J Orthop Spine Trauma. 2026 February; 12(1): 1-4. DOI: 10.18502/jost.v12i1.21115

Review Article

A Brief Review of Kyphoplasty Complications: Incidence, Risk Factors, and Prevention

Reza Yousefvand[1], Javad Moeini[2,*]

[1] MD Candidate, Center for Orthopedic Trans-Disciplinary Applied Research, Tehran University of Medical Sciences, Tehran, Iran
[2] Spine Surgery Fellowship, Department of Orthopedic Surgery, School of Medicine, Iran University of Medical Sciences, Tehran, Iran

[*]Corresponding author: Javad Moeini; Department of Orthopedic Surgery, School of Medicine, Iran University of Medical Sciences, Tehran, Iran. Tel: +98-21-33542001
Email: saeenmedicine@gmail.com

Received: 11 August 2025; **Revised:** 15 October 2025; **Accepted:** 17 November 2025

Abstract

Kyphoplasty is a minimally invasive procedure primarily used for the treatment of osteoporotic vertebral compression fractures (VCFs), traumatic fractures, and spinal involvement due to metastatic cancer. Even though kyphoplasty is generally regarded as a safe intervention, physicians should be aware of its potentially serious complications, although they are rare, especially considering the high number of patients who have the procedure done each year. This study aims to review the most significant complications related to kyphoplasty, along with their incidence, risk factors, and preventive strategies. We reviewed relevant articles from PubMed, Google Scholar, and credible sources to write this article. Cement leakage and adjacent vertebral fractures (AVFs) –the latter being the most frequent –are two of the most serious side effects. There are several ways that cement leakage can occur, including paravertebral (the most common), epidural, intradiscal, pulmonary embolism (PE), and foraminal leakage. It has been demonstrated that the eggshell technique, directional balloon placement, high-viscosity cement, and smaller cement volumes all lower the chance of cement leakage. Two important risk factors for AVFs are intradiscal cement leakage and preexisting osteoporosis in nearby vertebrae. Thus, managing these two elements could help avoid this issue. Achieving the best therapeutic results requires understanding the potential side effects of kyphoplasty and implementing effective management and prevention techniques.

Keywords: Kyphoplasty; Postoperative Complications; Compression Fractures; Secondary Prevention; Risk Factors; Bone Cements

Citation: Yousefvand R, Moeini J. **A Brief Review of Kyphoplasty Complications: Incidence, Risk Factors, and Prevention.** *J Orthop Spine Trauma* 2026; 12(1): 1-4.

Background

Kyphoplasty is a minimally invasive procedure designed to restore vertebral body height and reduce the associated kyphotic deformity. In kyphoplasty, an inflatable balloon tamp is inserted into the collapsed vertebra under imaging guidance. The balloon is inflated to create a cavity. After that, acrylic bone cement is poured into the cavity to preserve the correction and stabilize the bone (1-5). Kyphoplasty is an extension of vertebroplasty that offers several advantages, including reduced cement extravasation, improved restoration of vertebral body height, and greater reduction of kyphotic angle. However, vertebroplasty has been proven to be more effective in pain reduction (3, 6, 7).

Kyphoplasty is commonly indicated for osteoporotic vertebral compression fractures (VCFs), traumatic fractures, and malignancy-related fractures (e.g., multiple myeloma or metastatic disease) (1, 8-12). VCFs are prevalent in the elderly, particularly postmenopausal women (13), and spinal metastases are an increasing concern in patients with cancer (14). Thousands of kyphoplasty procedures have been documented across numerous studies and patient populations, according to systematic reviews and extensive meta-analyses (10, 12, 14). Even though the majority of kyphoplasty complications are silent, clinicians should be highly aware of any potential side effects (15).

This review aims to examine the most significant complications following kyphoplasty, their incidence, clinical relevance, associated risk factors, and strategies for their prevention.

