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Vertebral Fragility Fractures in Osteoporosis – A Comprehensive Review on its Management

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Abstract

Introduction: Approximately 20% of individuals older than 50 years of age have been reported to present with vertebral fragility fractures (VFF) – a prevalence which is anticipated to steadily increase in future. VFF is associated with disabling pain, significant impairment of quality of life, reduced ambulatory capacity, impaired social interactions, and poor quality of sleep. Early detection, appropriate management, evaluation of osteoporosis, and prevention of future fragility fractures would form the crux of treatment. Nevertheless, there is no consensus on what constitutes the ideal management protocol for symptomatic VFF.

Methods: Preferred Reporting Items for Systematic Reviews and Meta-Analysis guidelines were used to prepare this review. A detailed review of the literature was performed using PubMed, EMBASE, MEDLINE, and Cochrane Database of Systematic Reviews, which were searched for eligible studies with terms "treatment of VEF," "osteoporotic vertebral fracture (OVF)," "management of osteoporotic compression fracture," "imaging in OVF," "percutaneous vertebral augmentation," and "conservative treatment of OVF" from inception to November 2021. Duplicate studies, case reports, and letters to the editor were excluded from the study.

Results: A total of 286 studies were identified using our search criteria. Of these, 142 were duplicates and 107 did not meet inclusion criteria. After removal of these articles through various stages of screening, a total of 37 studies were finally included in the review. Plain radiographs, computed tomography (CT), and magnetic resonance imaging (MRI) are helpful in the diagnosis, evaluation, and management of these fractures. Radiologically, unstable VFFs need to be identified based on the following criteria (>50% vertebral height loss, kyphosis ≥25–35°, substantial retropulsion of bony fragments, significant bony, or ligamentous posterior column injuries). Conservative treatment (which includes analgesics, orthoses, and early mobilization) has remained the traditional way of treating these fractures. More recent systematic reviews have demonstrated a significant improvement in early pain control, vertebral height restoration, and ambulation with percutaneous augmentation (PKP or PVP) procedures. These studies have recommended cement augmentation in patients with intractable pain, not responding to medications. Surgical stabilization is recommended in elderly patients with pseudoarthrosis, substantial intervertebral instability, intractable pain with vertebral collapse, neurological deficit, and kyphosis. The need for long-term medical therapy to improve the bone density cannot be understated.

Conclusion: A high index of suspicion is necessary to diagnose VFFs in elderly patients with back pain. Conservative treatment has remained the traditional way of treating these fractures. Recent evidence shows early pain control and better vertebral height restoration with cement augmentation procedures (PKP or PVP). Open surgical stabilization can be helpful in a subset of patients with substantial intervertebral instability, deformity, and neuro-deficit.

Keywords: Osteoporosis, vertebral fragility fractures, cement augmentation, kyphosis.

Introduction

The term "vertebral fragility fractures (VFF)" has been used to describe radiographically-evident abnormalities, which develop secondary to a minor injury (defined as a force equivalent to fall from standing height or less) or in the absence of any specific injury episodes [1]. For a VFF to be recognized as "symptomatic," a credible correlation between the occurrence of clinical

