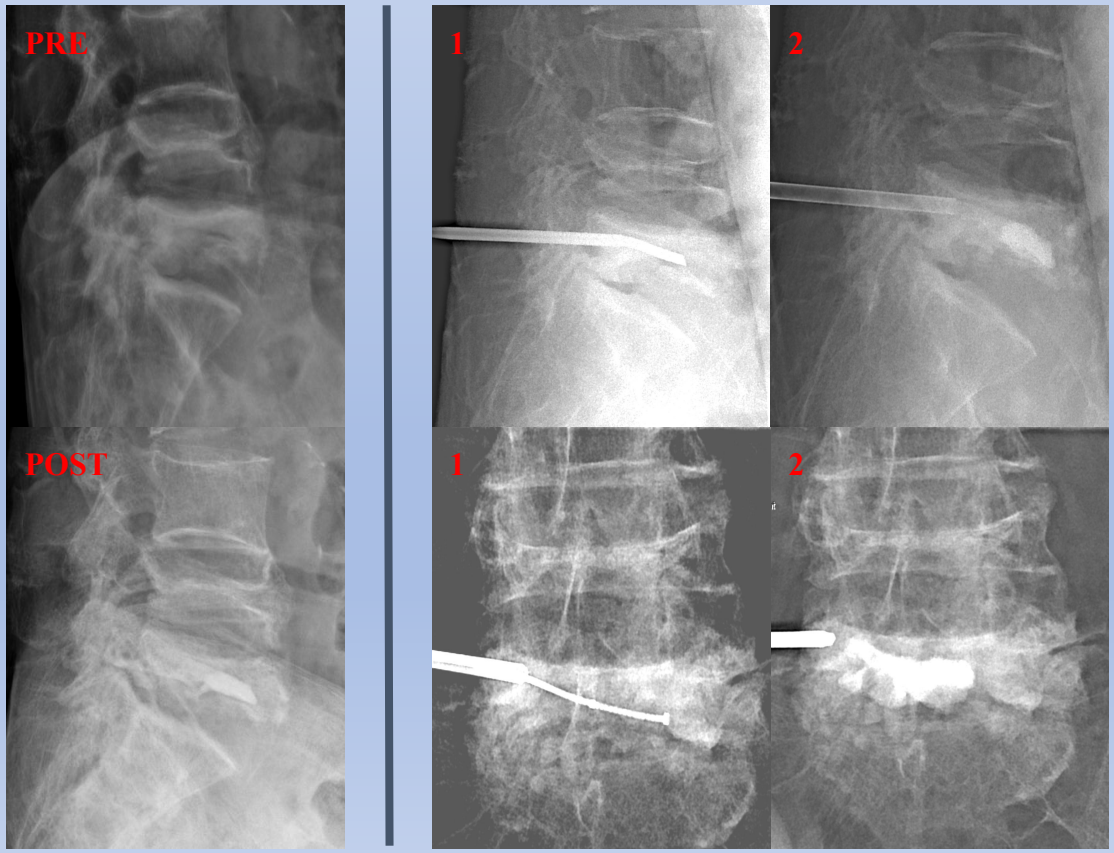
Beyond the Basics: A Pictorial Essay of Advanced Percutaneous Vertebral Augmentation Techniques

