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Effect of *Panchatikta Ksheera Basti* and *Praval Panchamrut Vati* in *Asthikshaya w.s.r.* to Osteopenia/ Osteoporosis – A Randomized Controlled Pilot Study

Research Article

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Abstract

Background: Osteopenia and Osteoporosis are common prevailing ailments exhibiting reduced bone density and occur especially aging population. Various factors lead to Osteopenia/Osteoporosis including sedentary lifestyle and hormonal changes that affect the bone metabolism. Conventional management of Osteopenia/Osteoporosis focuses primarily on Calcium and Vitamin D supplementation. *Asthi kshaya*, a similar condition to Osteoporosis, has been mentioned in *Ayurveda* wherein vitiated *Vata* causes reduction in bone mass and is associated with same symptoms as Osteoporosis. *Panchatikta Ksheera Basti* is a formulation made from *tikta dravya siddha Ksheera* (milk decoction made from five bitter herbs), *Panchatikta Ghrita* and honey. Objective: To evaluate the efficacy of *Panchatikta Ksheera basti* and *Praval Panchamruta Vati* in *Asthikshaya* (Osteopenia/Osteoporosis) and compare the same with the conventional treatment. Trial Design: A Randomized Controlled Pilot Study. Method: Patients with signs and symptoms of *Asthi kshaya* and BMD (T-score) =<-1 were randomized, Group A (Trial group) patients received *Panchatikta Ksheera Basti* and *Praval Panchamrut Vati* while Group B (Control group) patients received oral organic Calcium and Vitamin D for 30 days. Primary Outcome: To improve the functional and physical activities of the patients. Secondary Outcome: To improve Serum Calcium, Serum Phosphorus and Vitamin D levels and BMD score. Results: Statistically significant results were observed in both the groups, however pain relief was better in Study group A, while Serum Calcium levels were significantly improved in both the groups. Conclusion: *Panchatikta Ksheera Basti* and *Praval Panchamruta Vati* have equal potential for addressing *Asthi Kshaya* (Osteopenia / Osteoporosis) in comparison to conventional management.

Keywords: Bone Mineral density, Osteopenia, Osteoporosis, *Asthikshaya, Basti, Panchatikta ksheera, Praval Panchamruta.*

Introduction

Osteoporosis is a common prevailing issue in old age group due to the sedentary lifestyle and dietary habits of the developed world (1,2). It is marked by a micro architectural deterioration of bone tissue associated with low bone mass and progressive bone fragility and susceptibility to fracture (3). Usually, the loss of bone mineral density begins at the age of 30–40 years in both men and women. In women of menopausal age, there is an immediate decline in bone mass and density within a year and this reduction continues until 10 years after menopause, coming to a steady rate as the age progresses (4). It is estimated that 1 in 3 women and 1 in 5 men above the age of 50 experience osteoporotic fractures worldwide (5). India has a population of around 1.2 billion people, with approximately 10% population (more than 100 million) over the age of 50 years (6). It is observed that around 50 million people in India suffer from osteoporosis or have a low bone mass (7). Osteopenia is a clinical term used to describe a decrease in bone mineral density below the normal reference values, but not low enough to be considered osteoporotic (8). Individuals with Osteopenia or Osteoporosis may not present with any complaints until they suffer a bone fracture leading to pain and disability. The conventional approach to Osteopenia/Osteoporosis is supplementation of Calcium and Vitamin D as these are the two primary nutrients related to bone health and play an important role in bone metabolism (9).

