

case report

Ischemic stroke in relation to brain polymethylmethacrylate embolism after percutaneous kyphoplasty: a case report

Accidente cerebrovascular isquémico en relación con el embolismo de polimetilmetacrilato en el cerebro después de la cifoplastia percutánea: un informe de caso

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Receipt: 4 / 12 / 2022
Acceptance: 6 / 03 / 2023

ABSTRACT

Kyphoplasty is one of the minimally invasive interventions which provides pain relief in osteoporotic or malignancy related vertebral compression fractures. Severe complications associated with percutaneous kyphoplasty or vertebroplasty are rare, and usually related to cement leakage out of the vertebral body (Lamy *et al.*, 2014). We report the case of an 83-year old female who suffered an ischemic stroke during the immediate post-operative period after a three-level percutaneous kyphoplasty (L2-L3-L4) due to a paradoxical embolism via an atrial septal heart defect.

Key Words: kyphoplasty; vertebroplasty; severe complication; ischemic stroke; paradoxical embolism

1. Introduction

Percutaneous kyphoplasty is a safe and minimally invasive procedure widely used for the treatment of painful vertebral fractures of different origins: osteoporotic compression fractures, pathological or traumatic fractures. It provides short-to-medium term pain relief when comparing with conservative treatment (Marlin *et al.*, 2012) The surgical technique consists in injecting acrylic cement (polymethylmethacrylate – PMMA) percutaneously in a previously created cavity in the vertebral body through both pedicles, under fluoroscopy control. Most of the complications are associated with cement leakage into the paravertebral region or perivertebral venous plexus. Despite their low incidence, potentially serious complications like cement leakage into the spinal canal, intervertebral foramina or pulmonary embolism are possible. In most cases, these complications are clinically asymptomatic (Hassan *et al.*, 2018; Zhan *et al.*, 2017), but fatal cardiopulmonary complications such as pulmonary infarction, hypercapnia, and even cardiac arrest have been reported.

The purpose of the present case report is to describe cerebral infarction secondary to cement embolism through an atrial septal defect after percutaneous kyphoplasty. This information may be useful for clinicians when addressing the development of neurological symptoms in patients following this procedure.

2. Case Presentation

We report the case of an 83-years old female with several months of intense back pain after a low energy trauma. Her previous history included atrial fibrillation in treated with anticoagulant therapy (acenocoumarol), multiple valvular heart disease and an atrial septal defect previously diagnosed as an incidental finding during a transthoracic echocardiogram. Pain was localized in the upper lumbar spine, exacerbated by weight bearing, and showed no improvement with conservative treatment. Physical examination revealed mild tenderness to palpation over the lumbar spine. Radiographs showed compression fractures at L2, L3 and L4 (fig 1). A subsequent magnetic resonance imaging revealed subacute fractures with no evidence of pathologic involvement (fig 2). After discussion of the risks and benefits of kyphoplasty, the patient elected to undergo the procedure.