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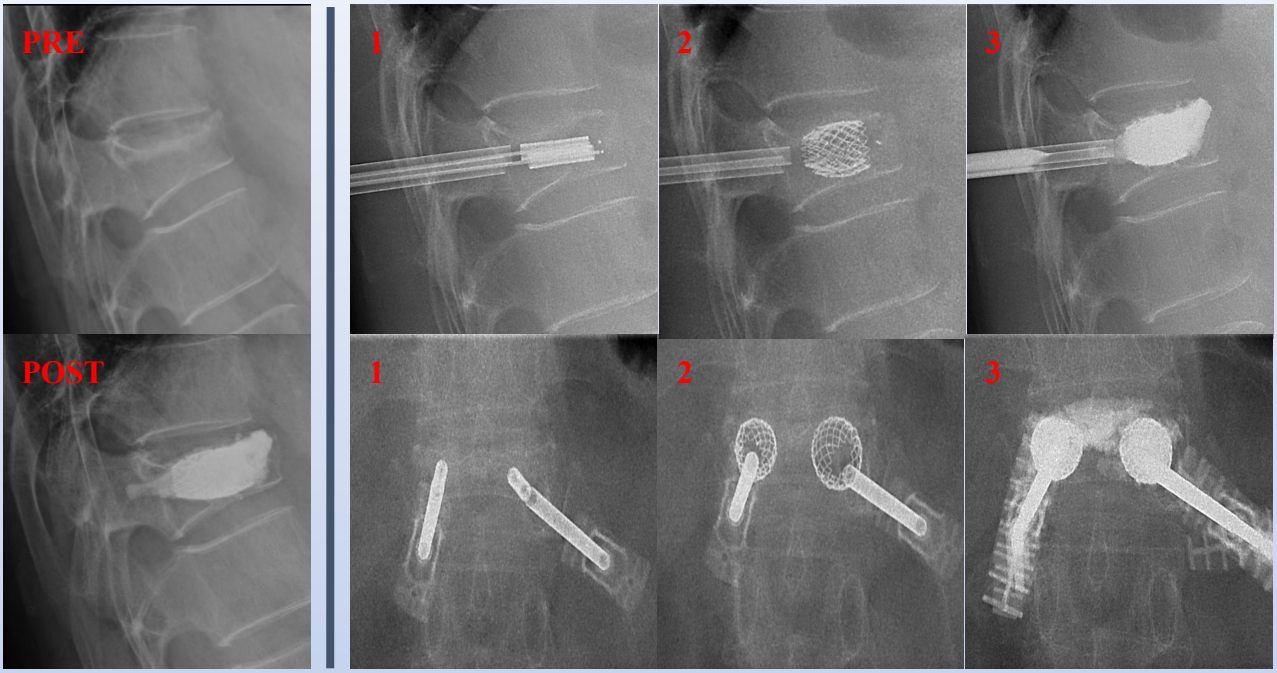
Objective:
Vertebral augmentation procedures are minimally invasive, image-guided interventions designed to restore mechanical stability and alleviate pain in compromised spinal segments. Traditionally utilized as vertebroplasty or balloon kyphoplasty for osteoporotic, traumatic, or neoplastic compression fractures, these techniques have evolved to manage complex spinal hardware failures. A prime example is periprosthetic cementoplasty, used to stabilize interbody fusion cage subsidence into weakened endplates. Across all applications, the core biomechanical goals remain identical: the targeted delivery of polymethyl methacrylate (PMMA) bone cement to achieve rapid pain relief, immediate rigid segment stabilization, and the prevention of progressive spinal deformity or construct migration.

Materials and Methods:
A retrospective review was conducted of patients who underwent percutaneous vertebral augmentation procedures at Princess Margaret Hospital, Hong Kong SAR, between 2025 and 2026. Relevant cases were identified utilizing the hospital's electronic patient record database, and post-procedural imaging findings were evaluated to assess structural outcomes.

