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Review

SURGICAL INTERVENTION IN OSTEOPOROSIS: FOLLOW-UP AND MANAGEMENT OF FRACTURE PATIENTS AND THE FRACTURE LIAISON SERVICE (FLS) MODEL

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ABSTRACT: Osteoporotic fractures in older adults are a complex clinical challenge that requires systematic, multidisciplinary coordination among orthopedic surgery, geriatrics, and metabolic bone specialists. Clinical evidence indicates that after an initial fragility fracture, the risk of subsequent fractures rises sharply, particularly within the first 1 to 2 years. Despite these serious consequences, most patients in current practice remain under-evaluated and under-treated for their underlying osteoporosis. This review updates the core principles of surgical intervention for osteoporotic fractures and effective perioperative management protocols, with particular attention to the implementation of the Fracture Liaison Service (FLS) model. FLS has proven to be an effective, structured, and coordinated care model that optimizes the patient management pathway, improves long-term treatment adherence, prevents secondary fragility fractures, reduces associated mortality, and lowers overall healthcare costs. Wider adoption and expansion of the FLS framework is an essential step toward a standardized system of continuous, comprehensive, high-quality care for patients with osteoporosis throughout Vietnam.

Keywords: Osteoporosis; osteoporotic fracture; surgical management; Fracture Liaison Service; perioperative management; secondary fracture prevention

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1. INTRODUCTION

Osteoporosis is a skeletal disorder characterized by reduced bone strength, leading to an increased risk of fracture. Bone strength combines bone mineral density (BMD) and bone quality. Bone quality reflects trabecular microarchitecture, cortical porosity, the accumulation of microfractures, and the rate of bone turnover [1]. In current practice, BMD measurement by dual-energy X-ray absorptiometry (DXA) remains the diagnostic standard, but additional indices such as the trabecular bone score (TBS) are increasingly used for a more comprehensive assessment of bone quality.

Osteoporosis is considered a "silent disease" until a fracture occurs. In the United States, about 1.5 million osteoporotic fractures are recorded each year, and about 1/3 of women and 1/5 of men over 50 years of age will sustain an osteoporotic fracture during their remaining lifetime [1]. In Vietnam, epidemiological studies estimate that about 20% of women and 10% of men over 50 years of age have osteoporosis, and this burden is expected to rise rapidly as the population ages.

Hip and vertebral fractures are the most important types of osteoporotic fracture. Hip fractures substantially increase the risk of hospitalization and death. Vertebral fractures cause chronic back pain, spinal deformity, and functional limitation, and increase the risk of hospitalization and death [1].

2. SURGICAL TREATMENT IN SEVERE OSTEOPOROSIS

Severe osteoporosis is defined as a T-score ≤ -2.5 together with at least one fragility fracture. Some authors use the term "advanced severe osteoporosis" to describe patients at very high fracture risk, with multiple recurrent fractures, or with further fractures despite treatment. However, this term has no agreed definition in official guidelines. These patients require close coordination between surgical intervention and intensive medical treatment [2, 3].

2.1. Treatment principles

Surgeons treating osteoporotic fractures face two challenges at once: poor bone quality makes fixation difficult, while patients are usually elderly, with multiple comorbidities and limited physiological reserve. In this setting, the goal is no longer simply anatomical union; more importantly, it is to return patients to weight-bearing and independent living as early as possible [4, 5].

The timing of surgery directly affects outcomes. A meta-analysis by Simunovic et al. (2010) of more than 13,000 patients with hip fracture showed that surgery within the first 24 to 48 hours reduced 30-day mortality and medical complications compared with a delay of more than 48 hours [6]. However, early surgery must be accompanied by preoperative medical optimization, particularly anticoagulation management, fluid balance, and cardiovascular assessment [2, 4, 5]. In elderly patients with displaced femoral neck fractures or complex fractures, arthroplasty allows immediate weight-bearing after surgery and reduces the risk of reoperation due to fixation failure [4, 5].