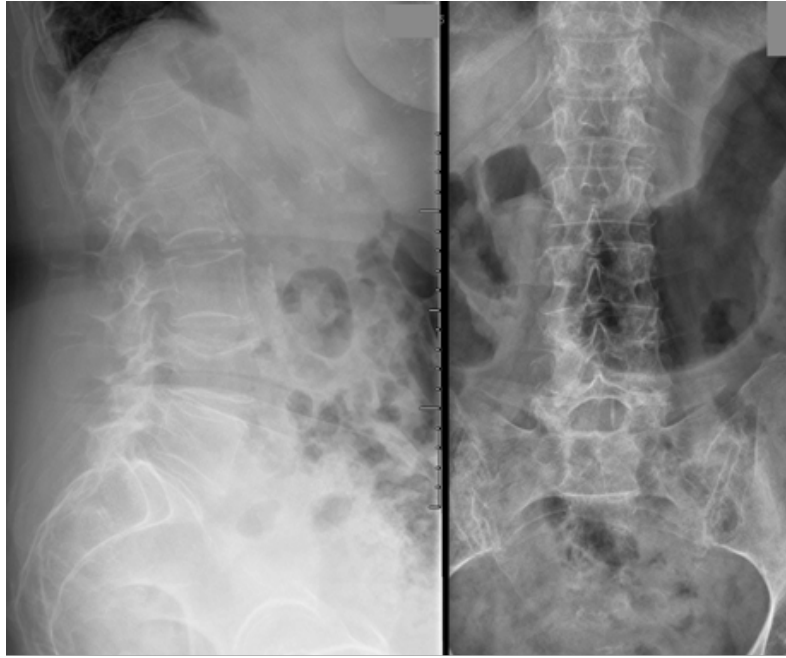


Fig 1. AP and lateral radiographs showed compression fractures at vertebral bodies of L2, L3 and L4.

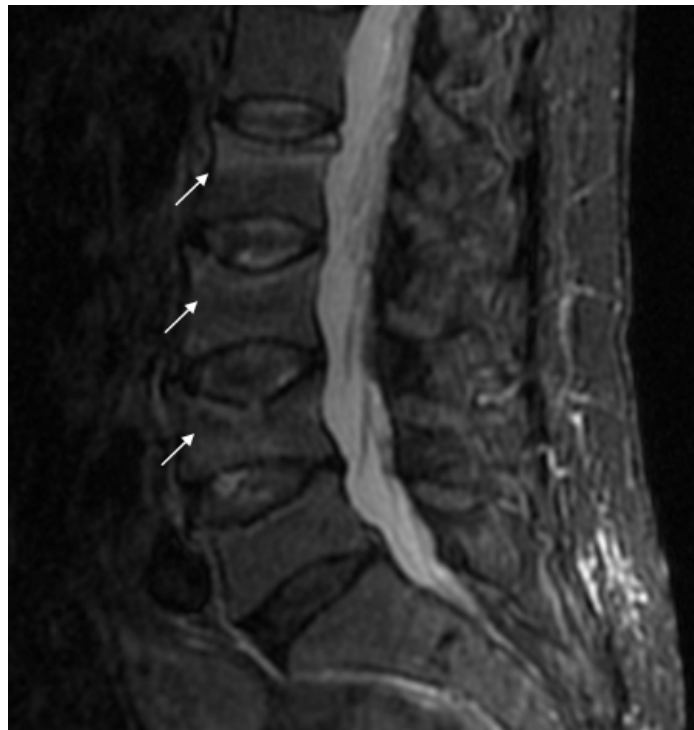


Fig 2. MRI (STIR sequence) revealed subacute compression fractures at vertebral bodies of L2, L3 and L4 with no evidence of pathologic involvement.

The intervention was performed under general anesthesia. A standard bilateral transpedicular approach was performed to access the vertebral bodies. Balloons were inflated to a maximum of 6 cc of volume and 120 PSI each. The cement hardened to an appropriate viscosity, and was introduced into vertebral bodies under fluoroscopic control five minutes after the preparation, according to the manufacturer's recommendations. The three levels were cemented sequentially, taking approximately one minute for each level. The maximum amount of cement introduced was 2.5 cc for each pedicle. Leakage of a small amount of cement into the lateral perivertebral venous system was detected at L2 and the injection was stopped at this level. No other adverse events were detected during the procedure. In the immediate postoperative period, the patient developed neurological symptoms including dysarthria, bradypsychia and right upper extremity claudication. The stroke code protocol was activated, and brain CT and supra-aortic trunks angio-CT were performed, revealing the presence of undetermined endovascular material in the territory of the left middle cerebral artery and brain and lung parenchyma, compatible with PMMA embolism (fig 3,4,5). The patient was considered not to be a suitable candidate for thrombolysis, therefore full anticoagulation treatment with low molecular weight heparine was initiated. An MRI was performed two days after the surgery, demonstrating cortico-subcortical ischemic regions in the territory of the left middle cerebral artery. The patient evolved satisfactorily, showing a complete resolution of her neurologic symptoms in the next 48 hours, and was discharged from hospital with no neurological sequelae.