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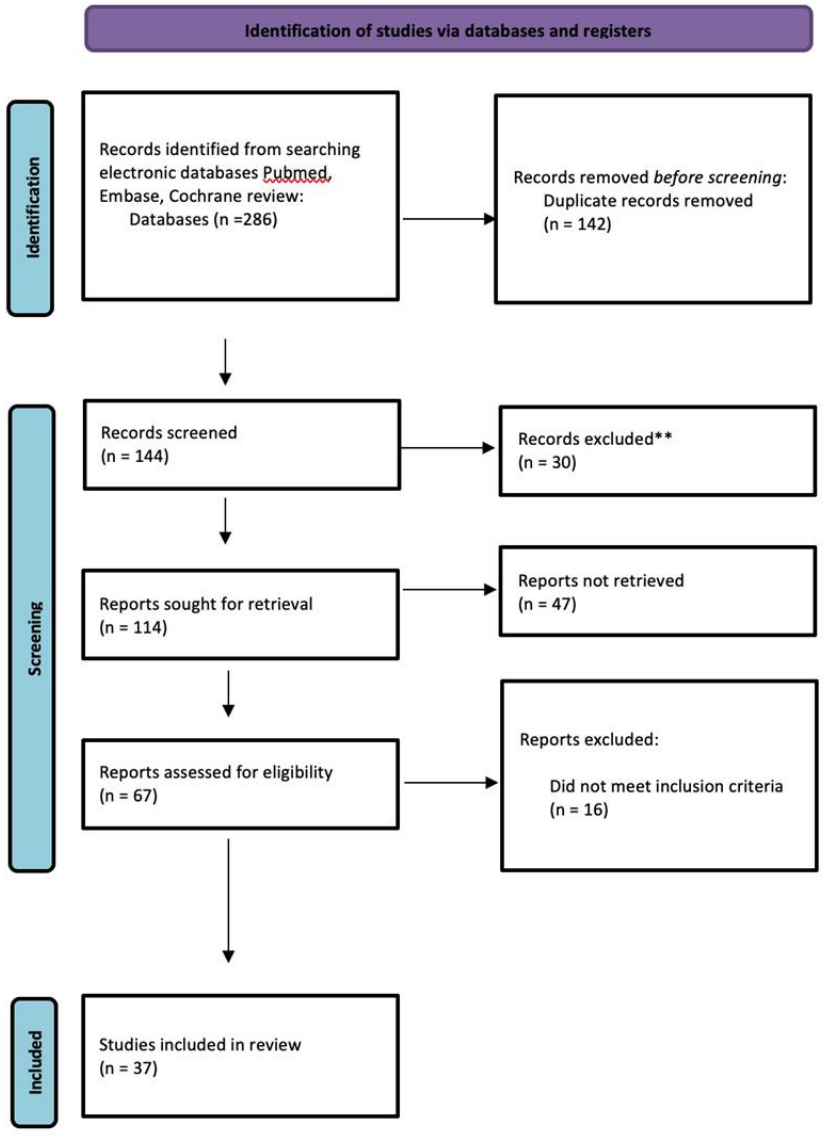

Figure 1: PRISMA Flow Sheet

symptoms and radiological aberrations must be clearly established [2]. "Incident" fractures are defined as those fractures identified when a patient presents with a complaint (e.g., acute pain), which is correlated with a radiological finding [including advanced imaging like magnetic resonance imaging (MRI)] suggestive of new-onset fracture [2]. "Prevalent" fractures include those fractures, which are diagnosed incidentally as part of regular screenings or on radiological evaluation obtained for another purpose (e.g., plain chest radiograph) [2]. Although a majority of VFFs are associated with certain degree of pain or disability, "incident" fractures usually present with the most severe manifestations [1, 2]. Alternatively, symptomatic VFFs may be associated with chronic back pain due to the associated spinal deformity or altered tension of adjoining muscles or tendons [2]. Based on the duration of symptoms, VFF can also be classified as acute (episodes lasting < 6 weeks), sub-acute (episodes lasting between 6 and 12 weeks), and chronic VFF (episodes of at least 12-week duration) [1].

These fractures are important markers of frailty and are associated with significant morbidity secondary to chronic pain. With a global increase in the ageing population, the incidence of VFFs continues to rise and is approximately 8 times higher in women aged between 85 and 89 years, as compared with those aged 60–64 years [1, 3, 4]. The cost of management of these fractures has also increased over the past years and is projected to rise even further [5]. Understanding the patho-physiology and management of VFFs is therefore, of utmost clinical and health-economic significance. Although multiple studies are available in the literature on the various treatment approaches to VFFs, a majority of these studies are of insufficient quality and the evidence is still largely ambiguous. This narrative

Figure 2: (a) Plain lateral radiograph showing acute vertebral fragility fractures (VFF) (AO type A3) with osteopenia and fresh fracture margins, (b) plain lateral radiograph showing healed VFF (AO type A4) with osteopenia, sclerosed vertebral body and fracture margins, (c) mid-sagittal T2-WI showing diffuse hyper-intense region at L1 representing acute edema within the vertebral body, (d) mid-sagittal short tau inversion recovery image showing diffuse hyper-intense region at L1 representing acute edema following fracture of vertebral body, (e) mid-sagittal T2-WI showing diffuse hypo-intensity at L1 representing old healed AO type A4 fracture without significant collapse, (f) mid-sagittal T2-WI showing diffuse hypo-intensity at L1 representing old healed AO type B2 fracture with significant kyphotic collapse (Cobb angle 36°).

