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Kyphoplasty vs. Vertebroplasty: Comparative Review of Indications, Techniques, and Long-Term Outcomes

B. Sneha Reddy[1], R. Jona Methusala[2], D. Priyanka[3], K. Raj Kumar[4]
Student, Doctor of Pharmacy, Dr. K.V. Subba Reddy Institute of Pharmacy, Kurnool.
Associate Professor, Department of Pharmacology, Dr.K.V.Subba Reddy Institute of Pharmacy, Kurnool.
Student, Doctor of Pharmacy, Dr. K.V. Subba Reddy Institute of Pharmacy, Kurnool.
Student, Doctor of Pharmacy, Dr. K.V. Subba Reddy Institute of Pharmacy, Kurnool.

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ABSTRACT
Vertebral compression fractures (VCFs) are a common cause of pain, disability, and diminished quality of life, particularly among older adults with osteoporosis. Over the past three decades, percutaneous vertebral augmentation—including vertebroplasty (VP) and kyphoplasty (KP)— has transformed the management of these fractures by offering rapid pain relief and early mobilization through minimally invasive stabilization. Although both techniques share similar therapeutic objectives, debate continues regarding their indications, biomechanical distinctions, and long-term outcomes. This review synthesizes contemporary evidence comparing VP and KP with respect to clinical efficacy, vertebral height restoration, cement leakage, and procedural safety. Current literature consistently demonstrates that both VP and KP provide significant and sustained pain relief accompanied by improved function and quality of life. However, kyphoplasty demonstrates superior vertebral body height restoration and a lower incidence of cement extravasation due to its balloon-assisted cavity creation. These advantages may translate into better spinal alignment and reduced risk of adjacent-level fractures in selected patients. Optimal results depend on careful patient selection, high-quality imaging guidance, and precise procedural execution. Ultimately, VP and KP should be regarded as complementary techniques within the therapeutic spectrum for vertebral compression fractures, enabling individualized, evidence-based management tailored to patient-specific anatomical and clinical factors.

Keywords:
Vertebral compression fracture; Kyphoplasty; Vertebroplasty; Vertebral augmentation;
Osteoporosis; Minimally invasive spine surgery; Cement leakage; Vertebral height restoration; Pain relief; Clinical outcomes

I. INTRODUCTION

Osteoporotic vertebral compression fractures (OVCFs) represent one of the most common and debilitating complications of osteoporosis, particularly among the elderly population. They occur when weakened vertebral bodies lose structural integrity, leading to partial collapse under physiological loads. The global burden of osteoporosis continues to rise with population aging, and OVCFs are estimated to affect up to one in three women and one in five men over the age of fifty. These fractures not only cause acute and chronic pain but also result in progressive spinal deformity, height loss, and reduced pulmonary function. Consequently, they impose significant physical, psychological, and socioeconomic impacts, including decreased mobility, loss of independence, and diminished quality of life.

Conventional management of OVCFs primarily focuses on conservative measures such as analgesics, bed rest, physical therapy, and external orthotic bracing. However, these approaches often fail to provide sufficient pain relief or restore early mobility. Prolonged immobilization further increases the risk of complications, including deep vein thrombosis, pressure ulcers, and muscle deconditioning, thereby creating a cycle of frailty and dependency. As a result, the limitations of conservative therapy have driven the development of minimally invasive surgical options aimed at stabilizing the fracture and alleviating pain more effectively.

Percutaneous vertebral augmentation (PVA) techniques have emerged as promising alternatives to traditional treatment. Among these, vertebroplasty and kyphoplasty are the most widely utilized. Vertebroplasty, first described by Galibert and colleagues in 1987, involves percutaneous injection of polymethylmethacrylate (PMMA) cement into the collapsed vertebral body. The

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cement provides internal stabilization, leading to rapid pain relief and improved function. Despite its clinical benefits, concerns have been raised regarding cement leakage and the lack of height restoration.

