

Integrative Ayurvedic Approaches in the Clinical Management of Osteoporosis: A Transdisciplinary Perspective on Bone Health and Regeneration

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ABSTRACT

Osteoporosis is a progressive skeletal disorder characterized by reduced bone mass and microarchitectural deterioration, leading to increased bone fragility and susceptibility to fractures. It is a major global health concern, particularly affecting postmenopausal women and the elderly. Despite being asymptomatic in the early stages, the condition often presents with debilitating fractures, impacting mobility, independence, and quality of life. While conventional pharmacological treatments are available, they are often accompanied by adverse effects and may not fully restore bone health. Ayurveda, the traditional Indian system of medicine, offers a comprehensive and individualized approach to the prevention and management of osteoporosis. Descriptions of conditions like *Asthikshaya* and *Asthisaushirya* in classical texts align closely with the modern understanding of osteoporosis. Ayurvedic treatment integrates dietary regulation, herbal formulations, Panchakarma therapies, Rasayana (rejuvenation), lifestyle modifications, and supportive practices such as yoga. These approaches aim not only to alleviate symptoms but also to correct underlying imbalances in bodily tissues and metabolic functions, especially *Vata dosha* and *Dhatvagni* (tissue metabolism). This paper presents a detailed review of the Ayurvedic perspective on osteoporosis, highlighting both classical and contemporary evidence supporting the efficacy of natural, safe, and holistic interventions. The integrative potential of Ayurveda offers a promising pathway for long-term bone health and regeneration when combined with appropriate diagnostic and monitoring tools from modern medicine.

KEYWORDS: - Osteoporosis, Asthikshaya, Ayurvedic Medicine, Bone Health, Vatavyadhi, Rasayana, Basti, Fracture Prevention, Yoga Therapy, Integrative Medicine

INTRODUCTION

Osteoporosis is a progressive skeletal disorder defined by reduced bone mineral density and compromised bone architecture, making bones fragile and susceptible to fractures. Unlike osteopenia, which is a milder form of bone loss, osteoporosis signifies pathological degeneration. This condition is termed a "silent killer" because it remains asymptomatic until a fracture occurs, most commonly in the spine, hip, or wrist. The diagnosis is often delayed, and many cases go untreated. Bone strength, determined by both bone density and bone quality, deteriorates with age, especially in postmenopausal women due to hormonal

changes. Globally, the increasing burden of osteoporosis led the World Health Organization to declare 2000–2010 as the "Bone and Joint Decade", and October 20 is recognized as World Osteoporosis Day. In India, the AYUSH ministry has acknowledged osteoporosis under its "Golden Triangle Partnership Program", highlighting its significance.

LITERATURE REVIEW

- Osteoporosis has been a subject of extensive research in both modern and traditional medical systems. In contemporary medicine, numerous studies have established its epidemiology, pathophysiology, and risk factors, particularly emphasizing the roles of aging, hormonal changes, nutritional deficiencies, and sedentary lifestyle. According to the World Health Organization (WHO), osteoporosis is a major public health issue globally, especially among postmenopausal women and the elderly. The clinical emphasis in allopathic practice primarily revolves around early diagnosis through bone mineral density (BMD) assessment and pharmacological interventions such as bisphosphonates, selective estrogen receptor modulators, and calcium-vitamin D supplementation. While effective in slowing disease progression, these treatments often carry potential side effects and do not reverse existing bone loss.
- In contrast, Ayurveda offers a deeper, tissue-based understanding of osteoporosis through the lens of *Asthi kshaya* (depletion of bone tissue), *Vatavyadhi* (neuromuscular and degenerative disorders), and *Dhatu kshaya* (tissue degeneration). Classical Ayurvedic texts such as *Charaka Samhita* and *Sushruta Samhita* describe the role of *Vata dosha* in bone degradation, especially in old age when Vata naturally increases. Therapeutic strategies mentioned include *Rasayana* therapy for rejuvenation, *Basti* (medicated enema) for systemic regulation of Vata, and the use of bone-supportive herbs and mineral preparations like *Lakshadi Guggulu*, *Ashwagandha*, *Praval Bhasma*, and *Kukkutanda Twak Bhasma*.
- Modern research has started to validate several Ayurvedic formulations and their osteoprotective potential. Studies have shown that *Ashwagandha* (*Withania somnifera*) improves bone mineralization and helps balance cortisol, while *Shatavari* (*Asparagus racemosus*) offers phytoestrogenic activity, making it particularly beneficial for postmenopausal women. Experimental models have demonstrated the anabolic effects of traditional formulations on bone metabolism, but larger clinical trials and standardized documentation remain limited.
- Yoga has also gained attention in recent literature as a complementary approach to bone health. Regular practice of asanas that apply mechanical load to bones has been shown to potentially improve BMD and reduce the risk of falls. Furthermore, yoga contributes to postural alignment, balance, and stress reduction, all of which are important in managing osteoporosis holistically.
- Overall, while the biomedical model provides diagnostic clarity and pharmacological solutions, the Ayurvedic system emphasizes individualized care, preventive strategies, and natural regeneration. An integrative approach combining the strengths of both systems could offer a more sustainable solution for managing osteoporosis.

