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Review Article

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Pain Intervention for Osteoporotic Compression Fracture, From Physical Therapy to Surgery: A Literature Review

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ABSTRACT

Osteoporotic vertebral compression fractures (OVCF) significantly contribute to increased morbidity and mortality in aging populations. When adjusted for age, South Korea has the highest global prevalence of OVCF, with rates of 544 per 100,000 men and 1,575 per 100,000 women. Moreover, patients with OVCF are at a heightened risk of additional fractures, with the risk of new vertebral fractures being up to 5-fold higher. Therefore, in treating patients with OVCF, it is essential to address the current symptoms and take preventive measures against further fractures. Although pharmacological treatment is crucial, it may be insufficient for all patients with OVCF, with more severe cases often requiring physical therapy or surgical intervention. This review aimed to explore effective physical therapy methods for patients with OVCF and summarize surgical techniques for high-risk older patients with various underlying conditions.

Keywords: Osteoporosis; Osteoporotic fractures; Vertebra; Surgery

INTRODUCTION

Osteoporotic vertebral compression fractures (OVCF) are a major cause of morbidity and mortality in aging populations.[14] Research has shown that 1 in 5 women with vertebral fractures will experience a re-fracture within a year, with a mortality rate approximately 2.7 times higher than those without fractures.[19] Globally, age-standardized data shows that South Korea has the highest prevalence of OVCF (544/100,000 men, 1,575/100,000 women), followed by the United States (707/100,000 men, 1,083/100,000 women) and Hong Kong (202/100,000 men, 764/100,000 women).[3] A nationwide study using the Korean Health Insurance Review and Assessment Service database reported that the total number of OVCF cases in South Korea from 2012 to 2016 was 644,500, with a gradual increase from 117,361 cases in 2012 to 139,889 cases in 2016.[8] Additionally, patients with OVCF have a higher risk of additional fractures, with the risk of new vertebral fractures being up to 5-fold higher.[24] Therefore, in treating patients with OVCF, it is essential to address the current symptoms and take measures to prevent further fractures.

Informed Consent
This type of study does not require informed consent.

Ethics Approval
This research did not require ethical approval as it does not involve human subjects, their data, or biological samples.

Pharmacological therapy forms the foundation for OVCF treatment. Recent studies have shown promising clinical outcomes with the use of anabolic agents (teriparatide or romosozumab).[18,53] However, pharmacological treatment alone remains insufficient for all patients with OVCF, with more severe cases often requiring physical therapy or surgical intervention. This literature review aimed to explore effective physical therapy options for patients with OVCF and summarize surgical techniques applied to high-risk older patients with various underlying conditions.

BED REST AND BRACE

Bed rest and the use of back braces are often recommended to prevent fractures from worsening and to reduce pain.[25] However, four major guidelines (American Academy of Orthopedic Surgeons, National Institute for Health and Care Excellence, Canadian Association of Radiologists, and American College of Radiology) for treating OVCF either do not recommend bed rest and bracing or suggest only weak supporting evidence.[11,29,35,40]

However, in a study comparing patients who underwent 1 week of bed rest to those who engaged in early ambulation, no significant difference in clinical outcomes was observed between the two groups. Moreover, the group that engaged in early ambulation experienced fewer bed rest-associated complications such as constipation, urinary tract infections, urinary retention, and respiratory issues, including coughing and sputum.[25]

Another study, which compared four cohorts of patients with OVCF (custom hard brace, custom elastic brace, ready-made elastic brace, and no brace), found that bracing was not a positive modifier of physical and mental functional outcomes. Additionally, bracing can cause side effects in older patients, including pressure sores, diminished pulmonary capacity, and weakening of the axial musculature.[7]

Therefore, minimizing bed rest and encouraging early ambulation along with physical therapy should be prioritized in treating OVCF. If bracing is applied, it should be for a limited period, with close monitoring for potential complications.

PHYSICAL THERAPY

A study involving nine young men with an average age of 33.1 years found that 60 days of bed rest led to a decrease in the paraspinal muscle, increasing the incidence of back pain.[4] Additionally, 7 days of complete bed rest can reduce leg muscle volume by approximately 3.0%.[12] Although these studies were conducted in young men, it is expected that the muscle atrophy caused by bed rest in older women with OVCF would be even more severe.

Muscle atrophy-associated paraspinal muscle fatty degeneration has been identified as an important predictor of progressive collapse in patients with OVCF (β=0.724, p=0.000).[20] Severe muscle atrophy can lead to vertebral body collapse, causing prolonged pain in these patients.