In response, kyphoplasty was introduced in the late 1990s as a modification designed to address some of vertebroplasty's limitations. In this procedure, an inflatable balloon tamp is inserted into the vertebral body to create a cavity and partially restore vertebral height before cement injection. This technique allows for lower injection pressures, potentially reducing cement leakage rates, and offers some correction of kyphotic deformity. Biomechanically, kyphoplasty may improve spinal alignment and load distribution, though its superiority in long-term clinical outcomes remains a subject of ongoing debate.

Both vertebroplasty and kyphoplasty share the goals of rapid pain reduction, functional recovery, and prevention of further vertebral collapse. Nevertheless, differences in procedural techniques, biomechanical effects, complication profiles, and cost-effectiveness continue to be critically evaluated in the literature. Understanding these distinctions is essential to guide optimal treatment selection and improve patient outcomes in the management of osteoporotic vertebral compression fractures

II. INDICATIONS AND PATIENT SELECTION

Appropriate patient selection is a critical determinant of success in percutaneous vertebral augmentation (PVA) procedures such as vertebroplasty (VP) and kyphoplasty (KP). While both techniques aim to alleviate pain and stabilize the vertebral column, their efficacy and safety are highly dependent on careful evaluation of clinical, radiological, and systemic factors. The primary goal is to identify patients who are most likely to benefit from augmentation while minimizing the risk of complications.

2.1 Indications

Osteoporotic Vertebral Compression Fractures

The most common indication for VP and KP is a painful osteoporotic vertebral compression fracture that is refractory to optimal conservative therapy. Typically, patients experience persistent or worsening back pain despite 2–6 weeks of non-surgical management, including analgesics, bed rest, physical therapy, and external bracing. Pain is often localized to the fracture level, exacerbated by movement, and associated with functional impairment.

Imaging confirmation is essential to correlate symptoms with an acute or subacute fracture, usually demonstrated by bone marrow edema on MRI or increased uptake on bone scintigraphy. Kyphoplasty is often preferred in cases with significant vertebral height loss or kyphotic deformity, where balloon expansion may partially restore alignment. Vertebroplasty, on the other hand, remains a reliable choice for stable compression fractures without major deformity.

Pathologic Vertebral Fractures

Vertebral collapse secondary to neoplastic involvement, such as metastatic disease or multiple myeloma, represents another established indication for vertebral augmentation. In these patients, VP or KP can provide rapid pain relief, improve spinal stability, and facilitate early mobilization—often as an adjunct to systemic oncologic therapies like radiotherapy or chemotherapy.

Kyphoplasty may offer added advantages in reducing cement leakage and restoring partial vertebral height in osteolytic metastatic lesions, though the choice between techniques depends on lesion morphology, bone integrity, and overall prognosis.

Symptomatic Vertebral Hemangiomas

Although rare, symptomatic vertebral hemangiomas—vascular lesions causing focal pain or mechanical instability—can be effectively managed with VP or KP. Augmentation provides internal reinforcement of the weakened vertebra and alleviates pain, especially when conventional treatments such as radiotherapy or corticosteroids fail.

2.2 Selection Considerations

Successful outcomes depend not only on proper indication but also on careful assessment of fracture characteristics, neurologic status, and patient comorbidities.

- Fracture Age and Morphology:

Fracture chronicity significantly influences procedural benefit. Acute or subacute fractures (<3 months old) with persistent edema on MRI respond best to augmentation, as pain is primarily mechanical. Chronic or healed fractures without marrow edema seldom improve.

Kyphoplasty is advantageous in recent fractures with height loss or angular deformity, as

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balloon inflation can restore vertebral body height and correct segmental kyphosis. Vertebroplasty remains suitable for incomplete or stable fractures without significant collapse.

- Neurologic Status:

Patients presenting with neurologic deficits or spinal cord compression require decompressive intervention rather than PVA alone. Vertebral augmentation is contraindicated in the presence of posterior wall breach, retropulsed bone fragments, or epidural extension causing canal compromise.