Three weeks after the intervention, the patient arrived at the emergency department with a new self-limiting dysarthria episode. The brain-CT showed no changes when comparing with the previous images. Thus, diagnosis at the emergency room was an uncertain topography transient ischemic attack.

In the follow-up appointment, one month after the surgery, a significant pain improvement was noticed, with no new neurological events. One month after the revision, the patient suffered a hemorrhagic stroke in the right side of the brain, presumably due to a bad acenocoumarol treatment control, and eventually died.

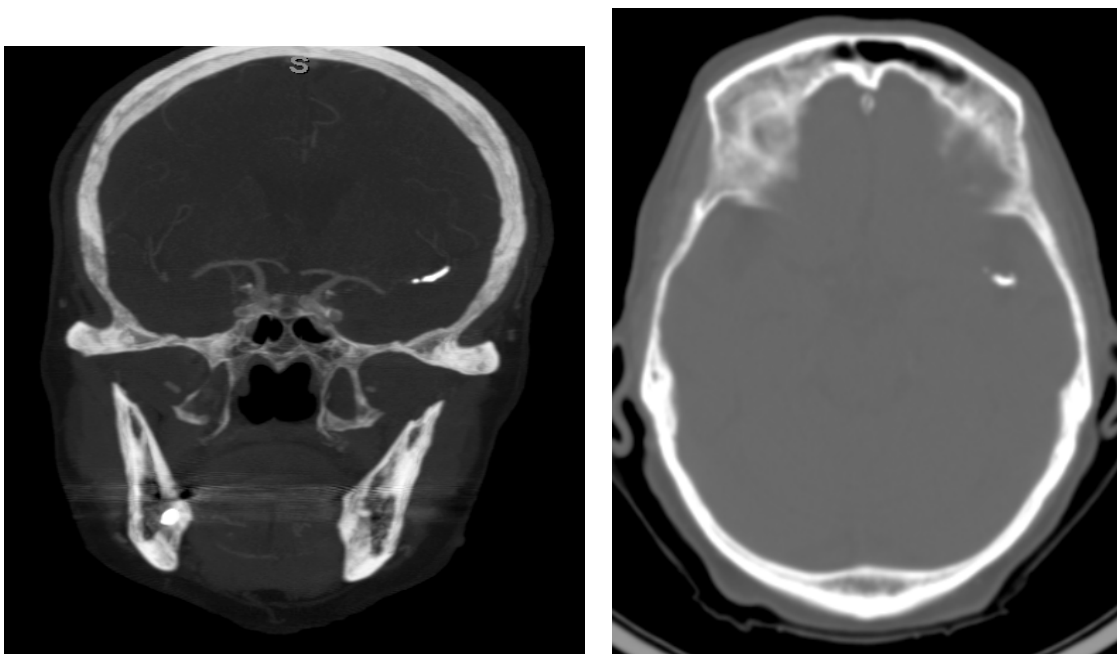


Fig 3 and 4. Cranial CT scan revealed the presence of undetermined endovascular material in the territory of the left middle cerebral artery, compatible with PMMA embolism.



Fig 5. Thoracic CT scan revealed the presence of undetermined endovascular material in the lungs, compatible with PMMA embolism.

3. Discussion

Ischemic stroke associated to paradoxical PMMA brain embolism constitutes an extremely rare adverse effect, therefore the bibliography related with this topic is scarce. To our knowledge, this is the third published case report in English literature that describes intravascular paradoxical embolization of cement after kyphoplasty (Scroop *et al.*, 2002; Marden *et al.*, 2008). Few similar cases have been reported associated with kyphoplasty, vertebroplasty or spinal instrumentation with cement augmentation. The presence of an atrial septal defect, patent foramen ovale or arteriovenous malformation is necessary in every case. In addition, a pressure increase in the right chambers of the heart is needed to allow the PMMA embolus to pass through the defect to the general blood flow. This pressure increase occurs due to the pulmonary embolism associated with cement leakage during the surgery, leading to a paradoxical right-to-left shunt.