According to Ayurveda, *Asthi* (bone tissue) is one of the seven *Dhatu's* (tissues) of the body which performs the function of *Dharana*(support) (10,11). The *Asthivaha Srotas* (System) regulates the metabolism of *Asthi dhatu* in the body and factors like excessive physical exertion, jerky movements of the body,

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increased friction between bones subject to *Vata* vitiating factors causes derangement of *Asthivaha Srotas* leading to *Asthi Pradoshaja Vikara* (diseases of the bony tissue)(12,13). The relation between *Asthi* and *Vata* is inversely proportional whereby increase of *Vata* causes *Asthi Kshaya* or decrease in *Asthi dhatu* (14). An individual with *Asthi Kshaya* suffers from pricking pain in bones, hair fall, brittleness of nails and erosion or fracture of teeth (15). Hence, the etiological factors for *Vata* vitiation also present as the etiological factors for *Asthi kshaya*. The vitiated *Vata* either due to *dhatu kshaya* (degeneration or undernutrition) or *margaavrodha* (obstruction) enters *Asthidhatu* and leads to *Asthi kshaya*. As per *Charaka Samhita*, the treatment for *Asthipradoshaja vyadhi* is *Panchakarm*a wherein *basti* prepared with *tikta dravya* (bitter herbs), *ksheera* (Cow Milk) and *ghrita* (Cow Ghee) along with the use of *Swayonivardhak dravya* (medicines having similar qualities of bone tissue) is indicated. The *Pakvashaya* or large intestine is the main site of *Vata dosha* in the body and *Basti* acts directly on the same, thereby regulating *Vata dosha* in the body (16). Owing to this specific property of *basti*, it is designated as *Ardha Chikitsa* (half treatment) for all diseases and especially those affecting the Musculoskeletal System (17). Ayurveda has already woven the interconnection between the atmospheric changes occurring in the nature and living beings. In *Varsha ritu* (rainy season), the *Vata dosha* tends to get aggravated with simultaneous accumulation of *Pitta dosha* in the body. This aggravated *Vata dosha* is best balanced by the *Basti* treatment and the aforementioned *Tikta Ksheera Basti* has been specifically advocated for vitiation of *Vata* with respect to *Asthi Dhatu*.

Ayurveda has clearly explained *Asthi Kshaya*, its associated symptoms and its management and hence this study was undertaken to evaluate the efficacy of Ayurveda management in symptoms of *Asthi kshaya* (Osteopenia/Osteoporosis). *Panchatikta Ksheera basti* is a type of *Brimhana basti* which pacifies the aggravated *Vata dosha* and *Pitta dosha whereas Praval Panchamrut vati* is a source of organic calcium and also complies as *Parthiva* component required for bone growth and repair. This study was conducted before the *Varsha ritu* ascends which aids both as a preventive and curative measure to condense the excess vitiation of *Vata dosha* in patients who were already having the symptoms. To compare this Ayurveda management with conventional therapy, a control group with oral calcium and vitamin D supplementation was assigned in parallel.

Materials and Methods

A Pilot Randomized Controlled Clinical study was conducted at Dr. D.Y. Patil College of Ayurved & Research Centre, Pimpri, Pune- 18, Maharashtra, India between January 2021 to June 2021 with Institutional Ethics Committee approval (DYPV/EC/12/18). The study was registered prospectively in CTRI with Registration Number (CTRI/2019/08/020840). The CONSORT (2010) guidelines were followed for reporting the outcomes of the study.

Participants

Individuals of both genders aged between 40 to 70 years were examined for classical signs and symptoms of *Asthi kshaya* along with Bone Mineral Density (BMD).

Inclusion Criteria

Individuals of either gender aged between 40 to 70 years with any 2 classical signs and symptoms of *Asthi kshaya* like *Asthishula, Keshapata, Nakha vikara and* Bone Mineral Density (BMD) (T-score) =<-1 were enrolled with due written informed consent.

Exclusion Criteria

Individuals with known case of Bone Cancer, Osteomalacia, Rheumatoid Arthritis, Gouty Arthritis, Diabetes Mellitus, Thyrotoxicosis, Hyperparathyroidism, Addison's disease, Paget's disease, Cushing's Syndrome, Chronic Renal, Hepatic or Cardiac ailments, those not willing to participate were excluded from the study.