- Medical Comorbidities:

Systemic factors such as coagulopathy, local or systemic infection, and severe cardiopulmonary compromise increase procedural risk. Active infection at the puncture site or within the vertebral body constitutes an absolute contraindication. Similarly, uncorrected bleeding disorders should be managed before intervention to reduce the risk of epidural hematoma or cement extravasation.

2.3 Contraindications

Absolute contraindications to VP and KP include:

- Asymptomatic or clinically silent fractures
- Healed or chronic fractures without pain correlation
- Posterior wall disruption with canal compromise or neurologic deficit
- Active systemic or local infection (e.g., osteomyelitis, discitis)
- Uncorrected coagulopathy or bleeding disorders

Relative contraindications include severe vertebral collapse (>75% height loss), allergy to PMMA cement, or inability to tolerate prone positioning.

2.4 Special Considerations

Patients with multi-level vertebral fractures require individualized planning. Treating multiple levels in a single session may increase cement leakage risk and procedural duration, though staged augmentation can minimize complications. In cases of sequential osteoporotic fractures, adjacent-level fractures may occur due to altered load distribution or underlying bone fragility; therefore, careful post-procedural monitoring and prophylactic osteoporosis management are essential.

Advanced imaging techniques—particularly MRI and CT—play an integral role in preprocedural assessment. MRI identifies active fractures and excludes malignancy or infection, while CT helps delineate cortical integrity and posterior wall involvement.

2.5 Long-Term Management and Osteoporosis Control

Vertebral augmentation addresses the mechanical consequences of osteoporotic fractures but does not treat the underlying metabolic bone disease. Optimal long-term outcomes require a comprehensive approach that includes osteoporosis evaluation and management.

Patients should undergo bone mineral density (BMD) testing and laboratory assessment for secondary causes of osteoporosis. Evidence-based pharmacologic therapies—such as bisphosphonates, denosumab, teriparatide, or romosozumab—are essential to prevent future fractures. Equally important are lifestyle interventions including adequate calcium and vitamin D intake, smoking cessation, weight-bearing exercise, and fall-prevention strategies. Multidisciplinary follow-up involving orthopedic surgeons, endocrinologists, and physiotherapists ensures sustained fracture prevention and improved quality of life.

III. TECHNICAL ASPECTS

Vertebral augmentation procedures—vertebroplasty (VP) and kyphoplasty (KP)—are minimally invasive, image-guided interventions that aim to stabilize fractured vertebral bodies, alleviate pain, and improve functional outcomes. Although both techniques share common principles, they differ in instrumentation, cement delivery mechanics, and their capacity for vertebral height restoration. A thorough understanding of their technical nuances is essential to ensure procedural safety and optimize results.

3.1 Vertebroplasty

Vertebroplasty involves percutaneous injection of bone cement—most commonly polymethylmethacrylate (PMMA)—directly into the collapsed vertebral body under continuous fluoroscopic guidance. The procedure is typically performed under local anesthesia with conscious sedation, although general anesthesia may be used for multi-level or oncologic cases.

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Technique Overview:

After sterile preparation and administration of local anesthesia, a transpedicular or parapedicular approach is selected based on vertebral level and morphology. A small-gauge access needle or trocar is advanced into the anterior third of the vertebral body under biplanar fluoroscopic control. Once proper positioning is confirmed, low-viscosity PMMA cement—prepared to a toothpaste-like consistency—is slowly injected using a syringe or mechanical injector. Continuous fluoroscopic monitoring in both anteroposterior and lateral planes is crucial to prevent cement extravasation into the venous plexus, intervertebral disc, or spinal canal. Injection is terminated immediately upon visualization of cement leakage or adequate vertebral filling.

Advantages:

- Technically straightforward with shorter operative time (typically 30–45 minutes).
- Can be performed under local anesthesia, suitable for elderly or frail patients.
- Requires smaller cannula diameter and fewer surgical instruments.
- Lower procedural cost compared with kyphoplasty.