2.2. Surgical principles

A key feature of osteoporotic bone is reduced screw-holding capacity due to loss of trabecular structure and cortical thinning, which increases the risk of mechanical failure such as implant loosening, screw cut-out, and peri-implant fracture [7, 8].

To compensate for reduced screw-holding capacity, angular-stable fixation systems such as locking plates and interlocking intramedullary nails have been developed. They distribute load through the plate–screw construct instead of relying on friction between the screw and the already thin cortex [4, 8]. At cancellous bone sites such as the proximal femur and vertebral bodies, cement augmentation increases screw anchorage, especially in patients with very low T-scores [9]. Minimally invasive plate osteosynthesis (MIPO) arose from the same understanding: minimizing soft-tissue stripping and preserving the blood supply around the fracture. These are the two basic conditions for

biological bone healing to proceed well [8] (Figure 1).

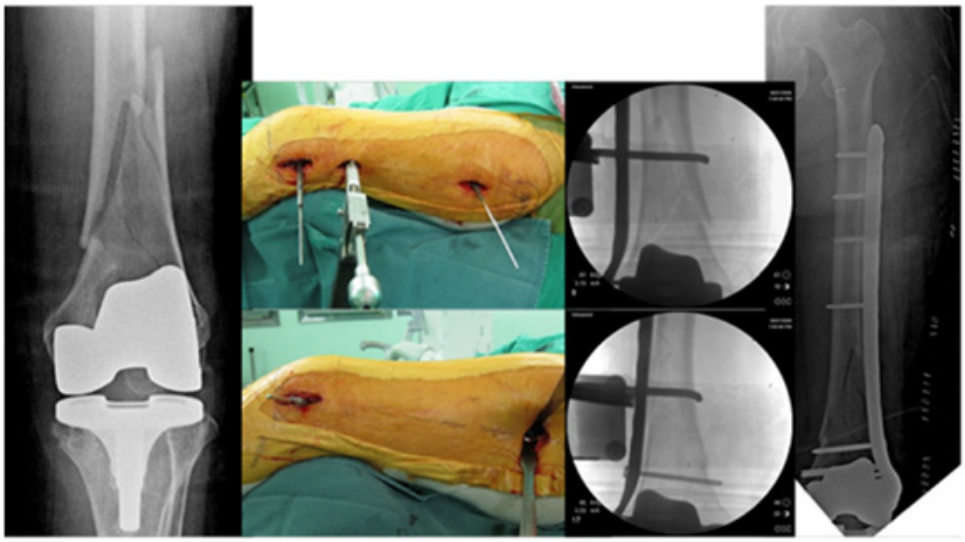


Figure 1. MIPO technique applied to a periprosthetic distal femoral fracture around a knee arthroplasty, with minimal skin incisions and biomechanically based fixation. Source: Kim, J. H et al (2017) [3]

2.3. Surgery for hip fractures

Osteoporotic hip fractures in older adults are often accompanied by pre-existing medical conditions, so careful preventive measures are needed before and after surgery [4, 5]. The general principle is to help patients regain as much independence in daily living as possible by achieving early stable fixation or performing arthroplasty.

Hip fractures of the proximal femur are classified by anatomical location as femoral neck, intertrochanteric, or subtrochanteric fractures (Figure 2A). Arthroplasty is usually indicated for displaced femoral neck fractures, or for minimally displaced fractures with a high risk of fixation failure due to severe osteoporosis (Figure 2B).



Figure 2. (A) Intertrochanteric fracture fixed with a proximal femoral intramedullary nail. (B) Femoral neck fracture treated with hemiarthroplasty. Source: Kim, J. H et al (2017) [3]

For intertrochanteric, subtrochanteric, and femoral shaft fractures, internal fixation is the widely accepted method. The main challenge is the difficulty of achieving stable fixation, which leads to characteristic complications such as nonunion, implant breakage, or loss of fixation stability [5, 8].