Although severe pain in patients with OVCFs may require prolonged bed rest, extended bed rest may accelerate muscle atrophy, exacerbating pain and decreasing quality of life (QOL). Therefore, physical therapy aimed at preventing muscle atrophy is crucial in treating patients

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with OVCF, alongside pharmacological therapy for osteoporosis. Specifically, exercises targeting muscles, such as back extensor muscles, are crucial for maintaining posture. Hyperkyphosis, associated with a lack of back extensor muscles, is highly correlated with falls and additional vertebral fractures.[14,17,21,22,44]

For older patients with osteoporotic vertebral fractures, the recommended exercise is a combination of resistance and balance training. Aerobic exercise alone is not recommended,[14] as it may not be sufficient to prevent falls or fractures. Therefore, healthcare providers should emphasize the importance of resistance and balance exercises in patients with osteoporosis or osteoporotic vertebral fractures.[10]

Resistance training, defined as "applying resistance to muscles to overload them, thereby producing a training effect on the muscular system," can be provided using bands, cables, dumbbells, or body weight. It is recommended to perform at least one exercise for each major muscle group, completing two sets of 8–12 repetitions per set. Balance training is defined as efficiently shifting the body weight from one part of the body to another or challenging specific aspects of the balance system. Balance exercises should be performed for approximately 2 hours per week, which can be divided into 15–20 minutes per day. A review of the literature on resistance and balance exercises has provided valuable insights for clinicians treating patients with OVCF (**TABLE 1**).[13,14,16,38,43,45]

MEDIAL BRANCH SPINAL NERVE BLOCK

Medial branch spinal nerve block (MBB) is employed to alleviate back pain in patients with OVCF by injecting local anesthetics, with or without steroids, into the medial branches of the dorsal rami of the spinal nerves.[2,47]

In a retrospective study comparing MBB and percutaneous vertebroplasty (PVP) in patients with single-level OVCF, both treatments showed similar levels of pain reduction at 1, 3, 12, and 24 months. Although MBB was superior to PVP in terms of procedure-related complications, the progression of compression fractures was slower in the PVP group in the first month.[2]

A two-arm feasibility randomized controlled study published in 2023 evaluated functional disability, pain reduction, QOL, activities of daily living, and pain medication usage in frail, hospitalized older patients with OVCF who underwent MBB (n=13) or PVP (n=14); outcomes were comparable between both groups up to 8 weeks post-procedure.[47]

TABLE 1. Balance and resistance exercises for patients with osteoporotic vertebral compression fracture

Type	Methods	Recommendations
Balance exercise	· One-legged stand · Tandem or semi-tandem stand · Standing on heels or toes only · Walking on heels or toes only · Walking backwards · Sit to stand or squat · Tandem walk	· Exercise for 15–20 minutes per day, accumulating 2 hours per week. · Can be done in short sessions throughout the day or integrated into daily activities.
Resistance exercise	· Upright row for upper back strength and posture · Diagonal lift for lower back strength · Chest press and biceps curl for upper limb strength	· Perform at least 2 days a week. · Perform 2 sets per exercise with 8–12 repetitions.*

*If more than 12 repetitions can be performed, the exercise is too easy. If fewer than 8 repetitions can be performed, the exercise is too hard.

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Although further research on the MBB is needed, considering currently available studies, MBB is expected to be a viable alternative to PVP for managing acute pain in older patients with OVCF who have risk factors.

VERTEBRAL AUGMENTATION

Vertebral cement augmentation involves injecting polymethyl methacrylate (PMMA) into the vertebral body through a pedicle and includes procedures such as PVP and kyphoplasty (KP).[41] It is typically indicated for severe pain due to acute OVCF of less than 2–3 months. Contraindications for this procedure include vertebral body infection, allergy to bone fillers, radiculopathy or myelopathy, and >70% compression.[15,41]

In prospective studies published in 2009, no significant difference in clinical outcomes was reported between patients with OVCF who underwent PVP and those who underwent a sham procedure.[6, 23] However, subsequent studies have shown that in patients with severe pain due to acute fractures, cement augmentation provides better pain relief than conservative treatment.[5,9,32] Many studies comparing PVP and KP have reported that both procedures produce similar levels of clinical improvement.[15] PVP has the advantage of being easier and safer to perform than PVP, as it can be performed using thinner-gauge needles. However, PVP is less effective in restoring vertebral body height and correcting kyphotic deformities. In contrast, KP has a lower rate of cement leakage (approximately 8% compared to 40% in PVP) and is more effective for height and angle correction. Despite these benefits, KP has a higher overall complication rate compared to PVP, as well as a higher incidence of additional postoperative vertebral compression fractures.[31,48]

