Review article

Non-surgical management of acute osteoporotic vertebral compression fracture: A review

Bhavuk Garg^a, Vivek Dixit^a, Sahil Batra^{a,*}, Rajesh Malhotra^a, Alok Sharan^b^a Department of Orthopaedics, All India Institute of Medical Sciences, New Delhi, India^b WESTMED Spine Centre, New York, NY, United States

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ABSTRACT

Osteoporosis is a major public health problem. Last decade has seen rise in osteoporotic vertebral fractures. Pragmatic management of osteoporotic VCF is challenging to the surgeons. In clinical settings, the situation becomes more complex when it comes to managing painful osteoporotic vertebral compression fractures (VCFs) due to various co-morbid factors that may limit aggressive interventions. Patients with Osteoporotic vertebral fractures are often characterized by general/relative immobility and physical frailty. Osteoporotic VCF not only affects the quality of life (e.g. pain) but also decreases the lifespan of the individual. The present review critically evaluates the currently prevailing non-surgical management modalities (conservative) offered in acute symptomatic osteoporotic VCFs that occur either within (0–5 days) of any incident event or present with the onset of symptoms such as pain.

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1. Introduction

Osteoporosis is becoming a major public health concern. With increasing life expectancy, the world demography is destined to change towards an elderly population, making senile osteoporosis a global challenge to tackle.

Osteoporosis is a systemic skeletal disorder in which the micro-architecture of the bone tissue gets deteriorated, leading to decreased bone mass, fragility, and thus increasing the risk of fractures. The magnitude of the problem is enormous as more than 10 million people (>50 years) were living with osteoporosis in USA alone as reported in 2004.¹ Out of 1.5 million osteoporotic fractures, half of them accounts towards vertebral fractures. The most common form of osteoporotic fracture is a vertebral compression fracture (VCF). However, only one third of vertebral compression fractures are symptomatic and present with pain.²

According to the European Vertebral Osteoporosis study, women are more prone to develop vertebral deformity than men which increase exponentially with age i.e. from 5% at 50 years to 25% at 75 years in women and from 10% to 18% in men.³ By 2020, it is projected that one in two American (over age 50) is likely to

have osteoporosis of the hip or osteoporosis at any other site in the skeleton.⁴

2. Clinical importance

A vertebral compression fracture (VCF) is characterized by decrease in height of at least 20% of anterior, posterior, or middle part of vertebra, or decrease of at least 4 mm of height as compared to baseline height (estimated based on vertebral body height of upper or lower vertebra).⁵

Unfortunately, the majority (two-third) of vertebral fractures are not diagnosed because they do not come to clinical attention. An osteoporotic vertebral fracture increases the possibility of future fracture risk irrespective of being symptomatic or asymptomatic in nature. There can be episodes of acute and chronic pain in these patients. Approximately, 1 in 5 men and women over 50 years of age have one or more vertebral fractures.⁵

3. Risk factors for osteoporotic vertebral fractures

- Age (above 50 years)⁶
- Sex (elderly women are at high risk than men)⁷
- Race/Ethnicity (higher risk in black women than white women)⁸
- Consumption of Alcohol (3 or More drinks/day)/current smoking
- History of taking drugs i.e. glucocorticoids, anti-thyroid medication, anti-tubercular medication

* Corresponding author.

E-mail address: sahilbatra25@gmail.com (S. Batra).

- Previous history of fracture (including morphometric fracture)
- Decrease in Height
- Decreased Body Mass Index (kg/m^2)
- Femoral neck BMD
- Rheumatoid Arthritis
- Secondary Osteoporosis
- Vitamin D deficiency
- Genetic history of vertebral fractures in first degree of relatives

The US National Osteoporosis Foundation in 2014 suggested that spine imaging should be considered into account for the following conditions (Table 1).

4. Clinical examination

- Postural changes (focal kyphosis and loss of lumbar lordosis)
- Decrease in height

5. Physical examination

- Weakness secondary to nerve root compression due to retro-pulsed bony fragment or narrowing of neural foramina.
- There will be positive straight leg raising test

6. Diagnosis

Imaging modalities for assessment of vertebral fractures

- Radiography (Anteroposterior and Lateral)
- Computerized tomography
- Magnetic resonance imaging
- Dual energy X-ray absorptiometry (DXA) for vertebral fracture assessment

Studies have shown that X-ray is the best diagnostic tool than CT for the recognition of vertebral fractures.¹⁰ While reporting the incidence of vertebral fracture, the clinical interpretation of spine imaging should be done in a clearly and decisive manner. Following points are useful in interpretation (identification and exclusion).