Methods

A selective search of PubMed, Google Scholar, and credible medical websites was conducted to identify relevant literature on kyphoplasty complications, risk factors, and preventive strategies. Search terms included combinations of keywords such as "kyphoplasty", "complications", "risk factors", "cement leakage", "adjacent fractures", "prevention", and "compression fracture". English-language publications, original research studies (clinical trials, observational studies), and review articles concentrating on kyphoplasty results were the requirements for inclusion. Studies with insufficient data and articles that were not primarily about kyphoplasty complications were among the exclusion criteria. Selected articles were screened based on titles and abstracts, followed by full-text reviews to ensure relevance. No systematic methodology was applied.

Risk Factors for Symptomatic Complications: Although research indicates that kyphoplasty is a reasonably safe procedure, even its rare complications can carry significant potential risks. It has been estimated that kyphoplasty has an overall complication rate of less than 4% (16, 17). The timing of the procedure relative to the vertebral fracture is a crucial factor in reducing the risk of complications after kyphoplasty. Research shows that kyphoplasty patients who receive treatment within eight weeks of the fracture have fewer complications, while those who receive treatment after more than twelve weeks typically have more complications. Furthermore, patients with osteoporotic fractures typically experience fewer kyphoplasty complications than those with cancer-related

metastatic fractures. Additionally, the shape of the fracture can significantly impact the risk of adverse events. Individuals with wedge fractures represent a lower incidence of complications compared to those with biconcave or crush fractures (17).

Cement Leakage: Cement leakage is one of the most important complications associated with kyphoplasty and vertebroplasty. The use of a balloon and the cavity it creates within the vertebral body are the primary reasons why kyphoplasty has a lower incidence of cement leakage compared to vertebroplasty. This process enables the application of more viscous cement at a significantly lower pressure than is required for vertebroplasty (18). Cement leakage has been reported at about 41% for vertebroplasty and 9% for kyphoplasty (10). Furthermore, the overall cement leakage rate following kyphoplasty, as confirmed by radiography, is roughly 6.9% (19).

Although cement leakage after kyphoplasty can occur in several anatomical locations, it most frequently happens in the paraspinal region, which is usually asymptomatic and accounts for approximately 48% of kyphoplasty leakages. Cement can also leak into the intervertebral disc space. This type of leakage can alter the disc's modulus of elasticity, leading to a transitional zone that increases the risk of adjacent vertebral fractures (AVFs). Roughly 38% of all observed cement leaks are of this type. Despite being less frequent, epidural leakage can result in mass effect and thermal damage to the spinal cord, which can cause symptoms associated with space-occupying lesions. It is estimated that approximately 11% of cement leakages following kyphoplasty are epidural leakages. Pulmonary embolisms (PEs) resulting from cement leakage are very uncommon and have been observed in only 1.5% of such cases. After this type of leakage, thoracic surgery is rarely necessary; supportive care is usually used to manage it. Foraminal leakage may also occur although its incidence is low - similar to that of PE - accounting for approximately 1.5% of cement leakages following kyphoplasty. It is often observed in patients who continue to report localized pain after cement injection (2).

Minimizing the Risk of Cement Leakage: The risk of cement leakage following kyphoplasty can be successfully reduced by taking steps like using high-viscosity polymethylmethacrylate (PMMA) cement, minimizing cement volumes, applying the "eggshell" technique, and utilizing the directional balloon technique. The eggshell technique, as illustrated in figure 1, involves inserting the balloon into the vertebral body, inflating it with 1 ml of volume, then deflating and removing it.

The cavity is then filled with a tiny quantity of doughy cement. The balloon is then put back in, inflated, and secured. An eggshell cavity is created around the balloon as the cement that was first injected starts to polymerize. When the cement hardens, inflation continues to exceed 1 ml until the balloon reaches a maximum pressure of 200 pound per square inch (psi) or its maximum size-dependent volume. The preformed area is then filled with the remaining cement (19-21).

AVFs: AVFs are the most frequent complications after kyphoplasty (Figure 2). After vertebroplasty, up to 12.4% of patients experience VCF within two years. The incidence of this type of fracture after kyphoplasty is lower than that of vertebroplasty because of the correction of kyphotic deformity (19, 22, 23). Intradiscal cement leakage and the presence of osteoporosis in other vertebrae, such as secondary osteoporosis induced by corticosteroid use, are two significant risk factors for these fractures (19, 24, 25).