The current trend has shifted from the concept of "absolute fixation" to "biological fixation" with relative stability. This is achieved through indirect reduction and minimal damage to bone and soft tissue to improve the chance of union [8].

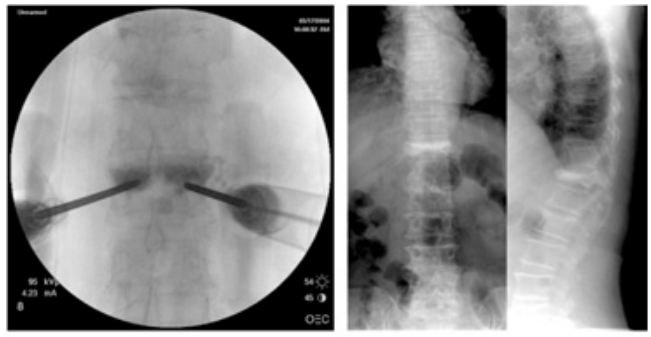
For proximal femoral fractures, intramedullary nailing is commonly used because it minimizes soft-tissue damage and has clear biomechanical advantages over plating. When a plate is used, a locking plate of sufficient length combined with the MIPO technique is the recommended option [3].

2.4. Spine surgery

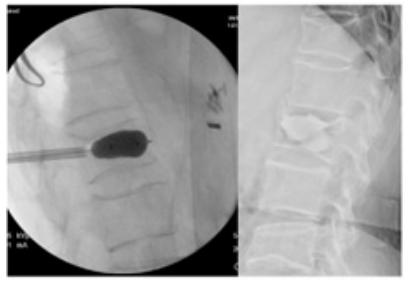
Most osteoporotic spinal fractures are vertebral compression fractures, which are stable and can be managed conservatively. The aim is to enable early mobilization and prevent further fractures by controlling pain and stabilizing the fractured vertebral body [10].

Initial treatment includes bed rest, analgesics, a spinal brace, and physical therapy. If severe pain or progressive collapse persists after 2 to 3 weeks of conservative treatment, percutaneous vertebroplasty (Figure 3A) or balloon kyphoplasty (Figure 3B) may be indicated [10].

Three randomized sham-controlled trials, by Kallmes et al. (2009), the VERTOS IV study (Firanescu et al., 2018), and Buchbinder et al. (2009), found no significant advantage of vertebroplasty over a sham procedure for sustained pain relief [11-13]. Nevertheless, the procedure is still used selectively as a minimally invasive intervention that provides rapid pain relief and supports early mobilization in patients who respond poorly to conservative treatment [10].



(A)



(B)

Figure 3. Percutaneous vertebroplasty (A) and balloon kyphoplasty (B). Source: Kim, J. H et al (2017) [3]

Open surgery is indicated when there is neurological injury or severe deformity. It

allows neural decompression and correction of spinal deformity, but it requires careful consideration because of the risk of complications such as implant loosening and pseudarthrosis in patients with poor bone quality [10] (Figure 4).



(A) (B)

Figure 4. Open corrective surgery for osteoporotic kyphotic deformity. (A) Preoperative radiograph: severe multilevel osteoporotic fractures with kyphotic deformity. (B) Postoperative radiograph: the vertebral body was resected and fixed with pedicle screws and rods. Source: Kim, J. H et al (2017) [3]

In spinal instrumentation, pedicle screw fixation is central. In patients with osteoporosis, construct stability correlates closely with BMD [3]. Principles that help optimize fixation include wide release of the deformed segment, avoiding forceful correction, adding anterior structural bone grafting, maintaining sagittal balance, and accurate screw placement [8]. The most common augmentation method is cement augmentation, which can be combined with multipoint fixation using bone grafts, laminar hooks, or sublaminar wires [3].

2.5. Surgery for other fractures

In distal radius fractures, an early manifestation of osteoporosis, volar locking plates distribute load evenly and improve stability, allowing early wrist motion and better functional outcomes [14].