1. Quality of radiograph
2. Sign of malignancy, if any
3. Severity of fracture using standard methodology (grades i.e. mild, moderate and severe)
4. Location of fracture
5. Number of fracture
6. Identification of pathological fractures (e.g. those due to multiple myeloma, metastatic cancer or infection)
7. Fracture due to with or without trauma
8. History of congenital and developmental abnormalities.
9. Identification of bone edema on MRI

Table 1
Criteria for spine Imaging.

S.No.	Gender	Age (years)	BMD Region	T Score
1.	Women	≥ 70	LS Spine, femoral neck	≤ -1.0
2.	Men	≥ 80	LS Spine, femoral neck	≤ -1.0
3.	Women	65–69	LS Spine, femoral neck	≤ -1.5
4.	Men	70–79	LS Spine, femoral neck	≤ -1.5

(Adapted from National Osteoporosis Foundation)(2014).⁹

7. Static radiograph

Static radiographs (Fig. 1a) are used to identify the type of fracture, the location, and documenting any vertebral loss of body height. When the collapse is not evident, MRI can be used to confirm the diagnosis.

8. Dynamic radiograph (Flexion-extension views)

For patients who have a VCF the dynamic radiographs are not possible as immobilization is a priority. Relative position of vertebra from hyper flexion to hyperextension can also be determined using these radiographs. Vacuum clefts (gas like area of radiolucency) and change of kyphotic angle can be ruled out using dynamic radiograph. Dynamic radiographs are useful in detection of unstable vertebral fracture in which there is retropulsion of bony fragment. (Fig. 1b)

9. Bone scan and MRI

Both bone scan and MRI are useful tools to determine the time since compression fracture, especially when trauma and fall history is negative. If the fracture history/presentation is of less than 10 days, MRI will show decreased signal on T1 sequences and marrow edema on T2 fat-saturation at the site of fracture (Fig. 2) whereas Bone scan will not show a fracture.

Before labeling as VCF, pathological fracture must be ruled out. The presence of soft-tissue mass or pedicle involvement on MRI is usually suggestive of tumor. There will be multiple areas of increased radionuclide uptake due to metastatic lesions in vertebra which can be identified on a bone scan.

Additionally, a positron emission tomography scan with fluoride-18 deoxyglucose (FDG-PET) can differentiate between osteoporotic and pathological vertebral fracture due to a high FDG uptake.¹¹

10. FRAX assessment

Fracture risk assessment is important and helpful in the prediction of future fracture risk (next 10 year risk). A FRAX model is helpful in reviewing fracture risk assessment with or without BMD. The patient can pick a country under the Calculation Tool before them and access the FRAX tool (Fig. 3). A recent study shows that a pre-BMD FRAX score helps to find the postmenopausal patients who are at risk and might require treatment and also decreases unnecessary DXA use.

11. Classification

Although several classification systems of vertebral fracture are given, but the most commonly used classification system for VCF in clinical practice was described by Sugita et al.¹³ In this classification system there are 5 types of fractures identified on lateral radiographic views that distinguishes fracture with different prognosis (Table 2) (Fig. 4).

12. Predictors of vertebral fracture

A simple and feasible strategy to report an incident of vertebral fracture is to monitor a patient's height with a wall-mounted stadiometer. Siminoski et al. have shown that historical height loss >6 cm or measured height loss >2 cm followed over 1–3 years is highly predictive of an underlying vertebral fracture.¹⁴

Fig. 1. a- Collapse Osteoporotic Vertebral fracture. b- Demonstrating instability in Flexion-Extension view.

Fig. 2. Showing Psuedoarthrosis in D12 vertebral body.

13. Management

Conservative management of osteoporotic vertebral fractures patients comprises of Pain relief and Rehabilitation. Usually surgery is not required for all acute osteoporotic VCF unless, complicated by neurological deficit.

The goal of management should consider three aspects:

- Improvement of quality of life
- Assessment of risk-benefit ratio
- Cost-effectiveness

The management of acute VCF usually includes:

- Short-term bed rest
- Pain relief with medications
- Bracing
- Physical Therapy

13.1. Pain relief

The acute pain due to new vertebral fracture generally resolves within 6–12 weeks with analgesics. Analgesia can be started with acetaminophen or salicylates and non steroidal anti-inflammatory drugs (NSAIDs).¹⁵ Additionally; opioids can be used along with first line of medications in those patients who didn't experience relief from pain adequately.¹⁶

Fig. 3. WHO FRAX assessment tool.

(Adapted from FRAX[®]: Prediction of Major Osteoporotic Fractures in Women from the General Population.)¹²

Table 2
Classification of osteoporotic vertebral compression fractures.