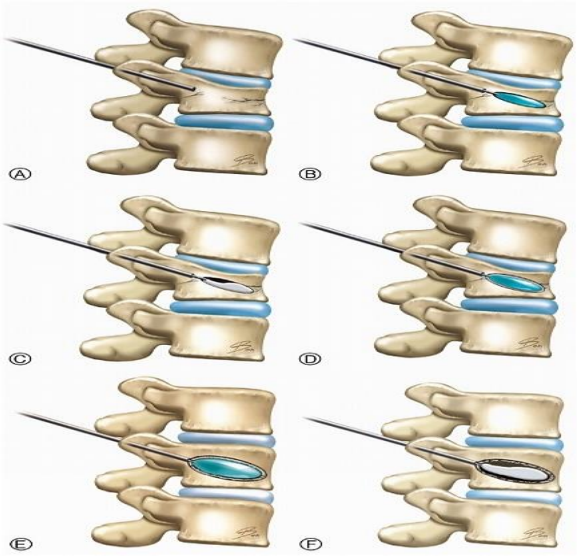

Figure 1. Step-by-step illustration of the eggshell technique. A) Insertion of working cannulas and inflatable bone tamps (IBTs) between the vertebral endplates; B) Initial inflation of balloons until a 1-ml volume is achieve; C) Injection of a small volume of polymethylmethacrylate (PMMA) cement into the created space; D) Reinflation of the balloons to press the cement against the endplates, forming an "eggshell-like" structure; E) After cement hardening, further balloon inflation is continued up to 200 psi or the maximum balloon capacity; F) Final PMMA injection into the cavity under continuous lateral fluoroscopic guidance [Adapted from Lee et al. (21) licensed under CC BY 4.0]

Thus, two important methods for lowering the risk of AVFs are stopping cement leakage and appropriately treating osteoporosis. In addition to these two measures, a balanced diet high in calcium and vitamin D, weight-bearing activities, and fall prevention techniques are just a few examples of specific lifestyle changes that can help lower the risk of further fractures. For those who are more susceptible to osteoporosis, these adjustments are especially crucial (26).

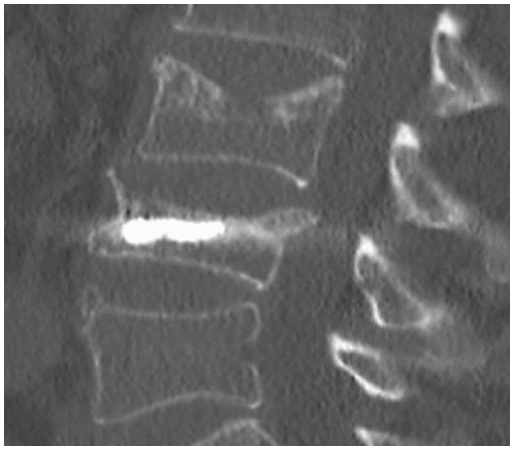

Figure 2. Sagittal computed tomography (CT) scan demonstrating an adjacent segment fracture (ASF) in the superior vertebral body following kyphoplasty [Adapted from Aboud et al. (27) licensed under CC BY 4.0]

Postoperative Pain Management: Kyphoplasty typically results in substantial relief of back pain associated with VCFs; however, some patients still have persistent or recurrent pain after the procedure. It has been demonstrated that local injections of anesthetics and corticosteroids can improve postoperative functional outcomes and reduce pain in the short term (28). After the

procedure, standard analgesics can also be given right away. Research suggests that as pain goes away, people tend to take fewer of these medications over time (29). Applying heat or ice can help control postoperative pain in addition to pharmacological management (26).