PATHOPHYSIOLOGY

Bone undergoes constant remodeling through resorption and formation. With advancing age, resorption outpaces formation, leading to porous, brittle bones. Peak bone mass is achieved in early adulthood and declines thereafter. Cortical thinning and trabecular loss further compromise skeletal integrity. In wider bones, although external bone growth occurs, the internal structure may become weaker due to loss of trabecular bone, increasing fracture risk in later life.

Osteoporosis is a systemic skeletal disorder characterized by a reduction in bone mass and deterioration of bone microarchitecture, leading to increased bone fragility and susceptibility to fractures. The pathophysiology involves an imbalance between bone resorption and bone formation.

A) Bone Remodelling and Homeostasis

Bone is a dynamic tissue that undergoes continuous remodelling throughout life. This process involves two key cellular activities:

1. **Osteoclast-mediated bone resorption**
2. **Osteoblast-mediated bone formation**

In a healthy adult, bone resorption and formation are tightly coupled to maintain bone mass and structural integrity. However, in osteoporosis, this balance is disrupted resorption outpaces formation.

Key Mechanisms Involved

1. Increased Osteoclast Activity

The overactivation of osteoclasts leads to excessive bone resorption. This can be triggered by:

- Hormonal changes, especially reduced **estrogen** levels in postmenopausal women
- Elevated **parathyroid hormone (PTH)** levels
- Increased production of **pro-resorptive cytokines** like IL-1, IL-6, and TNF- α

2. Reduced Osteoblast Function

Bone-forming activity is diminished due to:

- Aging-related decline in osteoblast progenitor cells
- Impaired differentiation of mesenchymal stem cells into osteoblasts
- Increased osteoblast apoptosis

3. Altered Calcium and Vitamin D Metabolism

Inadequate calcium intake or poor absorption, along with vitamin D deficiency, leads to secondary hyperparathyroidism, which stimulates bone resorption to maintain serum calcium levels.

4. Disruption of the RANK/RANKL/OPG Pathway

The **RANK/RANKL/OPG system** plays a central role in regulating osteoclast differentiation:

- **RANKL** (Receptor Activator of Nuclear Factor κ B Ligand) binds to **RANK** on osteoclast precursors, promoting their maturation.
- **Osteoprotegerin (OPG)** acts as a decoy receptor for RANKL, inhibiting osteoclastogenesis.
- In osteoporosis, increased RANKL or decreased OPG levels enhance osteoclast activity.

B) Age-Related and Secondary Factors

- **Senile osteoporosis** results from age-associated decline in bone formation and reduced calcium absorption.
- **Secondary osteoporosis** may result from endocrine disorders (e.g., hyperthyroidism), chronic corticosteroid use, gastrointestinal malabsorption, or immobilization.

C) Microarchitectural Changes

As bone mass declines, the **trabecular bone** (spongy bone) becomes thinner and loses connectivity, while **cortical bone** (compact bone) becomes porous and weak. These structural defects increase the risk of fractures, particularly in the spine, hip, and wrist.