S.No.	Types of vertebra	Shape	Characteristics	Prognosis
1.	Concave	Collapse of upper endplate without any fracture of the anterior wall	Short painful period & rapid healing	Good
2.	Dented	Fracture line interrupt the anterior wall	Short painful period & rapid healing	Good
3.	Swelled front	Anterior wall is convex anteriorly by more than 50%	Significant bone loss, painful, slow healing	Poor
4.	Bow shaped	Collapse of upper end plate with anterior wall is pinched inwards	Significant bone loss, painful, slow healing	Poor
5.	Projecting	Anterior wall is convex anteriorly by less than 50%	Significant bone loss, painful, slow healing	Poor

The role of muscle relaxant may be helpful in the management of painful paravertebral muscle spasms and they are significantly beneficial in the initial 1 or 2 weeks of treatment. Muscle relaxants should not be given for long as they can produce potential side effect such as drowsiness, dizziness, dependence and abuse in long term period.¹⁷ If the above general measures don't comply, calcitonin may be given as an analgesic, with discontinuation after 6–12 weeks.¹⁸

Bisphosphonates and teriparatide can also be used to relieve acute rapid and sustained pain relief.^{19,20} Since the introduction of teriparatide for treating osteoporosis, there have been reports of improvements in back pain with teriparatide treatment which may be related to decrease incidence of new vertebral compression fractures.²⁰

13.2. Bracing

The use of bracing can be an initial step in the management of patients with osteoporotic compression vertebral fracture. Bracing can be helpful in pain reduction from movement by stabilizing the spine. Bracing also reduced back fatigue which helps patients in an early mobilization. Therefore, bracing is mandatory during the initial 6–8 weeks for pain relief.²¹

There are several kinds of braces which are commonly used mostly in cases of acute VCF.

An ideal brace should be light weighted, easy wearing, and comfortable with compatible cushions. Thus, the choice to use a specific brace is based on patients need, clinical status and type & level of fracture. The different braces are used for different purposes (Table 3) (Fig. 5).

Fig. 4. Classification of Vertebral Fracture in Elderly.(Adapted from: Sugita M. et al. J. Spinal Disord Tech 18, 4, 2005).¹³**Table 3**

Different types of braces for the management of osteoporotic VCF.

S. No.	Types of Braces	Design	Merits/benefits
1.	Thoracolumbar Orthoses (TLO)		
	Jewett and Cruciform anterior spinal hyperextension (CASH) brace	<ul style="list-style-type: none"> • Hyperextension design • Two anterior pads and one posterior pad 	<ul style="list-style-type: none"> • Hyperextension of the spine • Hyperextension in sagittal plane which limits movement in flexion extension plane
	Cheneau brace	<ul style="list-style-type: none"> • Hyperextension design • Velcro straps anteriorly 	
	Taylor brace	<ul style="list-style-type: none"> • Paraspinal bars posteriorly • An interscapular band • Axillary straps and Anterior corset 	
	Knight-Taylor brace	<ul style="list-style-type: none"> • Lateral and posterior bands • Shoulder straps 	<ul style="list-style-type: none"> • Lateral bending • Helps in maintaining static and dynamic motor balance
2.	Thoraco-lumbar-sacral orthosis (TLSOs)	Custom-molded body jacket	<ul style="list-style-type: none"> • Trunk motion is restricted in flexion-extension • Lateral bending and axial rotation
3.	Lumbosacral orthosis (LSO)	<ul style="list-style-type: none"> • For lower lumbar fractures • Multiple holes for aeration with plastic shells anteriorly and posteriorly. Velcro straps are fastened anteriorly. 	<ul style="list-style-type: none"> • Trunk range of motion is restricted grossly • Restrict the axial rotation at lumbosacral level
4.	Chairback braces	<ul style="list-style-type: none"> • Chair shaped 	<ul style="list-style-type: none"> • Reduce muscle electrical activity

1. Thoracolumbar orthoses (TLO)

- Jewett brace
- ASHE brace
- Cheneau brace
- Taylor brace
- Knight-Taylor brace

2. Thoraco-lumbar-sacral orthosis (TLSOs)**3. Lumbosacral orthosis (LSO)****4. Chairback brace**

Studies have shown that a custom-molded TLSO worn in hyperextension is used to manage a severe osteoporotic vertebral compression fracture.²

Acceptability of braces may be an issue with few patients who can't tolerate it. Few patients don't wish to wear braces due to social and other practical reasons such as thick skin overlying bony prominences or impaired respiratory functions (Fig. 6).

Fig. 5. Most commonly used braces.

13.3. Other physical modalities

Following modalities are used by various treating surgeons worldwide, however there is no convincing evidence either in favor or against. These may include:

- Ultrasound
- Hydrotherapy
- Ice/heat application
- TENS
- Acupuncture

14. Rehabilitation

Rehabilitation of patients with a vertebral fracture is of utmost importance. The goal of rehabilitation includes

- Exercise programme
- Fall Prevention Program
- Decrease in kyphosis
- Improving axial muscle strength
- Maintaining correct spine alignment

Additionally, a spinal extensor muscle strengthening program and dynamic proprioceptive program demonstrated by Sinaki et al. are extremely helpful in increasing bone density and reduction of VCFs.²² Back extension exercises are much helpful in reducing the incidence of new fracture than abdominal flexion exercises (16% vs 89% respectively). Our preference is to use early mobilization, Stretching exercises to decrease muscle spasm, gentle strengthening exercise program, gait training and flexibility exercises. Besides we also refer these patients to our fragility fracture program for fall prevention and balance training.