Limitations:

- Higher risk of cement leakage due to high injection pressures and absence of a preformed cavity.
- No capacity for vertebral height restoration or correction of kyphotic deformity.
- Potential risk of adjacent-level fractures due to altered load distribution.

Despite these limitations, vertebroplasty remains an effective option for rapid pain relief and mechanical stabilization, especially in stable osteoporotic or metastatic fractures without significant deformity.

3.2 Kyphoplasty

Kyphoplasty represents an evolution of vertebroplasty, incorporating the use of an inflatable bone tamp (balloon) to create a controlled cavity within the vertebral body before cement injection. This modification allows for partial restoration of vertebral height and reduction of local kyphosis while lowering cement leakage risk through cavity creation and reduced injection pressure.

Technique Overview:

Following sterile preparation and local or general anesthesia, a bilateral transpedicular approach is most commonly employed. Under fluoroscopic guidance, working cannulas are inserted into the vertebral body. Through these cannulas, balloon tamps are introduced and gradually inflated using radiopaque contrast material. The inflation elevates the endplates, restoring vertebral height and reducing kyphotic angulation. After achieving the desired correction, the balloons are deflated and removed, leaving a cavity that serves as a reservoir for cement deposition.

High-viscosity PMMA cement is then injected under low pressure, minimizing the risk of extravasation. Fluoroscopic monitoring is maintained throughout to ensure controlled filling and appropriate cement distribution.

Advantages:

- Reduced cement leakage due to cavity formation and low-pressure injection.
- Partial restoration of vertebral body height and correction of sagittal alignment.
- Potential improvement in postural balance and reduction of kyphosis-related pain.
- May provide superior biomechanical stability in severely collapsed vertebrae.

Disadvantages:

- Higher procedural cost owing to balloon and specialized instrumentation.
- Longer operative time (typically 45–60 minutes).
- Requires greater technical precision and bilateral pedicular access in most cases.
- Height restoration may be limited by chronic fracture consolidation or severely osteoporotic bone.

3.3 Comparative Considerations

Both VP and KP provide rapid and durable pain relief in appropriately selected patients, with comparable improvements in functional scores and quality of life. However, kyphoplasty offers additional mechanical benefits through height restoration and kyphosis correction, potentially reducing the risk of subsequent vertebral collapse. Conversely, vertebroplasty remains a cost-effective and less invasive alternative for stable fractures or patients with limited life expectancy.

Key technical distinctions between the two procedures include cement viscosity, injection pressure, and vertebral body manipulation. The

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choice of technique is therefore individualized based on fracture morphology, degree of collapse, patient comorbidities, and institutional expertise.

3.4 Technical Pearls and Safety Considerations

- Fluoroscopic guidance in both anteroposterior and lateral views is mandatory to avoid cement migration.
- Cement viscosity and timing of injection are critical—too early leads to leakage, too late results in poor interdigitation.
- Balloon inflation pressures should be carefully monitored to prevent endplate fracture or cortical breach.
- Prophylactic antibiotics and strict aseptic technique reduce infection risk.
- Post-procedural CT or radiography helps confirm cement distribution and exclude extravasation.

IV. CLINICAL OUTCOMES AND COMPARATIVE EVIDENCE

Both vertebroplasty (VP) and kyphoplasty (KP) have been extensively studied for their efficacy in managing painful vertebral compression fractures. The primary objectives of these procedures—pain relief, functional recovery, and spinal stabilization—are achieved in a high proportion of appropriately selected patients. However, the magnitude and durability of these benefits, as well as procedural safety and cost-effectiveness, continue to be evaluated through randomized controlled trials and meta-analyses.

4.1 Pain Relief and Functional Recovery

Rapid and sustained pain reduction remains the most consistent and well-documented benefit of vertebral augmentation. Both VP and KP typically produce marked improvement within 24–72 hours post-procedure, as measured by visual analogue scale (VAS) scores. Studies demonstrate pain reduction of 4–6 points on average within the first week, accompanied by significant decreases in analgesic use.