Figure 3: (a) Parasagittal computed tomography (CT) sections showing fresh margins of L1 vertebral body fracture in acute osteoporotic vertebral fragility fractures, (b) parasagittal CT sections showing sclerosed and healed fractures of old T12 and L1 vertebral body fractures.

review was thus planned to comprehensively review this subject and provide an overview on major international clinical practice guidelines on the management of VFFs in osteoporosis.

Methods

Search strategy and study selection

Preferred Reporting Items for Systematic Reviews and Meta-Analysis guidelines were used to prepare this review. A detailed review of the literature was performed using PubMed, EMBASE, MEDLINE, and Cochrane Database of Systematic Reviews, which were searched for eligible studies with terms "treatment of VEF," "osteoporotic vertebral fracture (OVF)," "management of osteoporotic compression fracture," "imaging in OVF," "percutaneous vertebral augmentation," and "conservative treatment of OVF" from inception to November 2021. Additional inclusion criteria consisted of studies that were written in the English language, bracing in OVF, and had at least one of the specified outcomes of interest: Pain, spinal deformity, and pseudoarthrosis. All randomized control trials, systematic reviews, meta-analyses, case-control studies, observational cohort studies, and case series that focused on the treatment of VFF were included in the study. Duplicate studies, case reports, and letters to the editor were excluded from the study. Two investigators independently screened titles and abstracts based on the criteria above. Relevant studies were further assessed through full-text review. Consensus decision was used to resolve any discrepancies. A total of 286 studies were identified using our search criteria. Of these, 142 were duplicates and 107 did not meet inclusion criteria. After removal of these articles through various stages of screening, a total of 37 studies were finally included in the review (Fig. 1).

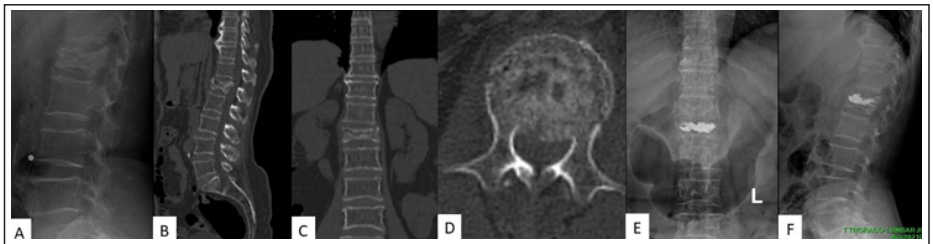

Figure 4: (a) Plain lateral radiograph (3 weeks post-injury) showing pseudoarthrosis and substantial collapse of L1 vertebra, (b-d) mid-sagittal, coronal and axial computed tomography showing pseudoarthrosis with sclerosed margins of L1 vertebra, (e and f) plain antero-posterior and lateral radiographs showing post-vertebroplasty status of L1 vertebra.

Incidence and prevalence

Osteoporotic VFFs are the most common osteoporotic fractures affecting nearly 1.4 million cases globally [5]. These fractures commonly involve elderly individuals, as the bone mineral density (BMD) of the spine steadily reduces with age [6, 7]. A recent systematic review reported a prevalence of 26% VFF among the Scandinavian and Japanese women; and 34% among elderly American women [4, 8]. The presence of previous vertebral fractures enhances the risk of sustaining a subsequent fracture by 5-fold [9].

Symptomatic osteoporotic VFFs clinically manifest with pain, vertebral deformity, reduced mobility and decreased pulmonary function; and thereby, enhance the risk of age-adjusted mortality [10, 11]. Management of VCF has been extensively discussed over the past years, with arguments put forth both in favor and against the conservative and operative lines of treatment [12, 13]. While enhanced mortality following VFFs has been well-established, the effects of various interventional modalities on mortality are still unclear [14]. This narrative review was thus planned to comprehensively review this subject; and provide an overview on the management guidelines for VFFs in osteoporosis.

Risk factors and clinical diagnosis

Apart from the factors which may predispose to falls, the risk factors for osteoporosis proposed by National Institute for Health and Care Excellence (NICE; Table 1) may be helpful in the evaluation of patients presenting with suspected OVF [15, 16]. The usual

Table 1: Risk factors for osteoporosis
Age >65 years (males), >50 years (females)
Previous history of OVF
Smoker
Asian/Caucasian ethnicity
Long-term steroid usage
Family history
Rheumatoid and other inflammatory arthritis

presentation is an acute exacerbation of an underlying chronic low back pain. On clinical examination, the most common findings include focal tenderness and kyphosis. Studies have reported that 30% of OVFs result from trivial events such as coughing or sneezing, which may occur when the patient is in bed. Clark et al. [17] put forth a set of 15 parameters on history and clinical examination, which may indicate the presence of an underlying vertebral fracture (Table 2). They observed a significant correlation between the location (over the lateral waist and not radiating down the legs) and character (crushing-type) of pain; and the presence of an underlying OVF. A recent review article [16] listed three key questions, which require to be answered during the patients' initial assessment, which include (a) Is the fracture new or old? (b) Is there a neurological deficit? and (c) Is the fracture stable or not?