In proximal humerus fractures, the main challenge is maintaining stability of the humeral head in osteoporotic bone. In complex fractures in older patients, reverse shoulder arthroplasty is increasingly considered a reasonable option because it does not depend on bone quality [15].

No single formula fits every case: the choice of implant, fixation technique, and timing of mobilization must all be individualized according to fracture site, severity of osteoporosis, and the patient's baseline condition. Treatment of the underlying osteoporosis is also needed at the same time to reduce the risk of refracture [16]. Surgical options by fracture site are presented in Table 1

Table 1. Choice of surgical method by site of osteoporotic fracture

Fracture site	Preferred method	Notes

Femoral neck (displaced)	Hemi- or total hip arthroplasty	Allows early weight-bearing
Intertrochanteric	Proximal femoral nail (PFNA, gamma nail)	Cement augmentation possible in severe osteoporosis or unstable fixation
Subtrochanteric	Long intramedullary nail	Good reduction needed before nailing
Femoral shaft	Intramedullary nail or MIPO locking plate	MIPO preferred for comminuted fractures
Distal radius	Volar locking plate	Early wrist motion
Proximal humerus	Locking plate or reverse shoulder arthroplasty	Arthroplasty for complex fractures in elderly patients
Vertebra (stable compression fracture)	Conservative treatment ± vertebroplasty/kyphoplasty	Consider vertebroplasty/kyphoplasty for persistent pain unresponsive to conservative treatment
Vertebra (neural compression)	Open decompression and pedicle screw fixation	Selected patients only; careful consideration in multimorbid patients

PFNA: Proximal Femoral Nail Antirotation; MIPO: Minimally Invasive Plate Osteosynthesis.

Perioperative optimization and the orthogeriatric co-management model

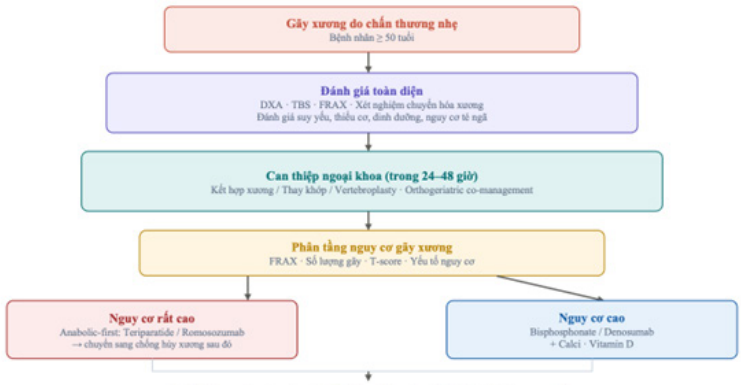


Figure 5. Flowchart for managing osteoporotic fractures from identification to long-term follow-up. Patients aged 50 years or older with a fragility fracture undergo comprehensive assessment, early surgical intervention within 24 to 48 hours, risk stratification to select an appropriate osteoporosis treatment strategy, and long-term follow-up through the FLS model. DXA: Dual-energy X-ray Absorptiometry; TBS: Trabecular Bone Score; FRAX: Fracture Risk Assessment Tool; FLS: Fracture Liaison Service.

In elderly patients with osteoporotic fractures, surgical outcomes depend heavily on perioperative management. Orthogeriatric co-management, in which orthopedic surgeons and geriatricians share care, has been shown to reduce complications, shorten hospital stay, and lower mortality after hip fracture [2, 4, 5].

Before surgery, nutritional status should be assessed (with protein, calcium, and vitamin D supplementation), and patients should be screened for frailty and sarcopenia: these two factors directly affect postoperative recovery. Multimodal pain control (paracetamol, NSAIDs when not contraindicated, regional anesthesia) reduces opioid use, a common cause of delirium and respiratory depression in older adults. In patients over 75 years of age, delirium prevention with non-pharmacological measures, such as maintaining the sleep–wake cycle and frequent reorientation, should be a fixed part of the protocol rather than optional. Anticoagulation management, venous thromboembolism

prophylaxis, and initiation of rehabilitation within the first 24 hours after surgery follow standard protocols [2, 8].

