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Vertebral Fragility Fractures (VFF)—Who, when and how to operate

Opinder Sahota[a,*], Terence Ong[b], Khalid Salem[a]

[a] Nottingham University Hospitals NHS Trust, Nottingham, UK
[b] University of Nottingham, UK

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ABSTRACT

Vertebral Fragility Fractures (VFF) are common and lead to pain, long term disability and increased mortality. Most patients will have mild to moderate pain symptoms and can be managed conservatively. However, patients with severe pain who have minimal or no pain relief with potent analgesia, or who only achieve adequate pain relief with high doses of morphine based analgesia which results in significant adverse events, should be considered for vertebral augmentation. Ideally, for vertebral augmentation, patients should present within four months of the fracture (onset of acute pain) and have at least 3 weeks of failure of conservative treatment although early intervention may be more appropriate for hospitalised patients, who tend to be older, more frail and likely to be less tolerant to the adverse effects of conservative treatment.

The Cardiovascular and Interventional Radiological Society of Europe (CIRSE) recommends Percutaneous Vertebroplasty as the first line surgical augmentation technique for VFF in older people, which has been shown to improve pain symptoms, allow early restoration of functional mobility and may reduce the risk of further vertebral collapse. CIRSE recommends percutaneous Balloon Kyphoplasty as second line treatment in VFF, although the optimal indication is for acute traumatic vertebral fractures (less than 7–10 days) in younger people. Assessment and treatment of underlying osteoporosis is important to reduce the risk of further fractures in older people with VFF.

Prevalence of VFF

Vertebral Fragility fractures (VFF) are the most common, single osteoporotic fracture with an estimated 1.4 million VFF occurring every year worldwide [1,2]. In osteoporotic patients, they can occur as a result of minimal trauma from day-to-day activities, such as bending forward, twisting, lifting objects, and even sitting from a standing position onto a low chair. Their prevalence increases exponentially with advancing age, and with ageing demographics, these fractures are expected to rise significantly over the next 10 years [3].

In contrast to hip fractures, many factors limit the reliable epidemiology of VFF [4]. It is estimated that one third of VFF are clinically silent and less than 10% of VFF patients are admitted to hospital [5,6], although this varies geographically, determined by the type and access to healthcare across the world. Rates of VFF are also dependent on whether the definition of a VFF is clinical or morphometric [7]. A recent review found similar prevalence rates worldwide, with the highest–lowest ratio between countries, within and across continents, varying from 1.4 to 2.6 [8]. The highest prevalence in Europe was Scandinavia (26%), in America, North American white women (20–24%), in the Middle East, Lebanon (20%) and in the Far East, Japan (24%). The age-standardised rates in studies combining hospitalised and ambulatory VFF, revealed the highest rates in South Korea, USA, and Hong Kong, with the lowest in the UK [9].

Symptoms and conservative treatment

VFF constitute a major health problem, leading to both acute and chronic back pain, substantial spinal deformity, functional disability and decreased quality of life [10]. VFF, even mild ones, appear to incur substantial health-care utilisation and costs [11], and are associated with an increased risk of future VFF and significant mortality [12,13]. VFF are highly predictive of future fracture risk, particularly of the hip and subsequent VFF [14–16]. 20% of osteoporotic women with a recent VFF will sustain a new VFF within the next 12 months [17]. The risk of a new VFF increases with both the number and the severity of prevalent VFF [18,19]. Age-adjusted mortality is increased eight-fold, similar to that observed following hip fracture [20] and increases with the

* Corresponding author at: Health Care of Older People, B Floor South Block, QMC, Nottingham University Hospitals, NHS Trust, UK.
E-mail address: Opinder.sahota@nuh.nhs.uk (O. Sahota).

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number of VFF sustained [21,22]. In 2010, the number of deaths causally related to fragility fractures in the EU was estimated at 43,000. In men, approximately 47% of fracture related deaths were due to hip fractures, 39% to clinical VFF and 14% to other fractures [23].

The acute VFF is the starting point, for many, of a long-lasting, severely painful, and disabling condition [24]. It has also been shown that health-related quality of life is considerably lower compared with controls up to 7 years post fracture, and these patients experience increased fear of pain and falling, as well as decreased self-esteem [25]. Pain reduces physical activity leading to muscle hypotrophy, weakness and further acceleration of bone loss [26–28]. Long-term, this leads to dependency, loss of confidence, and social isolation [29,30]. Most patients who sustain a VFF will have mild to moderate symptoms, however a significant proportion develop substantial pain and disability and require admission to hospital [31]. Hospitalised patients tend to be more elderly, frail, have co-existing comorbidities [32] and their symptoms are more difficult to manage (Fig. 1).

Universal standard conservative therapy, for the more painful VFF consists of potent morphine based analgesia, bedrest and back bracing, but are poorly tolerated, particularly in the elderly, leading to additional health problems [33]. A meta-analysis by Furlan and colleagues [34] showed that nausea is the most common side effect of morphine based analgesia. The mechanism of action is through the direct stimulation on the chemoreceptors trigger zone and vestibular apparatus and through the anticholinergic effects on the gastrointestinal system [35]. Other common morphine based side effects include constipation, urinary retention, sedation and confusion. Less frequent, but more serious side effects include respiration depression and hypoactive delirium [36]. Opioid induced hyperalgesia is another recognised and important feature and is the phenomenon of increasing sensitivity to both pain (hyperalgesia) and non-painful stimuli (allodynia) due to the toxic opioid metabolites [37]. Chronic pain often necessities long term treatment.