Challenges and Future Directions

Since cement leakage is important and can have serious repercussions, more research is required to create biocompatible cements with less extravertebral penetration and to improve early leak detection using cutting-edge imaging methods. Reducing the risk of AVFs is another significant challenge in this area that calls for more research. Promising directions for future research include kyphoplasty combined with osteoporosis management treatments and concurrent reinforcement of neighboring vertebrae during the procedure. Additionally, studies have begun to use artificial intelligence (AI) to forecast the location and magnitude of cement leakage and nearby fractures, as well as to evaluate the risk-benefit ratio for specific patients (30-33). It is recommended that future systematic reviews and meta-analyses carefully evaluate and compare these AI-based tactics. More advanced algorithms can be developed to identify high-risk patients, optimize patient selection, and personalize procedural approaches by integrating risk factors, clinical parameters, imaging results, and surgical outcomes and complications. Another issue seen in this field is the lack of clinical trials assessing the efficacy of physical therapy and rehabilitation following the procedure for pain relief and functional recovery. To develop precise and standardized physiotherapy protocols as a component of the treatment plan going forward, more controlled clinical studies should be planned and carried out.

Conclusion

Although kyphoplasty is a safe and efficient treatment for metastatic spinal lesions and VCFs, it is important to take into account potential side effects like cement leakage and nearby vertebral fractures. The risk of adverse events is greatly influenced by fracture morphology, the underlying indication for the procedure, and the time between fracture occurrence and kyphoplasty. Cement leakage –most commonly paraspinal –can be minimized by using high-viscosity cement, the eggshell technique, and controlled injection. Disc leakage and osteoporosis in nearby vertebrae are two leading causes of AVFs. Postoperative pain may occur, but is usually manageable. Further research is needed to identify predictors and improve long-term outcomes.

Conflict of Interest

The authors declare no conflict of interest in this study.

Acknowledgements

The author would like to express sincere gratitude to Dr. Mohammad Hossein Nabian, the founder of the Center for Orthopedic Trans-Disciplinary Applied Research, Tehran University of Medical Sciences, Tehran, Iran, for his support in facilitating the completion of this project. Appreciation is also extended to the Center for providing an academic environment that enabled the development of this review.

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

References

1. Dudeney S, Lieberman IH, Reinhardt MK, Hussein M. Kyphoplasty in the treatment of osteolytic vertebral compression fractures as a result of multiple myeloma. *J Clin Oncol*. 2002;20(9):2382-7. doi: 10.1200/jco.2002.09.097. [PubMed: 11981012].
2. Hardouin P, Fayada P, Leclet H, Chopin D. Kyphoplasty. *Joint Bone Spine*. 2002;69(3):256-61. doi: 10.1016/s1297-319x(02)00390-1. [PubMed: 12102271].