Complications from vertebral augmentation include cement leakage (extravasation), adjacent vertebral fractures, cement embolism, infection, and neurologic deficiency.[1,15,34] Leakage can occur into the disc, paravertebral, or epidural space, with epidural leakage posing a rare but serious risk of neurologic deficits.[34] To minimize the risk of extravasation, clinicians may inject small amounts of cement (0.2–0.5 mL) at a time, use high-viscosity cement, and conduct regular evaluations through fluoroscopic imaging.[52] Approximately 20% of patients experience adjacent vertebral fractures within 1 year after vertebral augmentation, with the risk being higher in cases with intradiscal cement leakage.[1]

Recently, a procedure known as titanium-implantable vertebral augmentation device (TIVAD), which involves inserting titanium devices into the vertebral body, followed by injection of PMMA, was introduced. Compared to KP, TIVAD has shown better clinical outcomes in terms of pain reduction and a lower incidence of adjacent vertebral fractures. However, further comparative studies of PVP and KP are needed.[39,49]

SURGICAL TREATMENT

Surgical intervention is required for patients with OVCF who present with kyphosis, neurological deficits, deformities, unstable fractures, or persistent pain that does not respond to conservative treatment or vertebral augmentation.[30] Surgical options include anterior, posterior, and combined anterior-posterior approaches.

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Anterior surgery

The primary advantage of anterior surgery is its ability to directly remove the fractured fragments from the vertebral body and insert a supportive graft from the front. This approach facilitates direct decompression and kyphosis correction while preserving the posterior structures for spinal stability.[30,51]

However, in patients with OVCF, due to fragile bones, the incidence of worsening kyphosis or hardware loosening is up to 30%. Therefore, additional posterior surgery is frequently required to achieve successful outcomes.[36,42,46] Additionally, anterior surgery requires a thoracotomy or retroperitoneal approach, which increases the surgical risk in older patients with multiple comorbidities and poor overall health.[26]

Therefore, anterior surgery is a good option for patients with OVCF who require single-level fixation, have relatively less severe osteoporosis, and have fewer comorbidities.

Posterior surgery

Posterior surgery is currently the most commonly performed procedure for patients with OVCF. For most spine surgeons, it is a familiar technique and less invasive than anterior surgery, as it does not require manipulation of thoracoabdominal organs or major vessels.[30] The posterior approach is particularly more beneficial for maintaining post-surgical stability in patients with multi-segmental fractures or severe osteoporosis. However, it may not provide sufficient decompression in cases of severe vertebral body collapse or significant spinal cord compression caused by large fracture fragments.

Indirect decompression can be achieved through the ligamentotaxis effect using posterior instrument distraction.[27] Additionally, excellent clinical outcomes can be obtained with short-segment fusion using spinous process plates and pedicle screws.[37] Lee et al.[28] reported that in patients with OVCF, transpedicular intravertebral cage insertion during posterior surgery alone can support the anterior column, resulting in a less invasive procedure with effective kyphosis angle correction (**FIGURE 1**).

Given that patients with OVCF are often elderly and have multiple comorbidities, the development of minimally invasive techniques in posterior surgery will make it a more suitable choice.

Combined anterior and posterior surgery

A combination of anterior support and posterior instrumentation can provide optimal biomechanical results, which are challenging to achieve with either anterior or posterior surgery alone.[30] Anterior surgery allows for kyphosis correction and decompression, while posterior surgery adds further decompression and screw fixation (**FIGURE 2**). Studies have shown that combined surgery is superior to posterior surgery alone in terms of reducing mechanical complications and maintaining correction rates.[33,50]

However, this combined approach is relatively more invasive, which increases the risk of intraoperative bleeding and postoperative complications,[46] limiting its use in older patients with multiple comorbidities.

