embolism leading to cement migration into the venous system are:
(1) insufficient polymerization of the PMMA at the time of injection;
(2) incorrect needle position; and
(3) overfilling of the vertebral body.9

Recommended procedures include:
(1) injecting PMMA slowly, and only during the pasty polymerization phase;
(2) balloon-assisted kyphoplasty, which allows low-pressure cement filling; and
(3) injecting no more than 4–11 ml.3

In addition, chest radiography should be routinely performed after the procedure in order to detect pulmonary cement emboli.

Although PMMA is commonly used in vertebroplasties, it is important to note that there are other types of cement available, for example, the cement commonly used in kyphoplasty. It has a higher viscosity and requires special adapters that enable placement of the cement in a more controlled manner and at lower pressures. We expect such a change to reduce the risk of embolism and thereby increase patient safety. We have implemented this change in our hospital after review of this case.

While this case was under general anaesthesia, many vertebroplasties are performed under local anaesthesia without an anaesthetist in attendance and with less than adequate physiological monitoring, thereby putting the patient at risk in the event of collapse because of PMMA leakage.

In our case, PMMA embolization to the central circulation occurred. PMMA attached to the triple lumen CVC located in the SVC. Through what mechanism the PMMA attached completely to the CVC remains highly speculative. We can present two hypotheses which, either alone or in conjunction, may be able to explain the phenomenon:

(1) PMMA adsorbed to the surface of the catheter, because it is more likely to attach to an artificial surface than to endothelium.
(2) Turbulent flow around the different lumina of the CVC reduced the speed of the floating PMMA and possibly made it more prone to attach to the CVC.

As mentioned in the introduction, the true incidence of systemic cement embolization and the normal course of this event are unknown. This case highlights the need to determine the true incidence of PMMA embolization, the actual mechanism of PMMA attachment to the CVC, and to establish precautionary measures.

In conclusion, cement migration through the venous circulation can lead to any or all of the following: pulmonary embolism, respiratory failure, and haemodynamic compromise.

Various approaches to eliminating the foreign material have been described in the literature.7 10 The method of choice largely depends on the location of the cement and the severity of symptoms, which include anticoagulation, interventional procedures, and open heart surgery.

This case emphasizes the importance of prompt diagnosis and treatment and illustrates the need for close monitoring of patients undergoing any spinal surgery that includes vertebroplasty.11 1 In the event of circulatory collapse, PMMA embolism is an important differential diagnosis.

**Declaration of interest**

None declared.

**References**

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