A Case Report Describing the Surgical Removal of Venous and Intracardiac Cement Leakage after Percutaneous Vertebroplasty in a Hybrid Operating Room

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AIM: Percutaneous vertebroplasty is generally considered a safe procedure, however, cases of cardioembolism and cardiac perforation have been reported.

CASE PRESENTATION: A 69-year-old woman was referred to our emergency department after an outpatient echocardiogram revealed a "thrombus-like" formation involving the right heart. Two weeks before she had undergone percutaneous vertebroplasty of the third to fifth lumbar vertebrae due to osteoporotic fractures. She presented with palpitations. Further investigations revealed polymethyl methacrylate leakage involving the inferior vena cava, the right atrium, and the right ventricle in the total.

RESULTS: Although the patient was clinically and hemodynamically stable, decisions about the timing and the specific technique for surgical removal of the foreign body were challenging. Considerable multidisciplinary teamwork involving cardiologists, cardiac surgeons, anesthetists, and bioengineer specialists of the bone cement was necessary due to the extension of the consolidated leakage.

CONCLUSIONS: Through a combined approach with sternotomy and fluoroscopic guidance, it was possible to remove the foreign body without intraoperative complications. The patient recovered and returned to her normal life, following cardiac and physical rehabilitation.

Keywords: cardiac mass; PMMA cardioembolism; fluoroscopy-guided cardiac surgery

Background

Percutaneous vertebroplasty (PVP) is a relatively new, minimally invasive procedure, widely used in clinical practice to treat conditions including osteoporotic vertebral compression fractures, osteolytic bone metastases, and pathological fractures in multiple myeloma, both for therapeutic and prophylactic purposes [1, 2, 3]. Under fluoroscopic guidance, semisolid bone cement, usually Polymethyl Methacrylate (PMMA), is directly injected into the affected vertebral body with the purpose of obtaining pain relief and preventing further damage to the bone tissue [4]. PVP is generally considered a safe procedure and the most common complications are transient and minor.

Occasionally PMMA can leak into the vertebral canal or the paravertebral venous system leading to more severe complications. Pulmonary cement embolism is detected in 1.0–28.6% of patients by post-operative imaging [5] and cases of cardioembolism and cardiac perforation have also been reported [6, 7].

Hereby, we report a striking case of a patient affected by an extensive PMMA leakage involving the inferior vena cava and the right cardiac chambers, who presented with non-specific symptoms and whose successful treatment required substantial multidisciplinary collaboration.

Case Presentation

A 69-year-old woman, symptomatic for palpitations in the previous two weeks, with no previous cardiovascular history, was referred to our Emergency Department (ED) after an outpatient echocardiogram revealed a "thrombus-like" formation involving the right atrium. She never experienced angina, dyspnoea, or syncope. On examination, she was normotensive and with a normal heart rate. General examination was unremarkable and no specific findings were detected. On continuous electrocardiogram (ECG) monitoring, frequent, isolated, and monomorphic ventricular ectopics were observed.

Two weeks before she had undergone PVP due to painful vertebral osteoporotic fractures. The intervention was per-

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formed without complications and no signs of cement leakage were observed through radioscopic guidance at the end of the procedure. A few hours after the procedure the patient became symptomatic for palpitations, which were consequently identified as isolated ventricular ectopics. The patient was therefore discharged.

Investigations

A transthoracic echocardiogram performed at our ED documented two hyperechogenic serpiginous linear images, both originating in the right atrium: the first extending through the tricuspid valve up to the right ventricular apex, the second extending into the inferior vena cava. This peculiar finding prompted an urgent contrast-enhanced computer tomography (CT) scan of the chest and abdomen. The scan demonstrated a long, linear, and hyperdense image, extending from the body of the fifth lumbar vertebra, through the inferior vena cava up to the right atrium, associated with a second similar image from the right atrium, through the tricuspid valve, continued into the right ventricle (Fig. 1). No signs of pulmonary embolism were detected.

Since the density of the linear images was found to be similar to the surgical material used for the PVP, a case cement embolism was hypothesized, and the diagnosis was later confirmed by a PVP specialist.