Diagnostic modalities and imaging (Figs. 2 and 3)

In all patients with OVFs, patients must be thoroughly assessed to rule out any secondary etiologies underlying osteopenia, namely, osteomalacia or metabolic illnesses, endocrine disorders, multiple myeloma, and renal osteodystrophy. It is of utmost importance to classify these fractures radiologically, as stable or unstable. In general, burst fractures with at least 50% vertebral height loss, kyphosis ≥25–35°, substantial retropulsion of body fragments, significant bony, or ligamentous posterior column injuries [6, 15, 16]. Although antero-posterior (AP) and lateral plain radiographs are the recommended initial imaging, it is challenging to distinguish acute from old fractures on the basis of X-rays alone. Computed tomography (CT) enables better assessment of the specific morphology of fractures, which may not be clearly defined on plain radiographs. CT demonstrates the integrity of posterior bony elements, injury to posterior vertebral wall, and the morphology of any retropulsed fragments with substantial accuracy. MRI provides the most reliable information regarding the chronicity of injury (based on extent and presence of intra-vertebral edema), ligament integrity, and neural compromise [12]. MRI Short Tau Inversion Recovery sequences are helpful in detecting acute VFFs. In patients with persistent pain following VFFs, the presence of a typical fluid signal pattern within the vertebral body can be indicative of pseudoarthrosis. In addition, BMD