Integrating these interventions into multidisciplinary team care has become the recommended standard [4, 5]. The comprehensive management pathway for patients with osteoporotic fractures, from initial identification to long-term follow-up through the FLS model, is illustrated in Figure 5.

3. FOLLOW-UP AND MANAGEMENT OF FRACTURE PATIENTS AND THE FRACTURE LIAISON SERVICE (FLS) MODEL

3.1. Patient follow-up

Patients with osteoporotic fractures, especially hip fractures, have a very high risk of subsequent fracture within 1 to 2 years after the first fracture, now referred to as "imminent fracture risk". The rate of a second fracture is about 9%, and mortality in the first year can reach 30%. Osteoporosis should therefore be treated actively alongside surgical treatment, starting from the first fracture [16].

In patients already treated with bisphosphonates, adherence should be assessed. If adherence is poor, the regimen or formulation should be adjusted. If adherence is good but fractures still occur, patients should be switched to an anabolic agent (teriparatide, romosozumab) or denosumab, depending on risk and patient characteristics. In patients with severe renal impairment (eGFR < 30–35 mL/min/1.73 m^2), bisphosphonates should be used with caution and may be replaced by denosumab, with monitoring for hypocalcemia [16, 17].

In atypical femoral fractures, the contralateral side should be examined because the risk of bilateral fracture is high (30% to 40%). If an occult lesion is present, prophylactic intramedullary nailing should be performed [3].

The concept of a "drug holiday" applies mainly to bisphosphonates after at least 5 years of oral or 3 years of intravenous therapy in low-risk patients. Denosumab should not be stopped arbitrarily, because rebound vertebral fractures after discontinuation have been reported in clinical practice [16].

3.2. Patient management

Patient management requires a comprehensive approach that includes drug therapy, lifestyle modification, and rehabilitation. The FRAX tool can help stratify fracture risk and guide treatment strategy after a first fracture [16]. Risk stratification and osteoporosis treatment strategies after fracture are summarized in Table 2

Table 2. Risk stratification and osteoporosis treatment recommendations after fracture

Risk category	Clinical features	Treatment recommendation
High risk	T-score ≤ -2.5 or fragility fracture; FRAX ≥ intervention threshold	Bisphosphonate or denosumab + calcium + vitamin D
Very high risk	T-score ≤ -2.5 with fracture; multiple recurrent fractures; imminent fracture; prior treatment failure	Anabolic-first: teriparatide or romosozumab → then switch to antiresorptive

Timing of osteoporosis medication after surgery

In clinical practice, the question of when to start osteoporosis medication after an acute fracture often arises. Based on current evidence, bisphosphonates can be started early after osteosynthesis without impairing fracture healing. Denosumab also does not need to be delayed. Teriparatide can be given early and even has potential benefits in promoting healing at some sites [17, 18]. Because the risk of a second fracture is very

high during the imminent-risk period, current recommendations stress that osteoporosis treatment should not be delayed after an acute fracture [17, 18].

All patients should avoid smoking, take adequate calcium and vitamin D, and do strength and balance exercises for 20 to 30 minutes, 3 to 4 times/week. BMD should be assessed after the fracture and monitored periodically (usually after 2 years), and treatment adherence should be checked after about 4 months [19].

Fall prevention is central. Measures such as balance training, reducing sedative use, and improving the home environment have been shown to lower the risk of falls. Hip protectors can substantially reduce the risk of hip fracture in high-risk groups [19].

3.3. The Fracture Liaison Service (FLS) model

An osteoporotic fracture is a warning sign of imminent fracture risk over the next 1 to 2 years. However, most patients who have had a fracture are still not adequately assessed or treated for osteoporosis, creating a "care gap" in the health system. In health systems without an FLS model, only about 18% to 25% of patients receive appropriate osteoporosis treatment after a fracture; implementing an FLS raises this proportion to 70% to 80% [20, 21]. FLS is therefore an essential component and a pillar of secondary fracture prevention strategies.

