

Osteoporosis : A Review

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Abstract- Osteoporosis is a common condition of aged grown-ups and is a major public health problem worldwide. As the population ages, the frequency of osteoporosis and performing osteoporotic fractures is raising. Although osteoporosis is more common in women than in men, the commonness in men is raising. The disability, mortality, and cost of hip and vertebral fractures are substantial in the quickly growing, growing population so that prevention and treatment of osteoporosis is a major public health concern. This paper reviews the impact of osteoporosis and provides an approach toward preventing and treating osteoporosis and its complications.

Keywords- Osteoporosis, Bones, Fracture, Porous bone, Estrogen.

I. INTRODUCTION

Bone is living towel that's constantly being broken down and replaced. Osteoporosis occurs when the creation of new bone does not keep up with the loss of old bone. Osteoporosis affects men and women of all races. But white and Asian women, especially aged women who are formerly menopause, are at topmost danger. medicines, healthy diet and weight-bearing exercise can help help bone loss or strengthen previously weak bones.

Osteoporosis is a condition that affects the bones. Its name comes from Latin for "porous bones".The inside of a healthy bone has small spaces, like a honeycomb. Osteoporosis increases the size of these spaces, causing the bone to lose strength and density. In addition, the outside of the bone grows weaker and thinner.

Osteoporosis is a silent disease. You might not know you have it until you break a bone. A bone mineral density test is the best way to check your bone health.To keep bones strong, eat a diet rich in calcium and vitamin D, exercise, and do not smoke. If needed, medicines can also help. It is also important to try to avoid falling down. Falls are the number one cause of fractures in older adults. Osteoporosis is a skeletal condition involving progressive bone loss and micro architectural deterioration, leading to increased bone fragility and susceptibility to fractures. It is the most prevalent metabolic bone disease among adults worldwide. The magnitude of the disease is immense.

Osteoporosis is a major clinical problem in older women and men. Almost any bone can fracture as a result of the increased bone fragility of osteoporosis. These fractures are associated with higher health care costs, physical disability, impaired quality of life, and increased mortality. Because the incidence of osteoporotic fracture increases with advancing age, measures to diagnose and prevent osteoporosis and its complications assume a major public health concern. BMD is a valuable tool to identify patients at risk for fracture, to make therapeutic decisions, and to monitor therapy. Several other modifiable and nonmodifiable risk factors for osteoporosis have also been identified.

Treatment of potentially modifiable risk factors along with exercise and calcium and vitamin D supplementation forms an important adjunct to pharmacologic management of osteoporosis. Improved household safety can reduce the risk of falls. Hip protectors have been found to be effective in nursing home population [M. Shrivastava, et al , 2002].

Treatment of osteoporosis is aimed at fracture prevention and includes modification of general lifestyle factors which have been linked to fractures in epidemiological studies and ensuring optimum calcium and vitamin D intake as adjunct to active anti-fracture therapy. A number of drugs are now approved for the treatment of osteoporosis. This review article will describe the pathogenesis of osteoporosis and focus on the methods currently in use for the identification of patients at high fracture risk and will highlight their usefulness and limitations.

Osteoporosis is a multifactorial disease that is an important public health and financial problem, associated with increased mortality and morbidity. Recently released fracture risk prognostic tools incorporate BMD and other independent clinical risk factors to estimate an individual's absolute fracture risk, thus aiding treatment decisions. Management should address investigation for secondary causes of osteoporosis and correction of this where possible. Treatment should focus on both non-pharmacological and pharmacological measures. Bisphosphonates are currently recommended as first choice treatment to postmenopausal women and men aged more than 50 years, in accordance with the NICE guidelines, due to its cost effectiveness and broad spectrum fracture efficacy data. To date, there is no consensus on best practice when it comes to treatment monitoring. Both

BMD and BTMs, when used appropriately, are clinically useful surrogates of antifracture effectiveness; however, limitations and benefits of both should be taken into account [Sunita K Sandhu, et al, 2011].

Osteoporosis is increasingly recognised in men. Low bone mass, risk factors for falling and factors causing fractures in women are likely to cause fractures in men. Bone mass is largely genetically determined, but environmental factors also contribute. Greater muscle strength and physical activity are associated with higher bone mass, while radial bone loss is greater in cigarette smokers or those with a moderate alcohol intake.