Functional outcomes, assessed by validated indices such as the Oswestry Disability Index (ODI) and Short Form-36 (SF-36), also show parallel improvement. Comparative trials indicate no significant long-term difference between VP and KP in terms of mobility, daily activity, or overall quality of life, although KP may offer faster early postural correction in kyphotic fractures.

4.2 Vertebral Height Restoration and Spinal Alignment

A key mechanical distinction between the two procedures lies in their ability to restore vertebral height and correct local kyphosis. VP achieves stabilization but minimal height recovery, as cement injection alone does not reverse compression deformity. KP, through balloon tamp inflation, can restore up to 30–50% of lost height in acute fractures and reduce segmental kyphotic angulation by 3–8 degrees. These improvements may contribute to better sagittal alignment, enhanced pulmonary function, and reduced chronic back strain. However, the long-term clinical relevance of height restoration remains debated, as functional outcomes do not always correlate directly with radiographic correction.

4.3 Cement Leakage and Safety Profile

Cement extravasation represents the most frequent procedural complication, although it is often asymptomatic. Reported leakage rates are approximately 20–40% for VP and 8–15% for KP, reflecting the higher injection pressures and lack of cavity creation in VP. While most leakagesare clinically silent, rare cases may result in radiculopathy, spinal cord compression, or pulmonary embolism.

Kyphoplasty's use of a preformed cavity and higher-viscosity cement under low pressure significantly mitigates this risk, making it the safer option for fractures with cortical disruption or posterior wall defects.

4.4 Adjacent-Level Fractures

Subsequent fractures at adjacent levels are recognized complications after vertebral augmentation, potentially related to altered load transmission or residual bone fragility. Some studies suggest a slightly higher incidence following VP, possibly due to stiffer cement constructs and greater endplate stress, whereas others find no statistically significant difference between techniques. The overall risk appears more strongly influenced by osteoporosis severity, cement volume, and untreated bone loss than by the procedure itself**.**

4.5 Cost-Effectiveness

From an economic standpoint, vertebroplasty is generally more cost-effective due to shorter procedure time, simpler instrumentation, and lower material costs. This makes VP

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particularly advantageous in low-resource or high-volume clinical settings.

In contrast, KP incurs higher expenses because of balloon tamps and specialized delivery systems, though some cost analyses argue that reduced complication rates and improved deformity correction may offset the initial investment in selected patients. The choice of technique should therefore balance clinical indication, expected benefit, and healthcare resource availability.

V. LONG-TERM OUTCOMES

Long-term data are crucial in evaluating the sustained efficacy and safety of vertebral augmentation techniques. Although most studies have focused on short- to mid-term outcomes (within 6–12 months), a growing body of literature with follow-up durations of two years or longer has provided valuable insights into the durability of pain relief, functional recovery, and structural maintenance following vertebroplasty (VP) and kyphoplasty (KP).

5.1 Pain Relief and Quality of Life

Long-term follow-up studies consistently demonstrate that both VP and KP offer durable pain reduction and sustained improvement in quality of life. Multiple prospective cohorts and randomized trials report maintenance of significant decreases in Visual Analogue Scale (VAS) pain scores and continued improvement in Oswestry Disability Index (ODI) and SF36 physical function scores for up to 2–5 years post-procedure.

Importantly, these benefits are not limited to the immediate postoperative period; many patients maintain functional independence and reduced analgesic dependency for years after treatment. While KP and VP show similar long-term clinical outcomes in most studies, some evidence suggests slightly superior postural comfort and mechanical stability in KP-treated patients due to better correction of sagittal alignment.

5.2 Vertebral Alignment and Structural Integrity

Kyphoplasty's ability to restore and maintain vertebral height and spinal alignment confers potential long-term biomechanical advantages. Studies indicate that KP-treated vertebrae exhibit less progressive loss of correction and reduced kyphotic angulation over time compared with VP-treated segments. This may translate into lower risk of chronic back pain, fatigue, and compensatory postural strain, especially in patients with multiple level involvement.