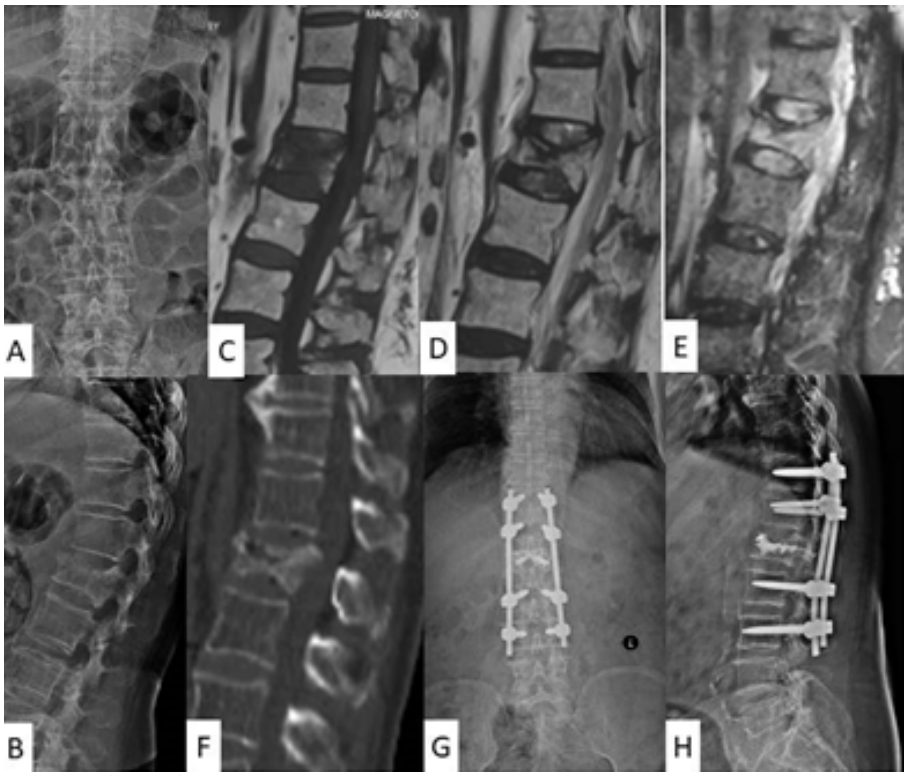

Figure 5: (a and b) Plain antero-posterior and lateral radiographs showing bow-string type of osteoporotic vertebral fragility fractures of L1 vertebra, (c and d) mid-sagittal T1-, T2-WI showing fractures of both superior and inferior endplates with diffuse edema of vertebral body, (e) mid-sagittal short tau inversion recovery image showing fractures of both superior and inferior endplates with diffuse edema of vertebral body and hypointense (black line) near the superior end plate (which is a poor prognostic factor for fracture healing, (f) mid-sagittal compute tomography section showing pseudoarthrosis at 5 weeks post-injury, (g and h) plain post-operative antero-posterior and lateral radiographs showing T11 to L3 posterior instrumented stabilization and L1 vertebroplasty and L1 laminectomy (as the patient presented with neurological deterioration).

Table 2: Who to image? Features in the history [14]
Older age
Female sex
Lateral waist pain
Back pain described as crushing
Back pain improving on lying down
Pain not radiating down the legs
Current smoking
Diagnosis of chronic obstructive pulmonary disease
Prior fracture
Late menarche
Cumulative corticosteroid dosage
Vertebral height loss of >4 cm
Low body weight
Rib to pelvis distance of two fingers or less
Spine tender to gentle percussion (acute fractures only)

studies are recommended for evaluating the severity of osteoporosis and in prognosticating the likelihood of subsequent fractures.

Classification of OVFs and prediction of non-union or kyphotic collapse

Various classification systems for OVFs have been put forth in an attempt to prognosticate these fragility fractures. Based on plain lateral radiographs, Sugita et al. [18] classified OVF into 5 types, namely, (a) swelled-front (when 50% of anterior wall is swollen), (b) bow-shaped (when both the anterior wall and end-plate are pinched in), (c) projecting (when 50% of anterior wall is projecting), (d) concave (when anterior wall is intact with falling-in of end plate), and (e) dented (when the center of anterior wall is dented). Among them, the former three types carry the poorest prognosis for pseudoarthrosis.

Based on the extent of signal change with respect to the quadrants drawn on MRI-T1WI, Kanchiku et al. [19] classified OVFs into 6 types: Total, central, superior, inferior, anterior, and posterior. Tsujio et al. [20] classified the signal intensity changes in OVF on T2WI-MRI as hyper-intense limited (or confined-high), hyper-intense diffuse (diffuse-high), hypo-intense limited (or confined-low), hypo-intense diffuse (diffuse-low), and normal intensity. Omi et al. [21] reported substantially poorer prognosis in lesions showing linear black signal area extending >50% of the length of vertebral body. Based on a prospective multi-centered trial involving 707 OVFs, Schnake et al. [22] recently proposed a morphological classification involving five sub-types, namely, (a) OF-1: No vertebral deformation, (b) OF-2: Deformation without or only with minor posterior wall involvement, (c) OF-3: Deformation with distinct posterior wall involvement, (d) OF-4: Loss of vertebral frame morphology, collapse or pincer-type fractures, and (e) OF-5: Distractional or rotational injuries.

A majority of osteoporotic VFFs heal well, with satisfactory clinical and functional outcome; and minimal residual deformity or pain. Infrequently, these fractures do not heal well resulting in nonunion, vertebral collapse, kyphosis, and neurological complications. Such complications are associated strongly with poor prognosis, compromised quality of life and chronic pain. In a recent meta-analysis by Muratore et al. [23] involving 11 studies, presence of intra-vertebral cleft, total-type fractures (on T1WI-MRI), diffuse-low or confined-high intensity patterns (on T2WI-MRI), middle column injury, thoracolumbar (TL) region, and superior end plate fractures were associated with the development of pseudoarthrosis or kyphotic collapse. Fractures with retropulsed fragments encroaching >40% of spinal canal and a change of >15° vertebral wedge angle on lateral dynamic X-rays were reported to be at risk for the development of neurological impairment. The key to avoidance of pseudoarthrosis is the prompt recognition of these risk factors and timely intervention.

Treatment options

The three primary goals of treatment in OVF include pain reduction, mobility restoration, and mitigation of risk of further vertebral compression fractures in future [6]. The main modalities for achieving these goals are conservative, percutaneous vertebral augmentation procedures, and surgical stabilization [4, 6, 12, 15].

Non-operative treatment

Conventionally, these fractures have been managed non-operatively with a combination of analgesics, a short period of rest with or without bracing and early mobilization.