Sex hormones have important effects on bone physiology. In men, there is no abrupt cessation of testicular function or ‘andropause’ comparable with the menopause in women; however, both total and free testosterone levels decline with age. A common secondary cause of osteoporosis in men is hypogonadism. There is increasing evidence that estrogens are important in skeletal maintenance in men as well as women. Peripheral aromatisation of androgens to estrogens occurs and osteoblast-like cells can aromatise androgens into estrogens. Human models exist for the effects of estrogens on the male skeleton. In men aged >65 years, there is a positive association between bone mineral density (BMD) and greater serum estradiol levels at all skeletal sites and a negative association between BMD and testosterone at some sites [Peter Robert Ebeling, et al, 1998].



Fig-1: Normal bone vs Osteoporosis

Postmenopausal osteoporosis may be treated with a bisphosphonate. If bisphosphonates are unsuitable then calcitriol may be considered. Estrogen should only be considered if there is significant risk for osteoporosis and other drugs are not suitable. New biologics agents,

Denosumab and Odanacatib are approved for treatment of osteoporosis. Both target osteoclasts to rebalance bone loss and bone building. The prevention of osteoporosis should be considered in early life and should be continued by regular physical activity and a balanced diet.

Bone tissue is continuously lost by resorption and rebuilt by formation; bone loss occurs if the resorption rate is more than the formation rate. The bone mass is modeled (grows and takes its final shape) from birth to adulthood: bone mass reaches its peak (referred to as peak bone mass (PBM)) at puberty; subsequently, the loss of bone mass starts. PBM is largely determined by genetic factors, health during growth, nutrition, endocrine status, gender, and physical activity. Bone remodeling, which involves the removal of older bone to replace with new bone, is used to repair microfractures and prevent them from becoming macrofractures, thereby assisting in maintaining a healthy skeleton.

Menopause and advancing age cause an imbalance between resorption and formation rates (resorption becomes higher than absorption), thereby increasing the risk of fracture. Certain factors that increase resorption more than formation also induce bone loss, revealing the microarchitecture. Individual trabecular plates of bone are lost, leaving an architecturally weakened structure with significantly reduced mass; this leads to an increased risk of fracture that is aggravated by other aging-associated declines in functioning. Increasing evidence suggests that rapid bone remodeling (as measured by biochemical markers of bone resorption or formation) increases bone fragility and risk of fracture [Lampropoulos C.E, et al, 2012].

Etiology:

Bone tissue is constantly being absorbed and replaced throughout one's life span. Bone mass decreases when the rate of absorption increases the rate of production; typically occurring with advanced age. Peak bone mass is met at an average age of 20. Those who develop less bone mass prior to this time, have a high chance of developing osteoporosis.

Causes of Osteoporosis:-

1) Low Estrogen in Women:

Bone loss accelerates after menopause, when older women have a quick drop in estrogen. Over time, the risk of osteoporosis and fracture increases as older women lose more bone than they replace. Younger women who stop menstruating – such as thin athletes or girls with anorexia – also have compromised bone density. Having both ovaries surgically removed, called a bilateral oophorectomy, may also

cause osteoporosis and low bone density. In one study, this surgery caused a 54% increase in hip, spine, and wrist fractures in postmenopausal women.

2) Low Testosterone in Men:

Men need both testosterone and estrogen for bone health. That's because men convert testosterone into bone-preserving estrogen.

3) Lack of Calcium:

Bones are the reservoir for two minerals – calcium and phosphorus. You need a constant level of calcium in your blood since many of your organs, especially your heart, muscles, and nerves, depend on calcium. When these organs demand calcium, they'll steal it from the mineral storehouse in your bones. Over time, as you deplete the mineral reservoir in your bones, you end up with thin, brittle bones.

4) Lack of Vitamin D:

Too little vitamin D can lead to weak bones and increased bone loss. Active vitamin D, also called calcitriol, is more like a hormone than a vitamins. Among its many benefits, vitamin D helps your body to absorb and use calcium.

5) Smoking:

Smokers suffer from lower bone density and a higher risk of fracture than non-smokers. Studies on smoking and bone health have turned up a host of other dire effects, from direct toxic effects of nicotine on bone cells to blocking the body's ability to use estrogen, calcium, and vitamin D.