ETIOLOGY

Osteoporosis is broadly classified into:

Primary Osteoporosis: Associated with aging and menopause. Risk factors include low body mass index,

poor nutrition, vitamin D and calcium deficiency, sedentary lifestyle, smoking, alcohol use, and hormonal changes.

Secondary Osteoporosis: Occurs due to underlying conditions such as endocrine disorders, chronic diseases, or medication use (e.g., corticosteroids).

CLINICAL FEATURES

Osteoporosis is commonly referred to as a "silent disease" because it progresses without noticeable symptoms until a fracture occurs. The condition typically remains undetected until significant bone loss has already taken place, making early diagnosis challenging. However, once the skeletal system becomes sufficiently compromised, certain clinical manifestations may begin to appear.

1. Fractures

The hallmark clinical presentation of osteoporosis is fragility fractures, which occur with minimal or no trauma. Common fracture sites include:

- **Vertebral fractures:** These are the most prevalent and often lead to sudden back pain, loss of height, spinal curvature (kyphosis), and restricted mobility.
- **Hip fractures:** Often resulting from falls, these injuries may require surgical intervention and carry a high risk of morbidity and mortality.
- **Distal radius (wrist) fractures:** These are frequent in early postmenopausal women and often result from falls on outstretched hands.

2. Loss of Height

Progressive compression fractures in the vertebrae may lead to a noticeable reduction in height, which is often the first visible sign in older adults.

3. Postural Changes

Chronic vertebral compression can lead to kyphosis (forward curvature of the spine), often referred to as a "dowager's hump." This deformity can affect breathing, balance, and overall quality of life.

4. Chronic Pain

Persistent pain in the back or hips may occur due to microfractures or deformities, significantly affecting day-to-day activities. Pain may worsen with movement and decrease with rest.

5. Decreased Mobility

Fractures and bone pain can lead to reduced mobility, increased risk of falls, and dependence on assistive devices for ambulation, further contributing to a sedentary lifestyle and worsening bone health.

6. Functional Decline

Patients may experience difficulty in performing daily activities such as bending, lifting, walking, or rising from a seated position. This may lead to loss of independence, particularly in elderly individuals.

7. Psychological Impact

Living with osteoporosis can contribute to anxiety, depression, and fear of falling. This psychological burden can have a profound effect on overall well-being and adherence to treatment plans.

INVESTIGATION/ DIAGNOSIS

Early detection is essential. Common diagnostic tools include:

- **Bone Mineral Density (BMD) Testing** – Dual-energy X-ray absorptiometry (DEXA) is the gold standard.
 - **Normal:** T-score ≥ -1

- **Osteopenia:** T-score between -1 and -2.5
- **Osteoporosis:** T-score \leq -2.5
- **Severe:** T-score \leq -2.5 with fractures
- **Biochemical Markers** – Used to assess bone turnover
- **Imaging Techniques** – Radiographs, QCT, and ultrasound

AYURVEDIC PERSPECTIVE

In Ayurveda, osteoporosis corresponds to conditions such as *Asthikshaya* (depletion of bone tissue), *Asthisaushirya* (porous bones), and is broadly considered a form of *Vatavyadhi* (disorder of Vata dosha).

Management Strategy in Ayurveda involves: -

1. Nidana Parivarjana (Elimination of causative factors)

Avoiding tobacco, alcohol, poor diet, and sedentary habits is fundamental to prevention.

2. Shodhana Therapy (Purification)

- **Basti (Enema therapy)** with medicated milk and ghee is advocated by Acharya Charaka for *Vata* disorders and *Asthikshaya*.