Recommendations on analgesics

The evidence-based guidelines in terms of pharmacological management of acute osteoporotic VFF in the literature have been scarce. Although a majority of patients experience a substantial decrease in pain over the initial 4weeks [24, 25], it is a general practice globally to administer simple analgesics (e.g., paracetamol) or nonsteroidal anti-inflammatory drugs or opiates to mitigate pain and facilitate early mobility. However, meta-analyses in the recent years have highlighted the paucity of high quality scientific data derived from randomized controlled trials on this subject till date.

Recommendations on calcitonin administration

A recent meta-analysis [1, 26], involving 11 placebo-controlled trials of moderate investigational quality evaluated the role of calcitonin in VFF, reported that calcitonin administration results in a statistically significant reduction in the severity of acute pain at rest at all follow-ups; and acute pain during walking at 1-week and 4-week follow-ups. There was no significant reduction in the severity of chronic pain following calcitonin administration. The study also cautioned against the possibility of 3-times greater risk of any side effect (mainly enteric-related and flushing) after calcitonin administration. The study also discussed the need for better quality study to clearly evaluate the association of cancer with calcitonin treatment.

Bracing and rehabilitation in VFF [27]

The management of VFF has been broadly divided into three phases: Acute, post-acute, and rehabilitation phases. In the initial two phases, the major aims include pain control, maintenance of fracture stability, limitation of bed rest and early mobilization of patient [27]. The disadvantages of prolonged bed rest in this elderly patient population include muscle atrophy and weakness, joint rigidity, pressure sores, deep venous thrombosis, respiratory complications, and depression. During the acute phase,

TL stabilization exercises with simultaneous range of motion exercises of limbs and deep-breathing exercises are helpful [28]. During the initial acute and sub-acute phases, resistive strengthening exercises are avoided [27].

An orthosis has generally been used to stabilize spine during the initial 8–12 weeks of conservative treatment of VFF. Two recent non-blinded trials [29] had reported a significant reduction in pain and disability with the additional use of semi-rigid lumbar brace for a period of 6 months in patients with acute VFF. The quality of evidence in these studies was reported to be fairly low [27, 28]. A recent systematic review involving seven articles (four randomized controlled and three prospective studies) by Kweh et al. [30] demonstrated a significant advantage of the use of spinal orthosis in neurologically-intact elderly patients with VFF in terms of enhanced biomechanical stability, improved kyphotic deformity, augmented postural stability, superior muscle strength, and meliorated functional outcomes. Dorsal extensor muscle strengthening exercises, balance, and proprioceptive exercises during the rehabilitative phase are important to mitigate the risks of falls, secondary fractures, and kyphosis [28]. Sinaki et al. [31] also demonstrated protective effects of strengthening exercises on long-term BMD.

Recommendations on teriparatide (rh-PTH 1–34) treatment

Teriparatide (TPD, recombinant human parathyroid hormone (rh-PTH 1–34), an osteogenic osteoporosis agent, has been shown to be effective as an adjuvant in both conservatively- and operatively-treated OVF [32, 33, 34, 35, 36]. It has been previously demonstrated to enhance healing rates of osteoporotic hip fractures [34]. Iwata et al. [36] demonstrated that a once-daily subcutaneous injection of 20 micrograms of teriparatide enhances the union rates, mitigates kyphotic collapse, reduces vertebral height loss, and obviates the need for percutaneous augmentation or open surgical interventions in OVFs. It has been shown that teriparatide effects peripheral bridging bone formation in OVF, which results in bone cross-linkage along the vertebral edges and subsequent vertebral stabilization. This prevents the development of vertebral clefting and progression of collapse. Teriparatide also results in ossification of the surrounding spinal ligaments (as is often seen in diffuse idiopathic hyperostosis), which can further augment intervertebral stability. Kong et al. [32] showed that 12-month treatment with teriparatide injections reduces back pain rates and enhances the quality of life in patients undergoing percutaneous KP. The studies by Ohtori et al. [33] and Kawabata et al. [35] also demonstrated the role of teriparatide in enhancing fusion rates in surgically-treated (undergoing instrumented fusions) patients with OVFs.

Operative treatment

In general, the interventional management of OVF includes percutaneous augmentation procedures (PVP or PKP) or open surgical stabilization (coupled with neural decompression or cement augmentation procedures). NICE guidelines recommend that augmentation techniques may be used in patients with severe on-going pain following an unhealed, recent OVF despite adequate pain management, and only when the correlation between the ongoing symptom and the level of fracture has been clearly established [32].