6) Medications:

Taking certain medications may lead to bone loss and an increase in bone fractures. Most common are corticosteroids, also known as cortisone, hydrocortisone, glucocorticoids, and prednisone. These drugs are used to treat asthma, rheumatoid arthritis, psoriasis, colitis, and a wide range of other conditions. Antiseizure drugs are linked to bone loss, as well.

7) Medical Conditions:

A host of medical conditions can lead to bone loss, from genetic diseases like cystic fibrosis to digestive diseases to the tumors called multiple myeloma, which infiltrate bones with abnormal cells. Abnormal calcium excretion also contributes to bone loss.

Primary Osteoporosis:

Primary osteoporosis has no known definite cause, but there are many contributing factors associated with the disorder. These include prolonged negative calcium balance, impaired gonadal and adrenal function, oestrogen deficiency, or sedentary lifestyle [Goodman, et al, 2003].

Types:-

- 1) Postmenopausal osteoporosis is associated with increased bone loss due to decreased production of oestrogen. Women commonly lose 1% per year after peak bone density has been met, for up to 8 years after menopause.
- 2) Senile osteoporosis is an age-related bone loss that often accompanies advanced ageing.
- 3) Idiopathic juvenile osteoporosis.

Secondary Osteoporosis:

Secondary osteoporosis is caused by prolonged use of medications or secondary to another disease or condition which inhibits the absorption of calcium or impedes the body's ability to produce bone.

Low calcium intake or absorption can greatly increase one's risk of developing osteoporosis. Life-long calcium intake is crucial in building up bone stock prior to peak levels of bone mass, as well as to maintain bone mass after the age of 20. Excessive alcohol consumption can decrease the body's ability to absorb calcium.

Bone responds to the load applied to it. Physically active individuals typically have higher bone density, than those who have a sedentary lifestyle.

Hormone levels, either too little or too much, can impede the body's ability to produce and maintain adequate bone mass. Dysfunction with sex glands, thyroid, parathyroid, or adrenal glands is often associated with osteoporosis [Lyles KW, et al, 2008].

Types:-

- 1) Endocrine origin
 - Hypogonadism/Hypogonadal state
 - Hypercortisolism
 - Hyperthyroidism
 - Hyperparathyroidism
 - Hyperprolactinemia

- Diabetes mellitus
- 2) Gastrointestinal diseases
 - Chronic inflammatory bowel disease
 - Malabsorption/Deficiencies
 - Malnutrition
 - Primary biliary cirrhosis
 - Lactose intolerance
- 3) Rheumatological and connective tissue diseases
- 4) Inflammatory diseases
- 5) Hematological and neoplastic disorders
- 6) Medications, e.g. -glucocorticoids, Chemotherapeutic/transplant drugs, Anticonvulsants
- 7) Immobilisation
- 8) Chronic alcoholism
- 9) Organ Transplantation

Risk Factors:

Risk factors for osteoporosis include the following :

- Advanced age (50 years)
- Female sex
- White or Asian ethnicity
- Genetic factors, such as a family history of osteoporosis
- Thin build or small stature (e.g., bodyweight less than 127 lb [57.6 kg])
- Amenorrhea
- Late menarche
- Early menopause
- Postmenopausal state
- Physical inactivity or immobilization
- Use of certain drugs (e.g., anticonvulsants, systemic steroids, thyroid supplements, heparin, chemotherapeutic agents, insulin)
- Calcium or vitamin D deficiency
- Dowager hump

Epidemiology:

Over 200 million people have osteoporosis and the incidence rate increases with age.

- Over 70% of those over age 80 are affected.
- It is more common in females than in males.
- In the developed world, 2% to 8% of males and 9% to 38% of females are affected
- Worldwide, there are approximately 9 million fractures per year as a result of osteoporosis.
- 1 in 3 females and 1 in 5 males over the age of 50 will have an osteoporotic fracture.

- Areas of the world with less Vitamin D through sunlight compared to regions closer to the equator have higher fracture rates in comparison to people living at lower latitudes.
- In the United States alone, approximately 10 million individuals are estimated to already have the disease and 34 million at increased risk for osteoporosis. 55% of Americans over the age of 50 have the disorder [Joann L. Porter , et al, 2019].