3. Shamana Therapy (Palliative treatment)

- **Asthi-pravartaka dravyas** (bone-supporting substances) based on *Samanya Siddhanta* are prescribed.
- **Examples:** Ajasthi Bhasma, Kukkutanda Twak Bhasma, Shankha Bhasma, Praval Pishti, Kapardika Bhasma

4. Taila and Ghrita (Medicated oils and ghee)

- **Tailas:** Lakshadi Taila, Bala Ashwagandhadi Taila, Ksheerabala Taila
- **Ghritas:** Panchatikta Ghrita, Mahatikta Ghrita, Indukanta Ghrita

5. Guggulu Kalpas (Resin-based formulations)

- Lakshadi Guggulu, Yogaraj Guggulu, Abha Guggulu, Maha Yogaraj Guggulu

6. Ksheerapaka (Herbal decoctions with milk)

- Arjuna Ksheerapaka, Ashwagandha Ksheerapaka

7. Rasayana Therapy (Rejuvenative therapy)

- Ashwagandha, Shatavari, Chyavanprash, Shilajatu Rasayana, Triphala Rasayana

PATHYA-APATHYA (DIET AND LIFESTYLE RECOMMENDATIONS)

Pathya (Recommended):

- Foods rich in *Madhura Rasa* (sweet taste): rice, milk, ghee, meat soups
- Daily gentle exercises
- Exposure to sunlight
- Balanced routine and stress management

Apathya (To Avoid):

- Excessive intake of bitter, pungent, astringent foods
- Alcohol, dry and processed meats, irregular eating
- Excessive physical exertion, sleep disturbances, and emotional stress

ROLE OF YOGA IN THE MANAGEMENT OF OSTEOPOROSIS

Yoga, an ancient practice rooted in Indian philosophy, offers a holistic approach that integrates physical postures (*asanas*), breath control (*pranayama*), and mindfulness. In the context of osteoporosis, yoga can play a significant supportive role in maintaining bone health, improving posture, enhancing balance, and reducing the risk of falls and fractures.

1. Improves Bone Strength and Flexibility

Certain yoga postures apply gentle, controlled stress to bones, which may help in maintaining or even improving bone density. Weight-bearing asanas stimulate osteoblastic activity, thereby promoting bone formation.

Beneficial Asanas:

- **Tadasana (Mountain Pose):** Enhances posture and strengthens the spine.
- **Vrikshasana (Tree Pose):** Improves balance and lower body strength.
- **Trikonasana (Triangle Pose):** Strengthens the hips, legs, and spine.
- **Bhujangasana (Cobra Pose):** Stretches and strengthens the spine.
- **Setu Bandhasana (Bridge Pose):** Strengthens the hips and back muscles.
- **Adho Mukha Svanasana (Downward Dog Pose):** Engages multiple muscle groups and promotes joint flexibility.

2. Enhances Balance and Coordination

Falls are a major cause of fractures in people with osteoporosis. Regular yoga practice improves proprioception (body awareness), balance, and muscle coordination, which can significantly reduce fall risk.

3. Alleviates Pain and Improves Posture

Yoga helps relieve chronic back pain caused by vertebral compression fractures. It also encourages spinal alignment and correction of kyphotic posture, thus improving quality of life.

4. Reduces Stress and Supports Hormonal Balance

The calming effects of pranayama and meditation can reduce cortisol levels, which may indirectly benefit bone health. Stress reduction also supports hormonal stability, particularly important for postmenopausal women.

Useful Practices:

- **Nadi Shodhana (Alternate Nostril Breathing):** Balances the nervous system and reduces stress.
- **Bhramari (Humming Bee Breath):** Calms the mind and aids relaxation.
- **Yoga Nidra (Guided Yogic Sleep):** Deepens rest and supports healing.

5. Complements Ayurvedic Lifestyle

Yoga harmonizes well with Ayurvedic principles by supporting *Vata* balance, enhancing *Agni* (digestive fire), and encouraging sattvic (pure) living, all of which are vital for preventing tissue depletion like *Asthikshaya* (bone loss).

PREVENTION

A) Primary Prevention: Strengthening the Foundation (Swasthasya Swasthya Rakshanam)

In Ayurveda, maintaining equilibrium in doshas, dhatus, and agni is essential for bone health. The *Asthi Dhatu* (bone tissue) is nourished through proper digestion and metabolism, which is regulated by *Jatharagni* and *Dhatvagni*.

- *Dinacharya* (daily regimen) and *Ritucharya* (seasonal regimen) are emphasized to preserve vitality and prevent early degeneration.