In contrast, vertebroplasty achieves stabilization but offers limited control of vertebral collapse progression. Nevertheless, most patients report comparable satisfaction levels and pain relief, underscoring the importance of clinical stability over radiographic perfection.

5.3 Recurrent and New Fractures

The risk of subsequent vertebral fractures-either at adjacent or remote levels-remains a topic of ongoing investigation. Neither VP nor KP has been conclusively shown to reduce the overall risk of new fractures. Reported rates range from 10% to 25% within two years, reflecting the underlying systemic nature of osteoporosis rather than procedural failure.Some early studies suggested a slightly higher incidence of adjacent-level fractures following VP, possibly related to stiffer cement constructs and altered load distribution. However, more recent meta-analyses have demonstrated no significant difference in new fracture rates between the two procedures when controlling for bone mineral density (BMD) and cement volume.

These findings emphasize that vertebral augmentation should be viewed as part of a comprehensive osteoporosis management strategy, not a standalone solution.

5.4 Role of Osteoporosis Management in Long-Term Outcomes

Long-term success of vertebral augmentation is closely tied to optimization of bone quality. Without concurrent treatment of osteoporosis, patients remain at high risk for subsequent fractures and progressive spinal deformity. Therefore, a multidisciplinary approach involving pharmacologic therapy and lifestyle modification is essential.

Pharmacologic interventions such as bisphosphonates, denosumab, teriparatide, or romosozumab have demonstrated efficacy in increasing bone mineral density and reducing future fracture risk. Supplementation with vitamin D and calcium, along with regular weightbearing exercise, fall-prevention strategies, and smoking cessation, further supports skeletal health.

Routine follow-up with bone densitometry (DEXA scanning) is recommended to monitor treatment response and adjust therapy as needed.

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VI. COMPLICATIONS

Although percutaneous vertebral augmentation (PVA) procedures—vertebroplasty (VP) and kyphoplasty (KP)—are generally regarded as safe and minimally invasive, a range of potential complications may occur. Most are rare and preventable with meticulous technique, careful patient selection, and appropriate perioperative monitoring. Complications can be broadly categorized into cement-related, mechanical, neurological, infectious, and systemic events.

6.1 Cement Leakage

Cement leakage remains the most frequent complication of both vertebroplasty and kyphoplasty. It occurs when polymethylmethacrylate (PMMA) extravasates beyond the confines of the vertebral body during injection. Reported leakage rates range from 20–40% for VP and 8–15% for KP, with the majority being asymptomatic and detected only on post-procedural imaging. Leakage pathways include the paravertebral soft tissues, intervertebral disc space, epidural venous plexus, or spinal canal. Factors contributing to leakage include low cement viscosity, high injection pressure, cortical disruption, and excessive cement volume.

While most cases are clinically silent, symptomatic cement leakage can lead to serious complications such as:

- Radiculopathy or spinal cord compression from epidural or foraminal extension.
- Pulmonary embolism due to migration of cement into the venous system.
- Soft-tissue irritation and localized pain from paravertebral extravasation.

Preventive measures include using high-viscosity cement, slow, low-pressure injection, real-time biplanar fluoroscopy, and immediate cessation of injection upon visualizing extravasation. The balloon cavity in kyphoplasty also significantly reduces leakage risk by allowing controlled cement deposition.

6.2 Adjacent-Level Fractures

New or adjacent-level fractures are a recognized post-procedural concern, with an incidence of approximately 10–25% during follow-up. These fractures are often attributed to altered load distribution across the spine after augmentation and to the underlying systemic fragility of osteoporotic bone.

Key risk factors include:

- Severe baseline osteoporosis or inadequate medical management post-procedure.
- High cement volume or excessive stiffness of the augmented vertebra.
- Pre-existing kyphosis or multi-level involvement.