Diagnosis:

Patients with a diagnosis of osteoporosis should have:

Laboratory assessment of their renal and thyroid function, a 25-hydroxyvitamin D and calcium level.

- DEXA scan – the World Health Organization (WHO) established that dual x-ray absorptiometry tests scans (DEXA) of the central skeleton is the best test for assessing bone mineral density.
 - Scores between negative 1 and negative 2.5 reflect a diagnosis of osteopenia.
 - Scores below negative 2.5 reflect a diagnosis of osteoporosis.
- The Fracture Risk Assessment Tool (FRAX) has become a more accurate way to measure 10 years fracture probability. The FRAX questionnaire takes into account elements that influence an individual's bone quality as well as his/her bone density.
- The Garvan Fracture Risk Calculator with BMD.
- Conventional radiography is used for the qualitative and semiquantitative evaluation.
- Secondary tests for screening of secondary osteoporosis to determine causes of osteoporosis like 24-Hour urine calcium level, Parathyroid Hormone levels, Testosterone and gonadotropin levels in younger men with low bone densities, serum markers of osteoclasts/osteoblasts, etc. [Goodman, et al, 2002].

Characteristics:

The physical exam rarely reveals any changes until osteoporosis is quite advanced. At that point, loss of height and kyphosis is evident from vertebral fractures.

In healthy individuals without risk factors, experts recommend:

- Start to screen women at the age of 65 years and men at the age of 70
- Patients with risk factors or a high score on an osteoporosis risk assessment test should be screened sooner

Clinical signs and symptoms:

- Back pain: Episodic, acute low thoracic/high lumbar pain
- Compression fracture of the spine
- Bone fractures
- Decrease in height
- Kyphosis
- Dowager’s hump
- Decreased activity tolerance
- Early satiety[Snyder, et al, 2007].

Physical Therapy Management:

Physical therapy intervention for individuals with osteoporosis, or even osteopenia, should include:

- 1) Weight-bearing exercises
 - Maintaining bone health in this population is extremely important, especially in the elderly as there is typically has a decline in bone mass with age[Zehacker CH, et al,2007].
- 2) Flexibility and strengthening exercise
 - These can help improve the individual’s overall physical function and postural control. E.g. Tai chi, Yoga
 - Balance exercises are also important to incorporate to further reduce the risk of falls.[Burke TN, et al, 2011].
- 3) Postural exercise
 - Flexion exercises are CONTRAINDICATED especially in patients with a risk of a spinal fracture. Anterior compressive forces to the vertebra can contribute to compression fractures. Flexion and twisting place a high compressive load on the vertebral bodies, these high levels should be avoided [Bonner JR, et al, 2003].
- 4) Balance exercise
- 5) Education - top tips easily given to clients
 - Follow a healthy diet that includes enough calcium and Vitamin D
 - Wear sensible, well-fitting shoes to avoid falls
- 6) Back pain
 - Physiotherapists may treat patients with osteoporosis for back pain

- Agility training, resistance training, and stretching have all been shown to decrease back pain and its related disabilities in this population[Liu- Ambrose TY, et al, 2005].
- 7) High-intensity training - Research highly supports high-intensity training in the prevention of bone loss for women in menopausal years and the early post-menopausal period
 - High-intensity training would include body-weight and resistive exercises at a high-intensity, similar to circuit training. This type of training is often contraindicated for individuals with low bone mass[Martyn- St James M, et al, 2017].
 - Non-weight-bearing, high force exercises were shown to have moderate effects on the femoral neck[Howe TE, et al,2011].