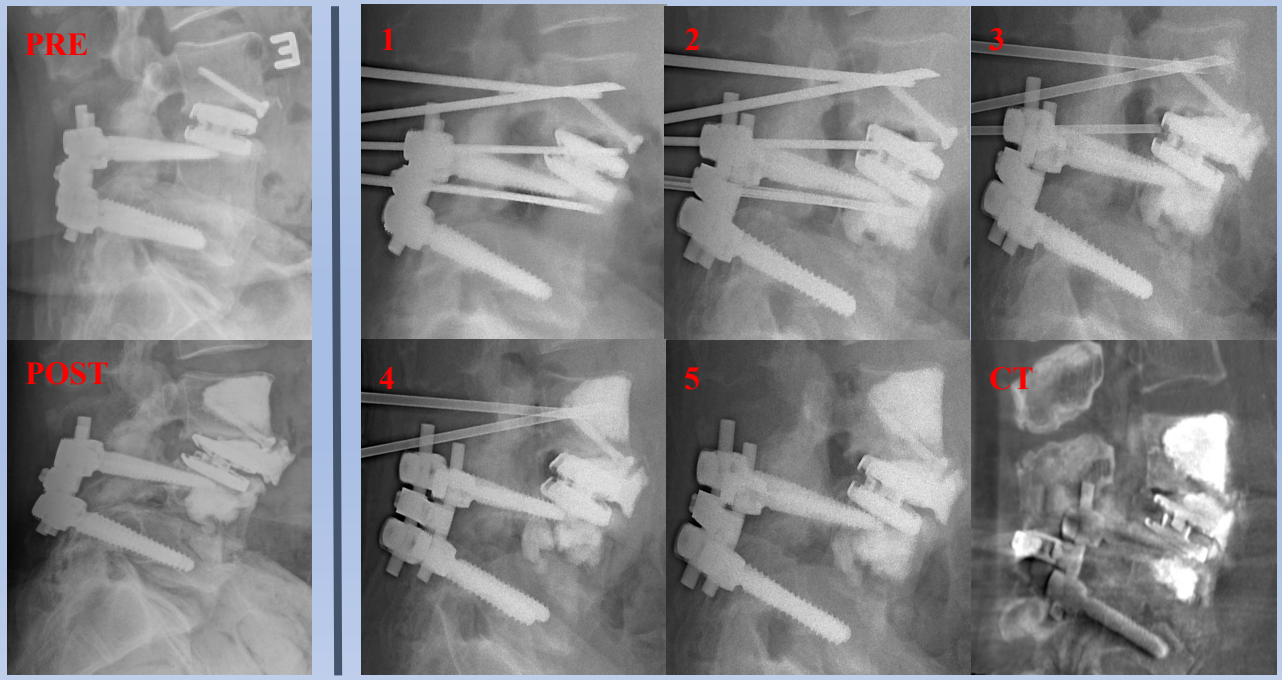
Case 1 (Osteoporotic collapse): A unipedicular approach using a steerable bevel-tip needle to minimize pedicle trauma and reduce the risk of cement leakage.



Case 2 (Post-SBRT vertebral collapse): A bipedicular approach was performed using both balloon kyphoplasty and an internal structural stent. The permanent metal stent provides an internal scaffold that helps maintain the restored vertebral height during cement injection.



Case 3 (Intervertebral Cage Subsidence at L3/4): Periprosthetic cementoplasty addressing a subsided L3/4 interbody cage that has depressed into the L4 superior endplate, creating a distraction gap beneath the L3 inferior endplate. Target-directed PMMA cement is injected into the vacant L3-cage interface to bridge the structural gap, as well as into the L3 and L4 vertebral bodies to anchor the failing implant, reinforce the osteoporotic endplates, and prevent further construct migration.



Results:
Percutaneous vertebral cementation is a highly versatile, image-guided intervention that utilizes high-viscosity polymethyl methacrylate (PMMA) to restore mechanical stability and alleviate severe pain in compromised spinal segments. This clinical spectrum includes standard vertebroplasty, balloon kyphoplasty for height restoration in acute vertebral compression fractures (VCFs), and advanced periprosthetic cementoplasty. The latter is an emerging salvage technique specifically deployed to manage interbody fusion cage subsidence by targeted delivery of PMMA into the compromised bone-implant interface to halt further hardware migration.

Operators customize the access route according to the specific structural requirements and fracture morphology:

- Bipedicular approach: Often combined with balloon inflation and placement of an internal structural stent to maximize vertebral height restoration and provide symmetrical bilateral load-bearing support in severe or complex vertebral compression fractures (VCFs).
- Unipedicular approach: A steerable, curved bevel-tip needle enables uniform midline cement distribution through a single entry point. This approach may reduce operative time, radiation exposure, and the risk of pedicle breach, making it particularly useful in patients with significant comorbidities.

Complications and risk mitigation:

- Vigilant real-time fluoroscopic monitoring is critical to minimize cement extravasation into the spinal canal or venous plexus, posterior vertebral wall breach, and pulmonary cement embolism. Commonly recognized absolute contraindications include active local infection, uncorrectable coagulopathy, allergy to bone cement, and, in many practice settings, vertebra plana.

Conclusion:
Advanced vertebral augmentation has expanded from treating acute compression fractures to salvaging complex spinal hardware failures. The clinical objective dictates the optimal strategy – whether performing minimally invasive unipedicular vertebroplasty, maximizing height restoration through bipedicular kyphoplasty, or securing failed implants such as subsided interbody cages. Ultimately, polymethyl methacrylate (PMMA) cementation remains an indispensable, versatile tool in the interventionalist's arsenal, offering customizable, minimally invasive solutions that restore immediate mechanical stability and provide rapid pain relief across a diverse spectrum of structural spinal pathologies.

References:

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