Percutaneous cement augmentation

Evolution of evidence on VP, KP, and conservative treatment of OVF (Fig. 4)

Over the past 10–15 years, our understanding regarding the management of osteoporotic VFFs has undergone substantial transformation. In August 2009, Journal of Neuro-Interventional Surgery published a consensus statement by five societies of neurosurgeons and radiologists, in which vertebral augmentation therapy was reported as an appropriate therapy for acute, painful VFFs [33]. Soon afterwards, the New England Journal of Medicine published two randomized studies [34, 35], both of which failed to show any substantial benefit of vertebroplasty over sham procedures. This was followed by a significant decline by 38.3% or 5.6% per annum in the annual proportion of Medicare patients in the United States undergoing percutaneous augmentation [12].

Following this, multiple other randomized-controlled (comparing with active, sham, or placebo controls) and prospective trials demonstrated significant benefits with regard to pain and functional improvement following augmentation procedures [14, 36, 37, 38, 39]. Meanwhile, opponents to these procedures also criticized these studies and their observations [40]. In 2018, Buchbinder et al. [40] published a Cochrane Vertebroplasty Review which concluded that there was no major clinically demonstrable benefit of PVP, as compared with placebo/sham procedures. Their sensitivity analysis demonstrated that trials comparing vertebroplasty with conservative treatment overestimated its advantages. Subsequently, a meta-analysis involving Level-I and II studies by Beall et al. [13] concluded that balloon kyphoplasty (BKP) had significantly better; and vertebroplasty tended to have significantly better pain reduction than non-operative treatment. BKP tended to have better restoration of vertebral height than VP. In a recent meta-analysis by Hinde et al. [36], significant mortality benefit was demonstrated (22% less mortality) up to 10 years after cement augmentation, as compared with conservative treatment. Recent trials

have also demonstrated significant pain reduction with both KP and VP, even when performed in the acute scenario (earlier than 3 to 6 weeks following injury) [38, 39, 41]. In a recently published meta-analysis of eight studies (which included 289 patients) on TL osteoporotic burst fractures [3], it was demonstrated that all functional [pain relief Visual Analogue Scale, and Oswestry Disability Index] and radiological parameters (vertebral height and kyphotic angle) showed significant improvement following PKP. The main complications encountered in this review following PKP were cement leakage with an incidence ranging between 7.7% and 45.4%; and adjacent vertebral fracture or re-fracture at rates ranging between 4.3% and 74.1%, respectively. In another recent meta-analysis [42], both KP and VP demonstrated similar short- and long-term pain relief, functional improvement, kyphosis correction, and vertebral height restoration in OVF with intra-vertebral cleft.

Complications associated with both kyphoplasty and vertebroplasty procedures are bleeding, infection, neurodeficit, systemic reactions to cement embolization and cement leakage into adjacent disc (9% in KP and 41% in VP) [43]. KP was demonstrated to be superior in terms of volume of injected cement and less cement leak [42]. The major disadvantages with KP were longer operation time, longer fluoroscopy times, and higher cost [42]. The adjacent level vertebral fracture can also be higher in KP, as there is increased vertebral stiffness locally [44]. The small risk of retention of balloon fragments following rupture intra-vertebrally has also been described [16]. Based on a recent meta-analysis, Shankar et al. [45] demonstrated that injection of cement into vertebral body with marrow edema improved the benefit, as well as mitigated the complications associated with both VP and KP.

Is it safe to add zoledronate (ZA) to PVP or PKP?

A recent meta-analysis involving 7 RCTs (929 subjects) concluded that ZA in combination with PVP or PKP is a safe, effective, and comprehensive treatment for OVF [46, 47]. The addition of ZA significantly improved the long-term analgesia and bone metabolism indices [including BMD, β-isomerized C-terminal telopeptide and N-terminal propeptide of type I collagen; and N-terminal molecular fragment levels]. Although complications such as fever or flu-like symptoms, arthralgia, and myalgia were more commonly observed in ZA group, the drug was overall well-tolerated without any major complications. Similar studies by Tang et al. [48] and Li et al. [49] also showed that the additional use of ZA offered significant benefits in terms of better functional outcome and improved re-fracture rates following percutaneous cement augmentation procedures.