Screening Methods

All recruited patients were thoroughly examined clinically and their data were recorded on various subjective and objective parameters. Laboratory investigations for Serum Calcium, Vitamin D, Serum Phosphorus levels and BMD were done at Day 0 and Day 30.

Research Design

This study was conducted by the Department of Kayachikitsa, Dr. D. Y. Patil College of Ayurved & Research Centre, Pimpri, Pune with Institutional financial support with the aim to prove the clinical efficacy of ayurveda intervention in Osteoporosis/ Osteopenia. A special BMD camp was organized wherein a total of 100 patients with signs and symptoms of *Asthikshaya* were screened with physical examination and Bone Mineral Density (Calcaneal bone) by using Ultrasonic Bone Densitometer. During the BMD screening,30 patients with BMD (T-score) =<-1 were selected and then randomized by Computer generated randomization table - block method into Trial Group A and Control Group B with 15 patients in each.

Intervention

Group A patients were given *Hingvashtaka Churna* 1 gm orally twice a day for first 3 days along with *Praval Panchamrut Vati* 250mg twice a day and administration of *Panchatikta Ksheera basti* 300ml once in a day for 30 days. Local *Snehan* (Oleation) by *Tila taila* (Sesame Oil) and *Nadi Sweda* (Fomentation) was given at abdomen and lower back before administering *Basti* per rectum.

The raw drugs were procured from FDA approved and GMP certified Sudhatatva Pharmacy of Dr.D.Y.Patil College of Ayurved & Research Centre, Pimpri, Pune and subjected for authentication and standardization at the Institutional Quality Control Laboratory as per Ayurveda Pharmacopeia of India (API) guidelines.

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Preparation of *Praval Panchamruta Vati* was done by grinding all the ingredients *Mauktika* (Pearl), *Shankha* (Conch Shell), *Shukti* (Pearl Oyster), *Kapardika* (Cowries) and *Praval* (Coral) *bhasma* in *khalva yantra* (mortar and pestle) to obtain a fine powdered mixture which was then triturated by Cow milk and then further processed to obtain granules. The granules were then transformed into tablets. The trituration by cow milk is a modification from the classical guideline where milk of *Calotropis Procera* has been indicated (18).

Panchatikta Ksheera Basti preparation was freshly done every day as per classical guidelines. 25 gm of *Panchatikta churna* (5 gm equal quantity of each herb) was added to 200 ml of cow milk and 800 ml of water. The mixture was boiled on low flame with continuous stirring until only 200 ml milk remained in the vessel. This remaining milk decoction *(Ksheera Paka)* was filtered and used for further process. Honey (30ml), *Panchatikta Ghrita* (50 ml), *Panchatikta kalka* (paste) (20 gms) and the obtained *Ksheera Paka* (200 ml) were sequentially mixed to obtain the final mixture of 300 ml (≈6 pala) as *Uttam Matra* of *Sneha Basti* (19).

The Control Group B patients were given oral organic Calcium and Vitamin D for 30 days once in a day. A standard combination of Organic Calcium Carbonate 1250mg (equivalent to elemental Calcium 500mg) and Vit.D 250 IU in tablet form was procured from Institutional Pharmacy Store.

Criteria of Assessment

Primary Outcome Criteria

Patients of both the groups were assessed on basis of *Asthishula*, *Kesha pata*, *Nakha vikara* and Visual Analogue Scale (VAS). The parameters were graded and scored from 0 to 4 according to severity (Table1) and assessed on day 0, in between treatment on day 15 and last day of treatment on day 30. *Asthishula* was assessed by bony tenderness on the shin of tibia bone and the spine. Visual Analogue Scale where the participant can rate the intensity of pain by two endpoint line scoring 0-10, one end representing 'no pain' and the other representing 'worst pain'.

Secondary Outcome Criteria

BMD, Sr. Calcium, Sr. Phosphorus and Vitamin D were done only on Day 0 and Day 30 and values were recorded.