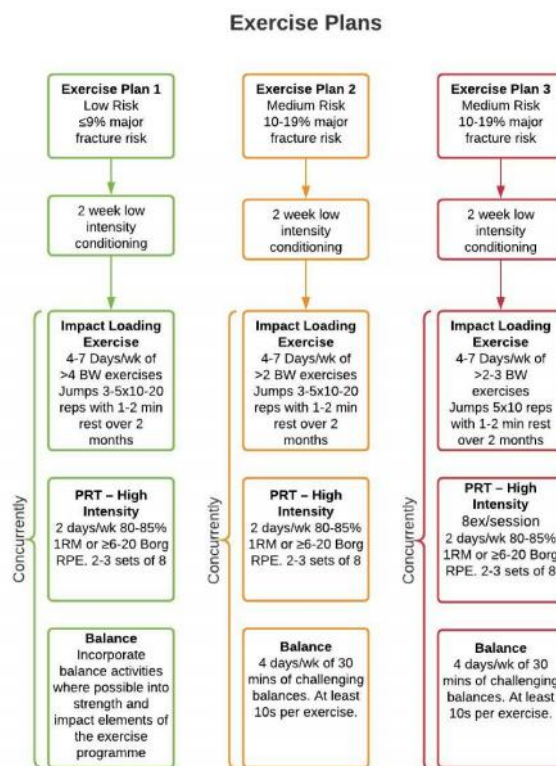


Fig-2 Exercise Plans

Dietary Management:

- The most important nutrients for people with osteoporosis are calcium and vitamin D. Calcium is a key building block for bones. Vitamin D helps the body to absorb calcium.

- Calcium can be from diet, supplements, or both (it is best to get these nutrients from food, rather than supplements)
- For adults aged 50 and older, the National Osteoporosis Foundation of the USA has recommended intake is 1000–1200 mg/day of elemental calcium.
- Optimal vitamin D can be acquired 3 ways:
 - Eating foods that naturally contain vitamin D or are fortified with vitamin D
 - Sensible sun exposure
 - few minutes, regularly, with good skin exposure, no sun cream and your shadow should be shorter than you. If it is longer than you are, you are not producing any vitamin D.
 - Taking a vitamin D supplement
 - For adults aged 50 and older, the National Osteoporosis Foundation of the USA has recommended intake is 700–800 IU/day.

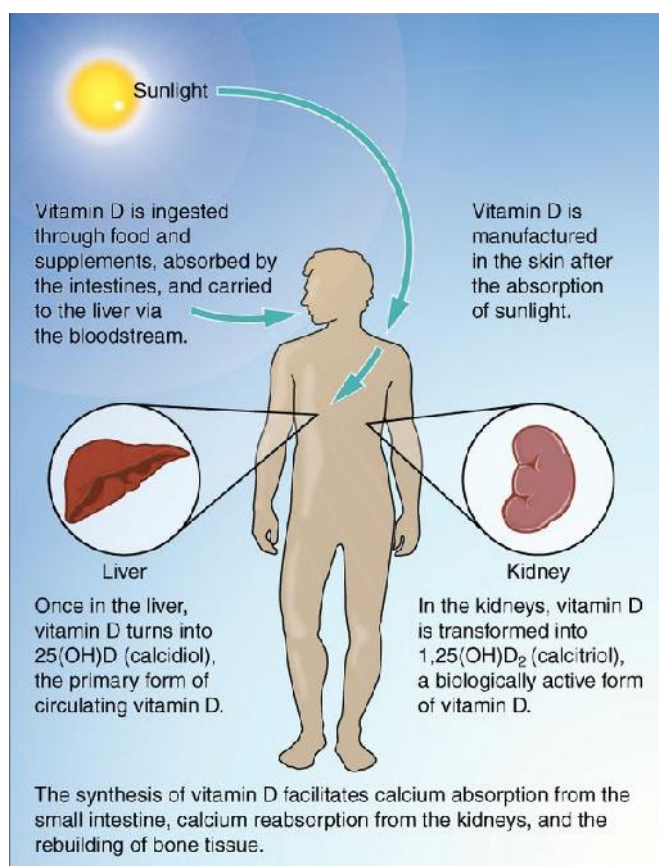


Fig-3 Dietary Management

Medicines for Osteoporosis:

Osteoporosis medicines can increase bone density and while the increases may appear small this can have a very positive effect on reducing fracture rates. For example, medication can increase bone density in the hip by approx. 1-3% and in the spine by 4-8%, over the first 3-4 years of treatment. Medication can reduce spinal fractures by around 30-70% and hip fractures by 30-50% (a positive effect can be seen as early as 6 – 12 months after starting treatment).

