Cement extravasation

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Cement extravasation is frequent in vertebroplasty procedure. It is well tolerated in the large majority of cases but is also the main source of vertebroplasty complications especially nerve root compression in case of cement leakage into the intervertebral foramen and pulmonary embolism of cement-complicating venous cement leakage. The rate of these complications are much higher in malignant than in osteoporotic collapses. The risk of neurological complication also increases at the cervical level. In addition, incidence of new vertebral fractures in adjacent vertebrae may be increased by vertebroplasty. General reactions possibly due to a reflex reaction to intramedullary bone injection and fat embolism may also occur. This article reviews the safety measures to reduce the risk of cement extravasation including high quality permanent radiological guidance enabling early detection of cement extravasation, use of conscious sedation, bilateral transpedicular approach at the thoracic and lumbar levels, careful selection of the bone penetration site in order to make a single vertebral needle path, careful needle placement to avoid the risk of cortical breakthrough, use of a well-opacified and refrigerated cement with a toothpaste consistency [1)].

Minimally invasive procedures for the treatment of vertebral compression fractures (VCFs) have been in use since the mid-1980s. A mixture of liquid monomer and powder is introduced through a needle into one or both pedicles, and it polymerizes within the vertebral body in an exothermic chemical reaction. The interaction between cement and the fractured vertebral body determines whether and how the cement stabilizes the fragments, alters morphology, and extravasates. The cement is intended to remain within the vertebral body. However, some studies have reported cement leakage in more than 80% of the procedures. Although cement leakage can have no or minimal clinical consequences, adverse events, such as paraplegia, spinal cord and nerve root compression, cement pulmonary embolisms, or death, can occur. The details of how the cement infiltrates a vertebral body or extravasates out of the body are poorly understood and may help to identify strategies to reduce complications and improve clinical efficacy.

Purpose: Apply novel techniques to demonstrate the cement spread inside vertebrae as well as the points and pattern of cement extravastation.

Study design: Ex vivo assessment of vertebral augmentation procedures.

Methods: Vertebrae from six fresh whole human cadaver spines were used to create 24 specimens of three vertebrae each. The specimens were placed in a pneumatic testing system, designed to create controlled anterior wedge compression fractures. Unipedicular augmentation was performed on the central vertebra of 24 specimens using polymethylmethacrylate/barium sulfate Vertebroplastic cements (DePuy Spine, Raynham, MA, USA). The volume of cement injected into each vertebra was recorded. Fine-cut computed tomography (CT) scans of all segments were obtained (Brilliance 64; Philips Medical Imaging, Amsterdam, The Netherlands). Using multiplanar reconstructions and volume compositing three-dimensional imaging (Osirix, www.osirix-viewer.com), each specimen was carefully assessed for cement extravasation. Specimens were then immersed in a 50% sodium hypochlorite solution until all overlying soft tissues were removed, leaving the bone and cement intact. The specimens were dried and visually examined and photographed to assess cement extravasation and fracture patterns. Specimens were cut in the axial or sagittal plains to assess the gross morphology of cement infiltration and extravasation. Finally, 25-mm block sections were removed from selected specimens and imaged at 14-µm resolution using a GE Locus-SP micro-CT system (GE Healthcare, London, Ontario, Canada).

Results: Infiltration was characterized by an intimate capture of trabecular bone within the cement, forming an irregular border at the perimeter of the cement that is determined by the morphology of the trabeculae and marrow spaces. Extravasation of the cement was assessed as “any” if any small or large amount of extravastation was detected and was also assessed as severe if a large amount of extravasation was found. Out of the 23 levels studied, some extravasation was visibly apparent in all levels. A wide spectrum of filling patterns, leakage points, and interdigitation of the cement was observed and appeared to be determined by the interaction of the cement with the trabecular morphology. The results support the fact that the cement generally advances through the vertebrae with relatively regular and easily identifiable borders.

Conclusions: Using a cadaver VCF model, this study demonstrated the exact filling and extravastation patterns of bone cement inside and out of fractured vertebrae. These data enhance our understanding of the vertebral augmentation and extravastation mechanics [2)].

The complications can be classified as mild, which may include a temporary increase in pain and transient hypotension; moderate, including infection and extravasation of cement into the foraminal, epidural or dural space; and severe such as cement leakage in the paravertebral veins, leading to pulmonary embolism, cardiac perforation, cerebral embolism or even death [3)].

Bone cement injected during vertebroplasty alters local biomechanics in elderly female spines, resulting in increased endplate disruption in treated and superior adjacent vertebrae. More specifically, bone cement increases subsidence in the posterior regions of the treated endplates and the anterior region of the superior caudal endplate. This increased subsidence may be the initial mechanism leading to subsequent compression fractures after vertebroplasty, particularly in vertebrae superior to the treated level [4)].

A 44-year-old female patient began to complain of L4 radiculopathy after L4 PVP. The lumbar

computed tomography (CT) demonstrated cement fragment closed to upper medial aspect of the left L4 pedicle. A minimally invasive translaminar endoscopic procedure was performed to remove cement fragment.

RESULTS: Following the endoscopic procedure, the patient's complaints resolved completely and was discharged on postoperative first day. The minimally invasive intervention provided shorter operation time, minimal blood loss, and reduced complication rate due to its simplicity. In particular, there was no need to undergo general anesthesia.

CONCLUSION: Endoscopic translaminar approach could be safely performed in patients with symptomatic cement leakage after PVP or PKP procedure [5].

Meleis et al. from the MD Anderson Cancer Center Houston and Baylor College of Medicine aimed to evaluate the outcome of percutaneous stabilization with cement augmentation of the pedicle screws in the management of patients with metastatic cancer to the spine.

They reviewed a retrospective case series of 74 patients with symptomatic pathological spine fractures treated with cement-augmented pedicle screws implanted with a percutaneous technique. The mean imaging follow-up was 11.3 months. Data on demographics, clinical outcomes, and complications were collected. Cement extravasation, spinal hardware integrity, and fusion rates were assessed on CT scans.

Among 50 patients with follow-up imaging, 23 patients (46%) showed facet joint fusion. The length of segmental stabilization was not a significant predictor of the occurrence of fusion. Pre- or postoperative radiation therapy, postoperative chemotherapy, and the location of spinal lesions did not have a statistically significant effect on the occurrence of fusion. Patients older than 60 years of age were more likely to have fusion across facet joints compared with younger patients. There was a significant difference in the mean visual analog scale pain score, with 6.28 preoperatively and 3.41 postoperatively, regardless of fusion status ($p < 0.001$). Cement extravasation was seen in 51% of the cohort, but in all instances, patients remained asymptomatic. Most importantly, the incidence of hardware failure was low (4%).

Percutaneous fixation with cement-augmented pedicle screws in patients with pathological spine fractures provides an improvement in mechanical back pain, with a low incidence of failure, and in some patients, spontaneous facet fusion was observed. Further research is necessary with regard to both short-term benefits and long-term outcomes [6].

1)
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