The cement leakage was further investigated with a transoesophageal echocardiogram which showed similar findings to the transthoracic scan (Figs. 1,2).

Ethical approval for the study was waived by Centro Cardiologico Monzino IRCCS. Informed written consent was obtained from the patient to include her anonymized information in this publication.

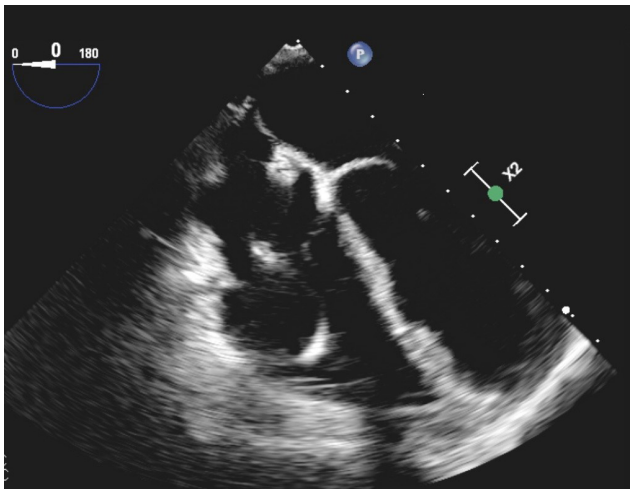

Fig. 1. Four-chamber view of the polymethyl methacrylate fragment in the right heart chambers via transesophageal echocardiography. X2, focus amplitude; P, probe.

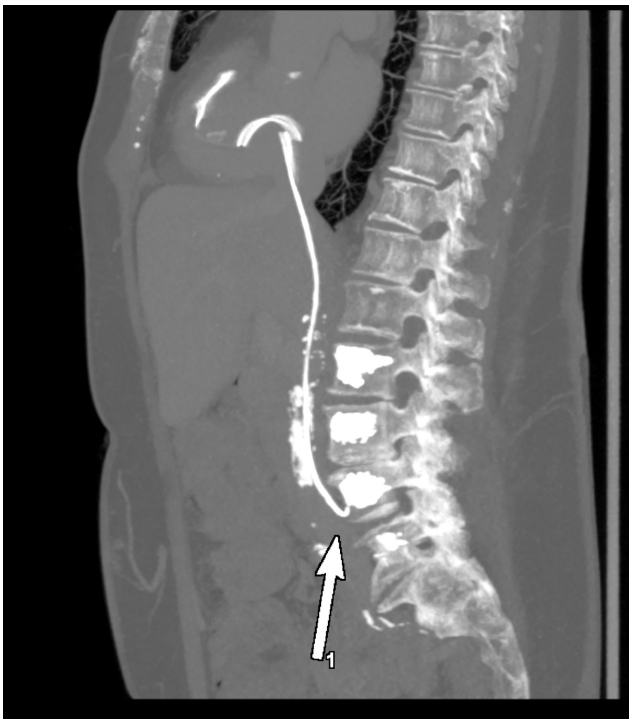

Fig. 2. Hyperdense linear image extending from cementitious material at the L5 vertebral body, with similar density, which enters anteriorly into the inferior vena cava up to the right atrium. At this site, the linear image is interrupted and another similar linear image is appreciated, which reaches the right ventricle passing through the tricuspid valve. The arrow shows the site where the cement goes from the vertebral body to the inferior vena cava.

Results

Following a multidisciplinary team discussion between cardiac surgeons, vascular surgeons, cardiologists, anesthetists, and experts in the PVP procedure, surgical removal of the cement from the right heart was considered the top priority, given the impending risk of right heart perforation, pulmonary embolism, and intra-cardiac thrombosis. Although necessary, removal of the PMMA fragments was considered to carry a high risk of major bleeding due to vein perforation, and embolization if the cement had broken into smaller pieces.

The preoperative surgical planning included a detailed three-dimensional reconstruction of the CT scan images and a demonstration of the physical properties of the PMMA cement provided by the PVP specialist.

The extraction of the foreign bodies was performed by an experienced cardiac surgeon. The intervention was performed via a full median sternotomy in a hybrid surgical room.