3. Lieberman I, Reinhardt MK. Vertebroplasty and kyphoplasty for osteolytic vertebral collapse. *Clin Orthop Relat Res*. 2003(415 Suppl):S176-86. doi: 10.1097/01.blo.0000093841.72468.a8. [PubMed: 14600608].
4. Norton RP. Kyphoplasty Cement Augmentation Technique. In: Razi AE, Hershman SH, Editors. Vertebral Compression Fractures in Osteoporotic and Pathologic Bone: A Clinical Guide to Diagnosis and Management. Cham, Switzerland: Springer International Publishing; 2020. p. 137-43.
5. Voormolen MH. Kyphoplasty. *Neuroradiology*. 2011;53(Suppl 1):S203-5. doi: 10.1007/s00234-011-0927-2. [PubMed: 21863432].
6. Eck JC, Nachtigall D, Humphreys SC, Hodges SD. Comparison of vertebroplasty and balloon kyphoplasty for treatment of vertebral compression fractures: A meta-analysis of the literature. *Spine J*. 2008;8(3):488-97. doi: 10.1016/j.spinee.2007.04.004. [PubMed: 17588820].
7. Gu CN, Brinjikji W, Evans AJ, Murad MH, Kallmes DF. Outcomes of vertebroplasty compared with kyphoplasty: a systematic review and meta-analysis. *J Neurointerv Surg*. 2016;8(6):636-42. doi: 10.1136/neurintsurg-2015-011714. [PubMed: 25964376].
8. Hulme PA, Krebs J, Ferguson SJ, Berlemann U. Vertebroplasty and kyphoplasty: a systematic review of 69 clinical studies. *Spine (Phila Pa 1976)*. 2006;31(17):1983-2001. doi: 10.1097/01.brs.0000229254.89952.6b. [PubMed: 16924218].
9. Moura DL. The role of kyphoplasty and expandable intravertebral implants in the acute treatment of traumatic thoracolumbar vertebral compression fractures: a systematic review. *EFORT Open Rev*. 2024;9(4):309-22. doi: 10.1530/eor-23-0190. [PubMed: 38579781]. [PubMed Central: PMC11044091].
10. Sørensen ST, Kirkegaard AO, Carreon L, Rousing R, Andersen M. Vertebroplasty or kyphoplasty as palliative treatment for cancer-related vertebral compression fractures: a systematic review. *Spine J*. 2019;19(6):1067-75. doi: 10.1016/j.spinee.2019.02.012. [PubMed: 30822527].
11. Wu W, Zhang X, Li X, Liu H, Yu S. Clinical Evaluation of Percutaneous Kyphoplasty for the Management of Osteoblastic-Related Metastatic Vertebral Lesions. *Acad Radiol*. 2022;29(Suppl 3):S183-s7. doi: 10.1016/j.acra.2021.08.015. [PubMed: 34561162].
12. Zhang Y, Ge J, Liu H, Niu J, Wang S, Shen H, et al. Kyphoplasty is associated with reduced mortality risk for osteoporotic vertebral compression fractures: a systematic review and meta-analysis. *Eur Spine J*. 2024;33(4):1490-7. doi: 10.1007/s00586-023-08032-5. [PubMed: 38062266].
13. Zhang JD, Poffyn B, Sys G, Uyttendaele D. Comparison of vertebroplasty and kyphoplasty for complications. *Orthop Surg*. 2011;3(3):158-60. doi: 10.1111/j.1757-7861.2011.00141.x. [PubMed: 22009645]. [PubMed Central: PMC6583283].
14. Klimo P, Jr., Schmidt MH. Surgical management of spinal metastases. *Oncologist*. 2004;9(2):188-96. doi: 10.1634/theoncologist.9-2-188. [PubMed: 15047923].
15. Suresh SP, Whitehouse RW. Vertebroplasty and kyphoplasty. *J Br Menopause Soc*. 2005;11(1):28-32. doi: 10.1258/1362180053654538. [PubMed: 15814060].
16. Wong CC, McGirt MJ. Vertebral compression fractures: a review of current management and multimodal therapy. *J Multidiscip Healthc*. 2013;6:205-14. doi: 10.2147/jmdh.S31659. [PubMed: 23818797]. [PubMed Central: PMC3693826].
17. Levin R. Kyphoplasty Risks and Potential Complications: spine-health [Online]. [updated 2018 Oct 18]. Available from: URL: https://www.spine-