- Ahara (diet) plays a vital role; consumption of calcium-rich foods like sesame seeds, milk, and green leafy vegetables is encouraged.
- Rasayana therapy, especially the use of herbs like Ashwagandha, Guduchi, and Shatavari, supports tissue regeneration and vitality.

B) Secondary Prevention: Early Detection and Intervention (Roga Prakopa Avastha)

Early stages of osteoporosis may go unnoticed. Ayurveda emphasizes Nidana Parivarjana (eliminating causative factors) and Samprapti Vighatana (breaking the pathogenesis).

- Lifestyle modifications to counter Vata aggravation, which leads to bone depletion, are prescribed.
- Therapies such as Abhyanga (therapeutic oil massage) with Ksheerabala Taila or Dhanwantaram Taila nourish bones and soothe Vata.
- Use of Medhya Rasayanas and Balya Dravyas helps strengthen bones and prevent progression.

C) Tertiary Prevention: Rehabilitative and Supportive Care (Vyadhi Avastha)

In advanced stages, where deformities or fractures occur, Ayurveda offers supportive therapies to improve quality of life and prevent complications.

- **Panchakarma**, particularly Basti Karma (medicated enemas), is considered highly effective in pacifying Vata and revitalizing Asthi Dhatu.
- **Rehabilitative care** includes gentle Yogic practices, particularly Vata-shamaka asanas and **Pranayama** to improve circulation and reduce stress-related catabolism.
- Internal medications such as **Laksha Churna**, **Hadjod (Cissus quadrangularis)**, and **Mukta Shukti Bhasma** are used for bone healing and remineralization.

DISCUSSION

Osteoporosis, often dubbed a "silent disease", gradually compromises bone strength, increasing fracture risk without apparent early symptoms. Modern medicine recognizes its high prevalence and devastating outcomes, particularly among aging populations and postmenopausal women. Despite advances in diagnosis and pharmacological intervention, side effects and limited reversibility of bone loss call for complementary approaches.

Ayurveda offers a valuable framework in understanding and managing osteoporosis. The classical descriptions of *Asthikshaya* and *Vatavyadhi* closely parallel the degenerative processes observed in osteoporosis. Ayurvedic principles emphasize individualized treatment, prevention through lifestyle modification, and rejuvenation of tissue through *Rasayana* therapy.

The strength of Ayurvedic management lies in its holistic nature. It not only addresses symptomatic relief but also targets the root causes, including impaired *Agni* (digestive fire), *Dhatukshaya* (tissue depletion), and aggravated *Vata*. Herbal-mineral preparations like *Praval Bhasma*, *Lakshadi Guggulu*, and *Ashwagandha Rasayana* help restore bone integrity, while *Basti* and *Ksheerapaka* therapies nourish and pacify vitiated *Vata*.

Moreover, dietary recommendations focusing on *Madhura* (sweet), *Snigdha* (unctuous), and *Guru* (nourishing) qualities help maintain bone health. Inclusion of milk, ghee, and protein-rich foods align with both Ayurvedic wisdom and modern nutritional science. Lifestyle practices such as regular physical activity, adequate sun exposure, and stress management also bridge ancient wisdom with current preventive strategies.

Although Ayurvedic literature provides detailed protocols, there is a pressing need for well-designed clinical studies, standardized formulations, and evidence-based validation to integrate these practices into

mainstream care for osteoporosis. Future research should focus on mechanistic studies and comparative trials to establish efficacy and safety of Ayurvedic regimens.

CONCLUSION

Osteoporosis is a significant public health concern with far-reaching consequences. Although modern medicine provides symptomatic relief, Ayurveda offers a comprehensive approach focusing on prevention, strengthening of bone tissue, and long-term management. Incorporating Ayurvedic principles, including dietary regulation, herbal formulations, and Rasayana therapy, can offer effective and holistic support to individuals at risk of or suffering from osteoporosis. Ayurveda provides a preventive and promotive framework for osteoporosis that aligns with modern concepts of primary, secondary, and tertiary care. Through personalized dietary, lifestyle, and therapeutic interventions, Ayurveda not only addresses symptomatic management but also aims to restore systemic balance and long-term resilience.

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