For the establishment of cardiopulmonary bypass, the arterial line was positioned in the aorta while the venous line was inserted in the right common femoral vein under fluoroscopy guidance. A right atriotomy was performed and

the PMMA fragment was removed from the right ventricle. At the end of the procedure, the tricuspid valve appeared competent.

The second PMMA fragment was then gently removed from the inferior vena cava under fluoroscopic guidance, by softly pushing it downwards to detach it from the fifth lumbar vertebra and then pulling it up to avoid tearing the vena cava (**Supplementary Material**). No systemic embolization occurred.

The postoperative recovery was uneventful and on the eleventh postoperative day, the patient was dismissed to a cardiac rehabilitation clinic.

At two-year follow up the patient has no recurrent cardiac-related symptoms and has an excellent quality of life.

Discussion

PVP is a percutaneous procedure widely used in clinical practice to treat either benign or malignant conditions [1, 2]. Although it is considered to be a rather safe procedure, in rare cases PVP has been related to serious complications due to cement leakage [5, 6, 7]. The PMMA may leak through the vertebral veins system into the venous central system and reach the right heart chambers and the pulmonary arteries causing cement embolism.

To our best knowledge, this is the first reported case of cement leakage forming an extensive wire-like structure and stretching from the fifth lumbar vertebra throughout the inferior vena cava up to the right atrium and ventricle, resolved with a single procedure in a hybrid operating room. The patient presented to our ED as paucisymptomatic. A rapid diagnosis of cement leakage was crucial due to the impending risk of thrombo-embolism and cardiac perforation.

Our case demonstrates the importance of a multidisciplinary approach and detailed preoperative planning. The main aim of the meticulous preoperative planning was to prevent potentially life-threatening complications, including major bleeding following the tearing of the vena cava caused by the sharp cement fragments, that could have led to further intervention with emergency laparotomy.

Furthermore, the safe and successful surgical removal of the foreign body was the result of the combination of experienced cardiac surgeons and the use of intraoperative imaging.

Our case is the first report that describes PMMA fragment removal under fluoroscopic guidance. We strongly recommend the implementation of this method in similar cases, as in our experience it was crucial for the good outcome of the procedure. Under fluoroscopic guidance, we had the opportunity to visualize surgical maneuvers in real-time and to monitor the position of the PMMA fragment. Moreover, fluoroscopy was essential for the optimal placement of the venous cannula for cardiopulmonary bypass, which was placed slightly less than 4 cm distal to the origin of the cement fragment in the inferior vena cava, to prevent potential rupture and embolization.

The main limitations of this report are the inability to generalize our findings due to the single-case experience, and the absence of a clear mechanistic explanation for the peculiar shape and path taken by the cement.

Conclusions

Although PVP is a safe procedure, non-specific symptoms such as palpitations, chest pain or dyspnoea in the early post-procedure period should not be underestimated and should prompt further investigations with appropriate cardiovascular imaging. Detailed preoperative assessment together with multidisciplinary teamwork should guide the surgical removal, given the unpredictable extension and behavior of the cement leakage. Fluoroscopic guidance is recommended to make this kind of procedure safer, by reducing the risk of accidental embolization of the cement.

Abbreviations

ED, Emergency Department; PMMA, Polymethyl Methacrylate; PVP, percutaneous vertebroplasty.

Availability of Data and Materials

The data that support the findings of this study are available on request from the corresponding author, GM.

Author Contributions

GM, EL, and EC wrote the manuscript. RM and FM provided the images and helped with the conceptualization of the manuscript. MA directed all the work and revised the manuscript. GM, MA, EC conceived the concept and design. EL acquired the data. All authors contributed to important editorial changes in the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

Ethical approval for the study was waived by Centro Cardiologico Monzino IRCCS. All procedures performed in this study were in accordance with the ethical standards of the institutional and national research committee(s) and with the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from the patient to publish this case report and accompanying images. A copy of the written consent is available for review by the editorial office of this journal.

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Conflict of Interest

The authors declare no conflict of interest.

Supplementary Material

Supplementary material associated with this article can be found, in the online version, at https://doi.org/10.62713/aic.3515.

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