health.com/treatment/back-surgery/kyphoplasty-risks-and-potential-complications#footnote1.
18. Medical Advisory Secretariat. Balloon kyphoplasty: an evidence-based analysis. *Ont Health Technol Assess Ser*. 2004;4(12):1-45. [PubMed: 23074451]. [PubMed Central: PMC3387743].
19. Robinson Y, Tschöke SK, Stahel PF, Kayser R, Heyde CE. Complications and safety aspects of kyphoplasty for osteoporotic vertebral fractures: a prospective follow-up study in 102 consecutive patients. *Patient Saf Surg*. 2008;2:2. doi: 10.1186/1754-9493-2-2. [PubMed: 18271950]. [PubMed Central: PMC2248169].
20. Greene DL, Isaac R, Neuwirth M, Bitan FD. The eggshell technique for prevention of cement leakage during kyphoplasty. *J Spinal Disord Tech*. 2007;20(3):229-32. doi: 10.1097/01.bsd.0000211276.76024.30. [PubMed: 17473643].
21. Lee J, Gwak H, Lee S-H, Joo J, Kwon J-W, Yoo H, et al. Double Sequential Ballooning (Eggshell) Method for Treatment of Severe Metastatic Compression Fractures with Extra-Compartment Involvement: In Comparison with Conventional Balloon Kyphoplasty. *Nerve*. 2018;4(2):42-9. doi: 10.21129/nerve.2018.4.2.42.
22. Uppin AA, Hirsch JA, Centenera LV, Pfiefer BA, Pazianos AG, Choi IS. Occurrence of new vertebral body fracture after percutaneous vertebroplasty in patients with osteoporosis. *Radiology*. 2003;226(1):119-24. doi: 10.1148/radiol.2261011911. [PubMed: 12511679].
23. Lunt M, O'Neill TW, Felsenberg D, Reeve J, Kanis JA, Cooper C, et al. Characteristics of a prevalent vertebral deformity predict subsequent vertebral fracture: results from the European Prospective Osteoporosis Study (EPOS). *Bone*. 2003;33(4):505-13. doi: 10.1016/s8756-3282(03)00248-5. [PubMed: 14555253].
24. Komemushi A, Tanigawa N, Kariya S, Kojima H, Shomura Y, Komemushi S, et al. Percutaneous Vertebroplasty for Osteoporotic Compression Fracture: Multivariate Study of Predictors of New Vertebral Body Fracture. *Cardiovasc Intervent Radiol*. 2006;29(4):580-5. doi: 10.1007/s00270-005-0138-5.
25. Harrop JS, Prpa B, Reinhardt MK, Lieberman I. Primary and secondary osteoporosis' incidence of subsequent vertebral compression fractures after kyphoplasty. *Spine (Phila Pa 1976)*. 2004;29(19):2120-5. doi: 10.1097/01.brs.0000141176.63158.8e. [PubMed: 15454702].
26. Physiopedia Contributors. Kyphoplasty [Online]. Physiopedia. 2024. Available from: URL: https://www.physio-pedia.com/index.php?title=Kyphoplasty&oldid=356042.
27. Aboud N, Eckardt N, Kamp MA, Senft C, Schwarz F. Occurrence of adjacent segment fractures after surgical treatment of an osteoporotic vertebral fracture: a retrospective comparison between two different treatment methods. *Arch Orthop Trauma Surg*. 2023;143(5):2333-9. doi: 10.1007/s00402-022-04434-0. [PubMed: 35403864]. [PubMed Central: PMC10110682].
28. Lin F, Zhang Y, Wu T, Niu Y, Su P, Hua J, et al. Local Anesthetic and Steroid Injection to Relieve the Distal Lumbosacral Pain in Osteoporotic Vertebral Compression Fractures of Patients Treated with Kyphoplasty. *Pain Physician*. 2022;25(4):E581-e7. [PubMed: 35793182].
29. Grafe IA, Da Fonseca K, Hillmeier J, Meeder PJ, Libicher M, Nöldge G, et al. Reduction of pain and fracture incidence after kyphoplasty: 1-year outcomes of a prospective controlled trial of patients with primary osteoporosis. *Osteoporos Int*. 2005;16(12):2005-12. doi: 10.1007/s00198-005-1982-5. [PubMed: 16078092].
30. Xi Y, Chen R, Wang T, Zang L, Jiao S, Xie T, et al. Deep learning-based multimodal image analysis predicts bone cement leakage during percutaneous kyphoplasty: protocol for model development, and validation by prospective and external datasets. *Front Med (Lausanne)*. 2024;11:1479187. doi: 10.3389/fmed.2024.1479187. [PubMed: 39364028]. [PubMed Central: PMC11446777].
31. Zhang A, Fu H, Wang J, Chen Z, Fan J. Establishing a nomogram to predict refracture after percutaneous kyphoplasty by logistic regression. *Front Neuroinform*. 2023;17:1304248. doi: 10.3389/fninf.2023.1304248. [PubMed: 38187823]. [PubMed Central: PMC10767997].
32. Jiang LM, Tong YX, Jiang JJ, Pi YW, Gong Y, Tan Z, et al. The vertebral Hounsfield units can quantitatively predict the risk of adjacent vertebral fractures after percutaneous kyphoplasty. *Quant Imaging Med Surg*. 2023;13(2):1036-47. doi: 10.21037/qims-22-588. [PubMed: 36819268]. [PubMed Central: PMC9929385].
33. Zhao Y, Bo L, Qian L, Chen X, Wang Y, Cui L, et al. Kissing Spine and Other Imaging Predictors of Postoperative Cement Displacement Following Percutaneous Kyphoplasty: A Machine Learning Approach. *World Neurosurg*. 2025;201:124322. doi: 10.1016/j.wneu.2025.124322. [PubMed: 40712848].