An increase in kyphosis usually occurs in patients with osteoporotic vertebral fracture and can cause pain and respiratory distress. For reducing kyphotic deformity, back extensor exercises provide better dynamic-static postural support. A randomized controlled trial performed by Papaioannou et al. showed better outcomes with home exercise program in patients with vertebral fracture. There was an improvement in the quality of life over 6 month.²³ Studies by Malmros et al. and Bennel et al. given a 10 week exercise programme were also in concordance with the above studies.^{24,25} Keeping in view of these above reports, physiotherapy and exercise has an important role in pain relief and improvement in quality of life.

Patients should also be advised to avoid such activities that may put them at risk for more vertebral fractures which include

- Forward bending
- Exercising with trunk in flexion
- Twisting
- Sudden abrupt movements
- Jumping, and jarring movements
- High-intensity exercise and heavy weight-lifting.

Moreover, the degree of activity restriction should be prescribed as per clinical judgment.

15. Prevention of subsequent vertebral fractures

Anti-osteoporotic regimens along with other pharmacologic therapies can significantly mitigate the chance of future vertebral fracture therefore patients diagnosed with vertebral fracture should be soon offered appropriate therapy at their earliest convenience. Identification of a vertebral fracture is an important part of a fracture liaison services. Effective fall prevention programmes (FPPs) applicability needs to be evaluated in specific health care settings before use in daily clinical practice. Multidisciplinary approach using home-based fall prevention method detects the risk of falling in seniors.²⁶

- Assessment of fracture risk; an important tool to estimate 10 year fracture risk assessment (FRAX).
- BMD assessment (at Spine, hip and forearm)
- Bone homeostasis (Vitamin D estimation, Calcium, Phosphorous, Alkaline phosphatase, and Parathyroid hormone)
- Bone turnover markers assessment (BALP, BCTx, P1NP and NTx)
- Fall prevention programmes²⁶
- Secondary fracture prevention programme
- Gait and balance training
- Bone health education
- Pharmacotherapy

16. Approach to osteoporotic VCF

The main focus of non-surgical management should be based on providing optimum care to the patient. Randomised clinical trial study done by Buchbinder et al. and Kallmes et al. have found that there is no difference in disability and pain score between vertebroplasty and sham surgery method in patients with

Conservative Management of osteoporotic vertebral compression Fracture

Fig. 6. Flow chart of Management of Acute osteoporotic vertebral compression Fracture.

symptomatic osteoporotic VCF of less than 12 months duration.^{27,28} Caution to be used in patients with multiple comorbidities, as prolonged bed rest/periods of inactivity with conservative treatment may lead to complications due to prolonged immobilization.²⁹

Hazzard M.A et al. found that conservative group patients are less likely to undergo of reoperation as compared to patients who underwent operation for VCF during the initial stage and on long term authors found that irrespective of treatment modality (surgically or conservatively) patients with VCF are likely to be associated with long term complications.²⁹

Osteoporosis most commonly presents as vertebral fracture in women with increasing prevalence with age is seen both in men and women. There is no increased risk of vertebral fracture seen among black and white women in South Africa.³⁰

In osteoporotic VCFs the chance for trunk muscle complications are higher due to higher bone-muscle interaction. With the use of Dynamic orthosis, there is improvement in the quality of life and pain relief in patients with osteoporotic compression fracture.⁸ Among anti-osteoporotic treatment regimens for Osteoporotic vertebral compression fractures, teriparatide was found better than alendronate at improvement of BMD along with bone turn over parameter.³¹

Shah S. and colleagues used a multidisciplinary primary approach for conservative management of osteoporotic vertebral fractures and found it effective in alleviating pain, reducing morbidity, reducing disease progression clinically and radiologically.³²

17. Summary

Osteoporotic vertebral fractures affect quality of life. Unfortunately to date, current understanding and knowledge for osteoporotic VCF are inconclusive. However, this review highlighted all the relevant non operative methods in the management of osteoporotic vertebral fractures. Treatment decisions should focus on improvement of quality of life of the patient, risk-benefit ratio and cost-effectiveness as well. Further, superior level of studies should be conducted to answer these vague conditions. Preventive and public health measures such as screening for osteoporosis in the community and fracture prevention strategies to include identification of risk factors are major methods to mitigate the rising burden of Osteoporotic vertebral fractures in the near future.

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