In practice, patients with osteoporotic fractures are often discharged after surgery without anyone asking, "Does this patient have osteoporosis? What treatment is needed to prevent the next fracture?" This is the care gap that FLS is designed to close. An FLS coordinator, usually a nurse or physician with specialized training, is responsible for screening patients aged 50 years or older with fragility fractures directly in the orthopedic or emergency department, and then coordinates with endocrinology, rheumatology, geriatrics, and rehabilitation for assessment, treatment initiation, and long-term follow-up [20, 22]. The coordinator is the "key link" that keeps patients from being lost to follow-up after discharge, which is the most common problem in post-fracture osteoporosis management.

The NoFRACT study by Andreasen et al. (2025) of more than 100,000 patients found that FLS reduced the risk of subsequent fracture by 13% in women (HR 0.87; 95% CI 0.83–0.92) and by 10% in men (HR 0.90; 95% CI 0.81–0.99) [23]. Integrating electronic medical records with ICD-10 codes more than doubled the identification rate of vertebral fractures [21]. FLS also contributes to an approximately 20% to 30% reduction in mortality after hip fracture through coordinated osteoporosis treatment, early rehabilitation, and fall prevention [20, 23].

Operationally, FLS follows a standardized 4I process with four steps: Identification, Investigation, Intervention, and Integration (integration and long-term follow-up). Complete FLS models can substantially reduce the risk of subsequent fracture, with the size of the reduction varying by model and follow-up duration, whereas incomplete models are clearly less effective [20]. The structure of the FLS model following the 4I process and the central role of the coordinator are illustrated in Figure 6

The FLS coordinator's role determines how well the service performs. With a dedicated coordinator, combined with an active identification system and a long-term follow-up mechanism, the proportion of patients receiving osteoporosis treatment after fracture can increase 3- to 5-fold within one year [21, 24].

As Vietnam's population ages rapidly, implementing FLS in general hospitals and geriatric hospitals is a necessary direction. In practice, however, implementation in Vietnam still faces many challenges, including a shortage of coordinators, limited interoperable electronic medical record systems, and the absence of a clear financing mechanism for secondary fracture prevention programs. Hospitals that pioneer FLS should develop procedures suited to local conditions, build on the experience gained, and then expand the model.