Osteoporosis medicines are grouped into different 'classes' depending on their 'active ingredient'

- 1) Bisphosphonates – Tablets (daily, weekly or monthly): Alendronate (brand name Fosamax, or other generic brands), Risedronate (brand name Actonel, or other generic brands), once yearly intravenous infusion: Zoledronic acid (brand name Aclasta).
- 2) Denosumab – 6 monthly injection: Denosumab (brand name: Prolia)
- 3) Selective oestrogen receptor modulators (SERMS) – Daily tablet: Raloxifene (brand name: Evista)

Denosumab works in a different way to bisphosphonates, but has the same effect of slowing the rate at which bone is broken down, with similar reductions in the risk of fracture.

- a) This medicine acts on bones in a similar way to that of the hormone oestrogen, slowing bone loss and reducing the risk of spinal fractures in women who have been through menopause
- 4) Hormone replacement therapy (HRT) – The active ingredient is the hormone oestrogen. Some HRT treatments also contain progestogen (combined HRT)
 - a) Even at low doses, HRT helps to slow bone loss, reducing the risk of osteoporosis and fractures in women who have gone through menopause. HRT is safe and effective for most women under the age of 60 who have osteoporosis and who also need hormonal treatment to relieve the symptoms of menopause. It may also be prescribed for women under 60 who are unable to take other osteoporosis medicines. It is particularly useful for women who have undergone early menopause (before 45 years of age)
- 5) Due to the small increased risk of heart disease, strokes and breast cancer in older women, other osteoporosis medicines are more suitable for women over the age of 60 [Mc Clung MR, et al, 2014].
- 6) Teriparatide – Daily injection for 18 months (self-administered): Teriparatide (Brand name: Forteo)

- a) This medicine stimulates bone-forming cells, resulting in improved bone strength and structure. It is only prescribed for people with severe osteoporosis when other osteoporosis medicines have not worked and the risk of more fractures is still very high. Teriparatide must be prescribed by a specialist and can only be taken for 18 months. Once the course of teriparatide is finished, another osteoporosis medicine must be started to ensure that the new bone formed is maintained and improved
- 7) Romosozumab – monthly injection: Romosozumab (brand name: Evenity)
- a) This medicine is a monoclonal antibody that binds and inhibits sclerostin, with a dual effect of increasing bone formation and decreasing bone resorption.[Cosman F, et al, 2016].

Complications of Osteoporosis:

Osteoporosis typically has no symptoms until a bone breaks and you feel pain. Bone pain is described as more intense than typical low back pain. Fractures from osteoporosis typically occur in the spine, sacrum, hip, and wrist, but other bones can break from osteoporosis too. These fractures can lead to balance problems that increase the risk of falls and future fractures. As bones in the spine develop compression fractures from osteoporosis, they may change shape from a rectangle to a wedge. If the compressed part of the vertebra is in the front of the spine, the spine may lean forward into a stooped or hunched posture (kyphosis), causing balance issues. Also, this rounded spine position places pressure on the stomach, causing people to feel full faster and sometimes leading to malnourishment.

When broken bones from osteoporosis heal, the joints can become arthritic very quickly causing more pain and requiring treatment. Occasionally, when the spine collapses from osteoporosis, the spinal cord or nerves exiting the spine become compressed or irritated, causing further pain and dysfunction.

The most common complication of osteoporosis is vertebral compression fractures (VCF). In people with advanced osteoporosis, compression fractures can occur while going about one's daily activities, such as bending or carrying heavy loads, or as the result of a minor fall.

The vertebrae are the building blocks of the spine stacked one on top of each other. With osteoporosis the blocks become hollow boxes. Compression fractures occur when the vertebrae collapse. Spinal compression fractures may lead to

difficulty walking and/or loss of balance leading to an increased risk of falling and breaking a hip, or other bones.

Vertebral compression fractures can change the shape of the spine. One such deformity is known as kyphosis but often called “dowager’s hump” or “humpback”[Ettinger B, et al, 1992].

II. CONCLUSION

- Osteoporosis is a common and silent disease until it is complicated by fractures
- It is estimated that 50% of women and 20% of men over the age of 50 years will develop an osteoporosis-related fracture at some stage
- These fractures are responsible for lasting disability, impaired quality of life, and increased mortality, with enormous medical and heavy personnel burden on both the patient’s and the nation’s economy
- Osteoporosis can be diagnosed and prevented with effective treatments before fractures occur
- The prevention, detection, and treatment of osteoporosis is important

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