Open spinal stabilization (Fig. 5)

Open surgical stabilization is recommended in elderly patients with pseudoarthrosis, substantial intervertebral instability (unstable burst fractures, associated injury to posterior ligamentous complex, distractional/rotational, or translational injuries), intractable pain with vertebral collapse, neurological deficit, and kyphosis [50, 51, 52, 53, 54,]. Ataka et al. [50] purported that instability at the fracture site is the primary cause for neurological deficits in OVFs. In their study, all patients (14 consecutive patients) with incomplete neuro-deficit, who underwent long segment posterior instrumented stabilization without any additional canal decompression, recovered neurologically by at least one Frenkel grade. None of patients in this series had any implant failure.

The presence of highly degenerated facets and osteophytes can pose difficulties during surgical exposure, identification of anatomical elements and pedicle screw insertion in these patients [50, 53, 54]. The pedicle screw instrumentation may offer poor fixation in patients with severe osteoporosis; therefore, alternate modalities of instrumentation such as laminar hooks or sub-laminar wires may be necessary. The use of larger diameter, longer (if possible, with bi-cortical purchase) pedicle screws with variable pitch can mitigate the chances of screw pull-out. Pedicle augmentation techniques such as calcium phosphate or hydroxyapatite or poly-methyl methacrylate (PMMA) augmented screws may also be used to enhance the purchase of screws in the bone. However, the use of PMMA can enhance the risk of cement leak with potential embolic insults. The addition of percutaneous KP or VP techniques to pedicle screw instrumentation has been reported as hybrid instrumentation. Such stabilization techniques can effectively shorten the length of the entire construct; and thereby mitigate the surgical trauma. In addition, the pedicle screws may also be inserted percutaneously [50, 52, 53, 54].

Based on a prospective multi-centered study, Schnake et al. [22, 51] recommended surgical intervention for all OVFs with OF-4 and OF-5 fracture pattern injuries. Patients with OF-3 fracture patterns may benefit from either conservative or surgical treatment. In a recent review article, the high rates of failure associated with pedicle screw instrumentation in elderly osteoporotic patients were highlighted. Although internal fixation loosening and reduction loss are commonly encountered, aging patients with ongoing pain and chronic illnesses may not endure the burden of surgery itself [16]. Therefore, the decision regarding open surgical procedures must be individualized and carefully evaluated.

Prevention of OVFs in future

Currently available anti-resorptive

medications include bisphosphonates and denosumab [anti-receptor activator of nuclear factor-kappa B ligand antibody] [55, 56]. Although both these agents inhibit the osteoclasts, they act through different pathways. The benefits of bisphosphonates peak at around 3–5 years and then plateau; while the action of denosumab is maintained until approximately 10 years. Teriparatide is the only anabolic agent which has been available for a long time. More recently, abaloparatide is another synthetic analog of PTHrP [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33], which has been developed. Due to the differences in preferential-binding conformations of PTH1 receptor between these two agents (teriparatide and abaloparatide), the latter agent has greater anabolic benefits with minimal resorptive action. An anti-sclerosin antibody, romosozumab, inhibits sclerosin (a canonical Wnt signal inhibitor from osteocytes), and increases canonical Wnt signaling. It robustly enhances bone formation and resorption; and thereby significantly improves BMD and reduces clinical osteoporotic fractures.

Kim et al. [55] proposed a concept of "advanced severe osteoporosis," which was defined as the presence of proximal femur fragility fracture or multiple (≥2) fragility fractures in patients with BMD (T-score) ≤(-2.5). They recommended that patients with "advanced severe osteoporosis," who undergo spinal instrumentation require aggressive medical management of osteoporosis using parathormone analogues or denosumab.

Conclusion

A high index of suspicion is necessary to diagnose OVFs in elderly patients with acute or chronic back pain. Conservative treatment (which includes analgesics, orthoses, and early mobilization) has remained the traditional way of treating such fractures. Cement augmentation procedures (PKP or PVP) are recommended in patients with intractable pain, not responding to medications. Such patients undergoing KP or VP demonstrate significant improvement in early pain control, vertebral height restoration, and ambulation as compared with non-surgical treatment. Open surgical stabilization is recommended in elderly patients with pseudoarthrosis, substantial intervertebral instability, intractable pain with vertebral collapse, neurodeficit, and kyphosis.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his consent for his images and other clinical information to be reported in the Journal. The patient understands that his name and initials will not be published, and due efforts will be made to conceal his identity, but anonymity cannot be guaranteed.

Conflict of Interest: NIL; **Source of Support:** NIL

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