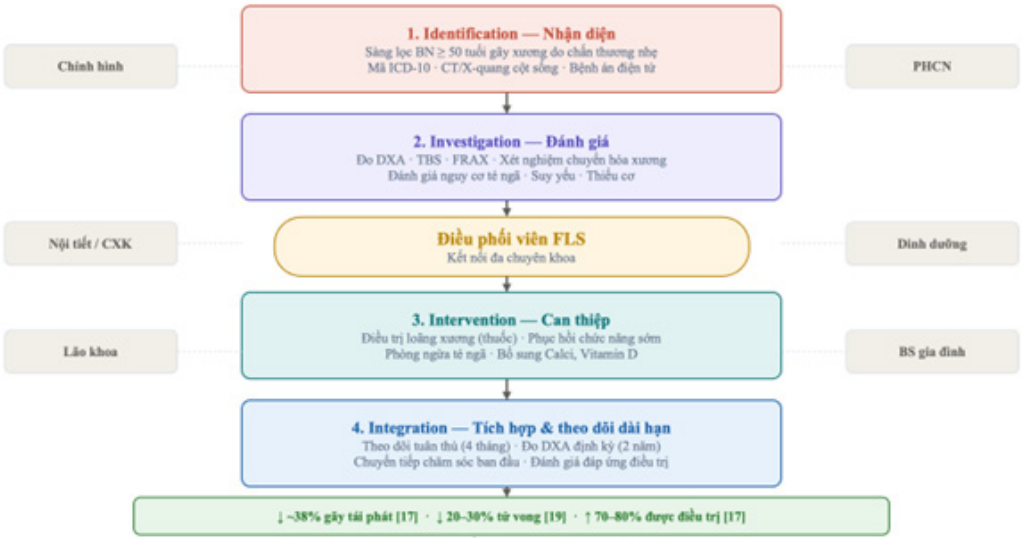


Figure 6. The Fracture Liaison Service (FLS) model following the 4I process. The FLS coordinator plays a central role, linking the specialties across Identification, Investigation, Intervention, and Integration (long-term follow-up). CXK: Rheumatology; PHCN: Rehabilitation; BS: Physician.

4. BONE HEALING TIME AND THE EFFECT OF OSTEOPOROSIS MEDICATIONS

A retrospective study in Vietnam (01/2020–01/2024) of 405 patients with fractures compared group A (242 fracture patients with osteoporosis) and group B (163 fracture patients without osteoporosis), with mean follow-up of 12.7 ± 3.6 months and 13.6 ± 3.25 months, respectively. Patients with osteoporosis were older and predominantly female ($p < 0.05$). Intertrochanteric fracture was the most common fracture site, with 81 patients (20%), of whom 52 (64.2%) had osteoporosis. Osteoporosis prolonged healing time in patients with intertrochanteric and femoral shaft fractures [25].

A study by Chandran et al. (2024) on the effects of osteoporosis medications on fracture healing showed that healing is a complex multistage process, and most fractures heal through a combination of intramembranous ossification and endochondral ossification [17].

Although experimental animal data show that osteoporosis impairs fracture healing, clinical studies in humans have not shown a clear association. Systematic reviews have consistently concluded that bisphosphonates and denosumab do not delay healing of distal radius, hip, or vertebral fractures [17, 18]. Teriparatide may shorten healing time in distal radius fractures and improve pain and function in hip and vertebral fractures. Romosozumab shows potential in animal models but has not been confirmed in humans [17]. Practical recommendations are summarized in Table 3.

Table 3. Effects of osteoporosis medications on fracture healing

Drug class	Effect on fracture healing	Practical recommendation
Bisphosphonate	No clinically significant delay in healing of distal radius, hip, or vertebral fractures	No need to delay or stop the drug in acute fracture
Denosumab	No clinical evidence of delayed healing	Continue treatment; monitor serum calcium

Teriparatide (PTH 1-34)	May shorten healing time in distal radius fractures; improves pain and function in hip and vertebral fractures	Consider in severe progressive osteoporosis
Romosozumab	Potential to promote healing in preclinical studies; no clear clinical evidence in humans	Not routinely recommended to promote healing
SERM	No clinical data on its effect on fracture healing	No specific recommendation

5. CONCLUSION

Osteoporotic fractures in older patients are not simply acute events requiring surgical management; they are warning signs of imminent fracture risk over the next 1 to 2 years. This understanding calls for a change in the model of care: from "operate and discharge" to a continuous pathway that includes early surgical intervention (within 24 to 48 hours), perioperative optimization through orthogeriatric co-management, and secondary fracture prevention through the FLS model. Current data indicate that bisphosphonates and denosumab do not impair fracture healing, so osteoporosis treatment need not be delayed after an acute fracture. In very high-risk patients (T-score ≤ -2.5 with recurrent fractures or prior treatment failure), an anabolic-first strategy (teriparatide or romosozumab) followed by a switch to antiresorptive therapy is recommended to maximize gains in bone density and reduce the risk of further fracture [16, 17]. In Vietnam, with its rapidly aging population, implementing FLS in general and geriatric hospitals is a necessary direction. However, several challenges need to be addressed, including a shortage of coordinators, non-interoperable electronic medical record systems, and the lack of a reimbursement mechanism for secondary fracture prevention programs. Studies evaluating feasibility, cost-effectiveness, and FLS models suited to Vietnamese conditions should be a future priority.

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