Well-known risk factors for cement leakage after vertebroplasty or kyphoplasty are vertebral cleft, cortical disruption of the vertebra, the injected cement total volume and cement viscosity (Zhan *et al.*, 2017; Zhao-Fei *et al.*, 2018; Ryu *et al.*, 2002). An inverse relationship between the cement viscosity at the time of cementation and the risk of cement leakage has been reported. The risk of complications also increases in relation to the number of levels treated (Zhan *et al.*, 2017). Other conditions such as age, sex, fracture type, operation level or surgical approach have not resulted significant in previous studies (Zhan *et al.*, 2017). Compared to vertebroplasty, kyphoplasty has proved lower cement leakage incidence, due to decreased intravertebral pressure at the time of cementation (Hassan *et al.*, 2018; Zhan *et al.*, 2017)

Intraosseous venography preceding the cement injection is a controversial option; although this practice may be helpful, especially for less experienced surgeons, better results in effectiveness or

safety have not been proved, if the behavior of the contrast and the cement itself are not necessarily the same (Gaughen *et al.*, 2002). Other disadvantages are the increase in fluoroscopy exposure time, as well as an increase in economic costs and procedure time. Adverse effects related to intravenous contrast also need to be addressed, although the injected volume is very low and complications are infrequent.

Regarding to the case reported, the patient suffered from a posterior small size atrial septal defect with left-to-right shunt diagnosed as an incidental finding during the study of her valvular heart disease. At the time of surgery, a minimum leakage to the right external vertebral venous plexuses was reported, at the level of L2 vertebral body. No significant monitoring alterations were reported during the surgical intervention, which was performed under general anesthesia. Cementation began five minutes after the mixture of cement, and the PMMA viscosity was checked before the injection. A further possibility is to perform the surgery under local anesthesia, avoiding general anesthesia risks and facilitating early diagnosis if complications are developed. We wonder if intraosseous venography before cementation, or avoiding a multiple-level procedure at the same time could be useful to prevent adverse effects, but nowadays the bibliography in relation with this topic does not answer these questions. Further studies should be necessary to increase safety in these particular group of patients.

4. Conclusions

Main adverse events associated to vertebroplasty or kyphoplasty are generally due to cement leakage to the paravertebral region or venous plexuses. Ischemic stroke in relation to cement embolization is an extremely rare immediate complication, and an atrial septal defect or arteriovenous malformation are required to allow the migration of the embolus from the right chambers of the heart to general blood flow. Patients should be informed of the increased risk in case of cardiac malformations.

In order to prevent complications, it is vitally important to be aware of the risk factors associated to cement leakage. These factors may be divided in fracture-dependent factors (intravertebral cleft and cortical disruption) and surgical technique-dependent factors (cement viscosity, injected volume and number of levels treated).

Ethical Aspects

The data collected from the study subject was kept confidential and the four bioethical principles of beneficence and non-maleficence, autonomy and justice were respected. Anonymity was also maintained, and the confidentiality of the results was respected.

Declaration Of Interest

The authors declare that there is no conflict of interest that could prejudice the impartiality of the research reported.

Funding

Personal funds were used for this research: No external funds were received.

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RESUMEN

La cifoplastia es una intervención mínimamente invasiva que está indicada en fracturas vertebrales por fragilidad para proporcionar alivio del dolor y en ocasiones recuperar parte de la altura vertebral. Las complicaciones graves asociadas con la cifoplastia o la vertebroplastia percutánea son raras y generalmente están relacionadas con la fuga de cemento del cuerpo vertebral (Lamy *et al.*, 2014). Presentamos el caso de una mujer de 83 años que sufrió un ictus isquémico en el postoperatorio inmediato tras una cifoplastia percutánea de tres niveles (L2-L3-L4), a causa de una embolia paradójica por presentar una comunicación interauricular.

Palabras clave: Cifoplastia, Vertebroplastia, Complicación grave, Ictus isquémico, Embolia paradójica.