Bedrest adversely affects every system in the human body [38]. A change in the distribution of fluid volume and loss of plasma volume (due to a decrease in aldosterone and renin sensitivity) leads to cardiac deconditioning, postural hypotension and increased blood viscosity. Within one week of bedrest, patients may lose up to 10% of their plasma volume [39]. An increase in blood viscosity leads to an increase in the risk of venous and pulmonary thromboembolism and mucus thickening and pooling in the lungs, increasing the risk of pneumonia. Further tissue hypoxia leads to the risk of pressure ulcers, which commonly occurs at the sacrum, ischial tuberosity, greater trochanters, heels, and ankles [40,41]. Bedbound patients often lose interest in their meals, and may report changes in smell and taste leading to poor nutrition, complicated further by the effects of potent morphine based analgesia on the gastrointestinal tract, as outlined above [42]. The most serious consequence of bedrest for future mobility and independence however is muscle atrophy. Bedrest over the first 7 days is associated with a 12% loss of strength and significant loss in muscle mass [43,44], predominately affecting the lower limbs [45,46]. Disuse creates muscle weakness and joint stiffness, increasing further the risk of falls. Calcium clearance in the bone is also 4 to 6 times greater in the first week of bedrest, affecting both cortical and trabecular bone, particularly the trabecular bone of weight-bearing limbs, progressing to localised osteoporosis [47].

Surgical augmentation for the treatment of VFF

Vertebral augmentation is a general term for several techniques used to treat VFF, with the aim of consolidating the fracture and, when possible, achieving height restoration. Percutaneous vertebroplasty (PVP) is a minimally invasive, image-guided procedure that involves injection of radio-opaque bone cement into a partially collapsed vertebral body, in an effort to provide pain relief and stability. This technique was originally described by Deramond et al. in 1987 for the treatment of an aggressive vertebral haemangioma [48]. The mechanism of pain relief is thought to be a combination of more favourable biomechanics after cement strengthening, chemical toxicity and the exothermic effect of cement polymerisation on nerve endings [49]. Other techniques include percutaneous balloon kyphoplasty (PBK), which attempts to restore vertebral body height by inflating a balloon prior to bone cement injection [50] and percutaneous implant procedures (PIP), which involve the placement of different types of expandable bone implant systems into the fractured vertebrae

Percutaneous vertebroplasty (PVP)

PVP is indicated for the treatment of painful VFF refractory to medical treatment. Failure of medical therapy is defined as minimal or no pain relief with the administration of physician prescribed analgesics, or achievement of adequate pain relief with only high doses of morphine based analgesia that induces excessive intolerable sedation, confusion or constipation [51]. The UK NICE guidance recommends intervention for patients who have severe ongoing pain after a recent, unhealed fracture of the spine despite treatment for pain, and the pain has been confirmed at the site of fracture [52]. A multidisciplinary team consisting of a radiologist, an orthogeriatrician, a spine surgeon and referring physician (rheumatologist, or endocrinologist) should come to a consensus as to which patients should undergo this procedure and further ensure appropriate adjuvant therapy, osteoporosis secondary prevention and follow-up measures as necessary. A detailed clinical history and examination with emphasis on neurological signs and symptoms should be performed to confirm that the VFF is the cause of debilitating back pain and to rule out other causes, such as degenerative spondylosis, spinal infection (eg spondylodiscitis) radiculopathy and/or neurological compromise. The typical patient suffering from a VFF has midline non-radiating back pain that increases with weight bearing and manual percussion of the spinous process of the involved vertebra [53]. The clinical signs and symptoms should always be correlated with the imaging findings. Multiple fractures may be present but not all of the fractures necessarily require treatment. MRI is a must in all patients considered for vertebral augmentation as it provides information regarding the age and healing status of the fracture (acute vs chronic, incompletely healed vs consolidated), defines fracture anatomy, assesses posterior vertebral body wall integrity and excludes other causes of back pain (such as facet arthropathy, spinal canal stenosis and disc herniation) [54]. Bone scintigraphy can be used to determine the age of a fracture in patients contraindicated for MRI, although this is recognised to be less sensitive. An increased uptake of the radionuclide tracer is highly predictive of a positive clinical response following PVP [55]. If the VFF level responsible for pain cannot be identified, despite the applied clinical and imaging examinations, manual examination of the spine under fluoroscopy may be useful, where percussion over the VFF guided by fluoroscopy reproduces the pain symptoms [56].

Optimal timing of PVP

The optimum timing for PVP remains controversial. Treatment of painful VFF worldwide is largely conservative for several weeks before taking into consideration vertebral augmentation techniques. The VERTOS III follow-up study evaluated the natural course of pain in a large cohort of symptomatic VFF patients and found

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