Table 1: Assessment Criteria of Subjective parameters

Symptoms	Grade 0	Grade 1	Grade 2	Grade 3	Grade 4
Asthishula **(Pain in bones)**	No pain	Mild pain	Moderate pain	Severe pain not affecting regular activities	Severe pain affecting regular activities
Kesha Pata **(Hair fall)**	No hair fall	Hair fall once in morning during washing/combing	Hair fall every time during combing	Hair fall without combing & raised hairline in frontal region of head	Visible or significant baldness in frontal/vertex region (caput)
Nakha Vikaras **(Nail deformities)**	No *Nakhavikaras* (Nail deformities)	Mild loss of natural texture & elasticity of nails	Moderate loss of natural texture & elasticity of nails	Visible brittleness of nails	Brittle nails

Statistical Methods

The statistical analysis was carried out as within the group analysis and between the group analysis by using SPSS software version 21(Table 2-5). For within the group analysis, Wilcoxon Signed Rank test was used for observations on ordinal scale and paired t-test for quantitative data. For the analysis of data between the groups, Mann Whitney test was applied for observations on ordinal scale and unpaired t-test for quantitative data. All tests were considered statistically significant at $p < 0.05$.

Observation and Results

Patient Profile

Gender - Total number of male patients enrolled were 50% and 21.4% while females were 50% and 78.6% in Group A and Group B respectively.

Age – The patients enrolled in the age group 40-49 years were 41.7% in Group A and 57.2% in Group B. In the age group 50-60 years total number of patients were 58.3% and 21.4% in Group A and Group B respectively. Total of 21.4% patients in Group B were from 60-70 years of age group.

During the study, 3 patients from Trial Group A and 1 patient from Control Group B were dropped from the study due to irregular visits for treatment and follow up.

Figure 1 Consort Flow Chart

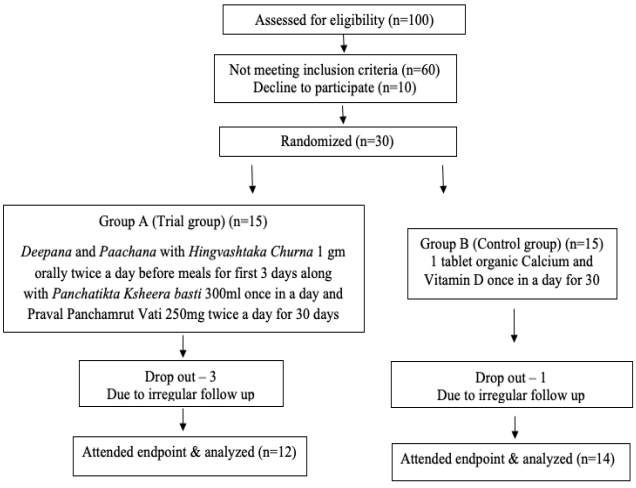

Table 2: Statistical analysis for within the group observations on ordinal scale (For Group A, n=12 and Group B, n=14)

Parameters	Group	Before		After		Wilcoxon signed Rank Test	p value
		Mean	SD	Mean	SD		
Asthishula	Group A	2.33	1.07	0.42	0.51	-2.980	0.003 (S)
	Group B	2	0.78	1.43	0.94	-2.828	0.005 (S)
Kesha pata	Group A	1.92	1.38	1.08	1.08	-2.887	0.004 (S)
	Group B	1.5	0.85	0.64	0.63	-2.972	0.003 (S)
Nakha vikara	Group A	0.17	0.39	0.08	0.29	-1.00	0.317 (NS)
	Group B	0	0	0	0	0	1 (NS)
Visual Analogue Scale (VAS)	Group A	5.33	1.50	2.08	1.16	-3.108	0.002 S
	Group B	6	1.24	3.71	1.27	-3.332	0.001 S

Statistically significant results were observed in both the groups for *Asthishula* and Visual Analogue Scale (VAS). Pain relief was better in Study group A. The symptom of *Kesha Pata* though showed significant results wherein the patients reported a drop in their hair fall but it is relatively premature to draw a concrete inference in a short duration.