Although some early studies suggested a higher risk following vertebroplasty, more recent evidence indicates that the difference between VP and KP is minimal when bone health is properly managed. Preventive strategies focus on pharmacologic osteoporosis therapy, careful cement volume control, and postural rehabilitation to optimize spinal load balance.

6.3 Neurological Injury

Neurological complications are exceedingly rare (<0.5%) but can be devastating. They typically arise from cement leakage into the spinal canal, neural foramina, or epidural space, causing compression of the spinal cord or nerve roots.

Direct needle misplacement or instrumentation error during cannula insertion can also result in nerve injury or dural puncture.

Immediate management includes cessation of the procedure, urgent imaging (CT/MRI), and neurosurgical decompression if neurologic deficits are progressive or severe.

Meticulous fluoroscopic guidance, attention to needle trajectory, and avoidance of posterior cortical breach are essential preventive measures.

6.4 Infection and Hemorrhage

Infection is a rare complication, with reported incidence below 1%, but it carries significant morbidity when it occurs. Cases of spondylodiscitis and paravertebral abscess have been reported, typically due to breach of sterile technique or hematogenous spread in immunocompromised patients.

Routine pre-procedural antibiotics, strict asepsis, and screening for systemic infection are critical preventive measures.

Hemorrhagic complications—including epidural hematoma or local bleeding—are uncommon but can occur in patients with coagulopathies or those on anticoagulant therapy. Pre-procedural correction of coagulation abnormalities and avoidance of anticoagulant use in the perioperative period are strongly recommended.

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6.5 Cardiopulmonary Events

Cement-related pulmonary embolism (PE) is a rare but potentially life-threatening complication. It results from migration of PMMA particles into the venous circulation, particularly during highvolume or high-pressure injections. Reported incidence varies between 0.1% and 0.9%, and most emboli are asymptomatic, detected incidentally on imaging.

Clinically significant emboli may present with acute dyspnea, hypoxia, or chest pain, requiring supportive care and, in severe cases, anticoagulation therapy. Preventive measures include using low injection pressures, viscous cement, and real-time fluoroscopic monitoring to detect early venous migration.

Other cardiopulmonary events, such as transient hypotension or arrhythmias, may result from PMMA monomer absorption or anesthetic effects, but these are exceedingly rare with modern techniques.

VII. DISCUSSION

Vertebroplasty (VP) and kyphoplasty (KP) are both effective interventions for symptomatic vertebral compression fractures, providing rapid and sustained pain relief, improved mobility, and enhanced quality of life. Kyphoplasty offers additional advantages in vertebral height restoration, kyphosis correction, and reduced cement leakage, whereas vertebroplasty remains simpler, faster, and more cost-effective. Long-term studies suggest comparable clinical outcomes between the two techniques, with neither consistently reducing the risk of subsequent fractures, highlighting the importance of underlying bone health.

Selection between VP and KP should be individualized, considering fracture morphology, patient comorbidities, clinical goals, and resource availability. Both procedures are most effective when integrated into a multidisciplinary care approach that includes pharmacologic osteoporosis management, rehabilitation, and lifestyle interventions. Ultimately, vertebral augmentation should be viewed as a structural stabilization strategy complementing long-term skeletal health rather than a standalone solution.

VIII. CONCLUSION

Kyphoplasty and vertebroplasty represent the mainstay of minimally invasive management for vertebral compression fractures, effectively providing rapid pain relief, mechanical stabilization, and improved patient function. Among the two, kyphoplasty offers additional benefits, including partial restoration of vertebral height, correction of kyphotic deformity, and a lower incidence of cement leakage, which may contribute to better long-term spinal alignment and reduced risk of complications. Nevertheless, vertebroplasty remains a valuable, cost-effective option, particularly in patients where height restoration is less critical or resources are limited. Ultimately, selection of the appropriate procedure should be guided by a careful assessment of patient-specific anatomical characteristics, fracture morphology, clinical needs, and economic considerations to optimize both short- and long-term outcomes

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