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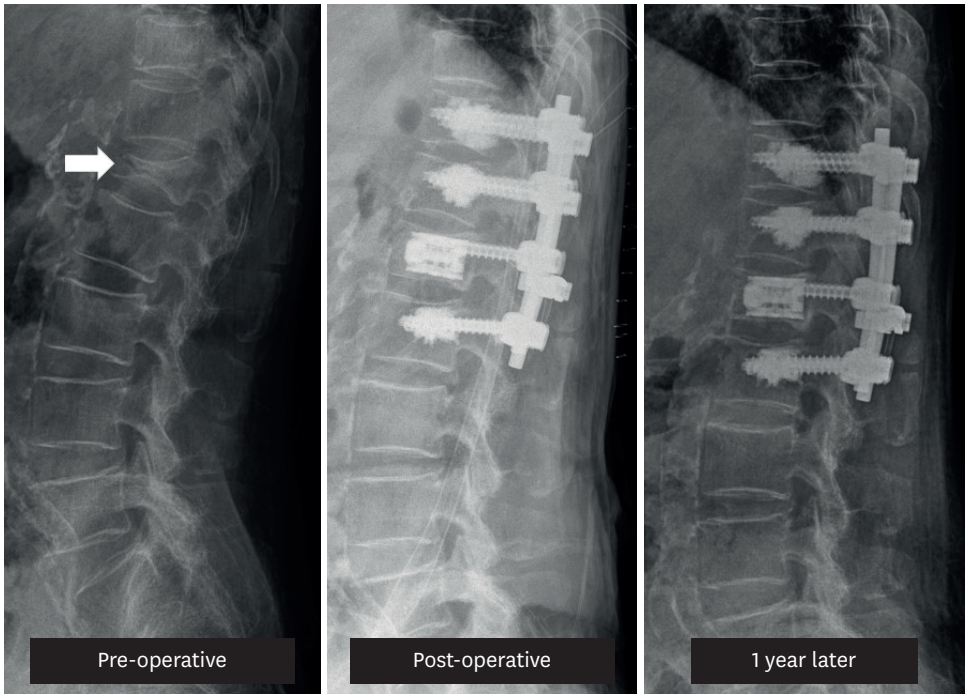

FIGURE 1. A case of transpedicular intravertebral cage insertion.
A transpedicular intravertebral cage insertion was performed for an osteoporotic fracture at the L1 vertebra (indicated by a white arrow), and it has remained stable up to one year post-surgery.

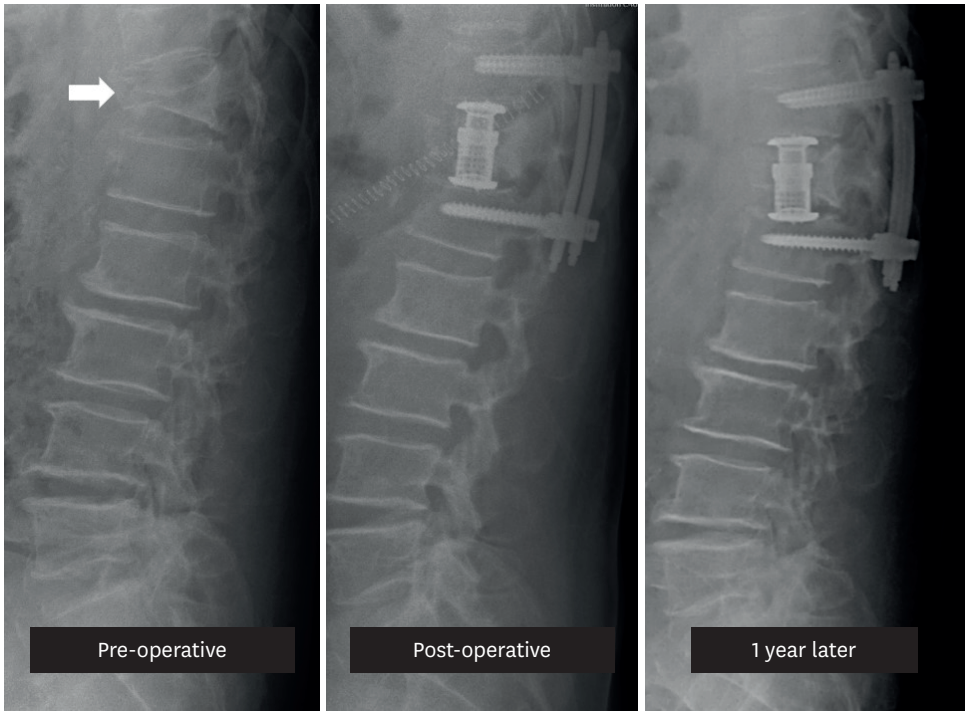

FIGURE 2. A case of combined anterior and posterior surgery.
An anterior corpectomy with insertion of an expandable cage was performed for an osteoporotic fracture at the T12 vertebra (indicated by a white arrow), followed by the insertion of percutaneous posterior screw fixation. The surgical site has remained stable up to one year post-surgery.

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CONCLUSION

As the population ages, the number of patients with OVCF is rising. Surgeons should pay greater attention to physical therapy to reduce the risk of additional fractures. To minimize the morbidity and mortality associated with various comorbidities, it is essential for surgeons to be proficient in various surgical techniques and select the most appropriate treatment option for each patient. With such efforts, the successful treatment of patients with OVCF can be anticipated.

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