Table 3: Statistical analysis for quantitative observations (within the group)

Parameters	Group	Before		After		Paired t	p value
		Mean	SD	Mean	SD		
BMD	Group A	-1.76	0.45	-1.33	0.86	-1.783	0.102 (NS)
	Group B	-1.81	0.58	-1.21	0.67	-2.810	0.015 (S)
Serum Calcium	Group A	8.75	0.82	9.47	0.75	-2.869	0.015 (S)
	Group B	8.36	0.83	9.44	0.42	-4.743	0.000 (S)
Serum Phosphorus	Group A	3.39	0.76	3.67	0.28	-1.602	0.138 (NS)
	Group B	3.34	0.60	3.30	0.58	0.265	0.795 (NS)
Vitamin D	Group A	15.69	10.83	19.12	13.63	-0.776	0.454 (NS)
	Group B	16.72	11.26	17.53	9.34	-0.462	0.652 (NS)

BMD score – The values of BMD score <-1 to <-2.5 (Osteopenia) was observed in 14 patients in Group A and 13 patients in Group B while BMD score <-2.5 (Osteoporosis) was observed in 1 patient in Group A and 2 patients in Group B.

Statistically significant results were noted in both the groups for Serum Calcium levels, while significant changes were seen for BMD in study group B after intervention.

Table 4: Statistical analysis for observations on ordinal scale (between the groups)

Parameters	Group	Mean Difference score	SD	Mann Whitney U test	Test Statistics Z	p value
Asthishula	Group A	1.92	1.08	27	-3.133	0.002 (S)
	Group B	0.57	0.51			
Kesha pata	Group A	0.83	0.58	85	-0.02976	0.976 (NS)
	Group B	0.75	0.62			
	Group B	0.21	0.43			
Nakha vikara	Group A	0.08	0.29	77	1.003	0.316 (NS)
	Group B	0	0			
Visual Analogue Scale (VAS)	Group A	3.25	0.87	40	-2.2374	0.020 (S)
	Group B	2.29	0.99			

Statistically significant results were observed for *Asthishula* and Visual Analogue Scale (VAS) with the Study Group A showing better outcome than Control Group B.

Table 5: Statistical analysis for quantitative observations (between the groups)

Parameters	Group	Mean Difference score	SD	SEM	Unpaired t	p value
BMD	Group A	-0.43	0.83	0.238	0.548	0.589 (NS)
	Group B	-0.60	0.80	0.214		
Serum Calcium	Group A	-0.72	0.87	0.250	1.055	0.302 (NS)
	Group B	-0.07	0.85	0.226		
Serum Phosphorus	Group A	-0.28	0.60	0.174	-1.370	0.183 (NS)
	Group B	0.04	0.59	0.157		
Vitamin D	Group A	-3.43	15.29	4.415	-0.583	0.565 (NS)
	Group B	-0.81	6.54	1.747		

Statistically non-significant difference was observed between the groups for all the parameters.

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Primary Outcomes

Within the group analysis showed statistically significant results in both the groups for *Asthishula*, *Kesha Pata* and Visual Analogue Scale (VAS). However, relief in *Asthishula* was better in Study Group A.

Statistically significant results were observed for *Asthishula* and Visual Analogue Scale (VAS) with the Study Group A showing better outcome than Control Group B in between group analysis.

Secondary Outcomes

Within the group analysis showed statistically significant results were noted in both the groups for Serum Calcium levels, while significant changes were seen for BMD in study Group B after intervention.

Statistically non-significant difference was observed between the groups for all the parameters.

Discussion

Bone metabolism is regulated by the action of Osteoclasts and Osteoblasts which in turn are tightly controlled by action of modulators such as Estrogen, Thyroid and Parathyroid hormones (20, 21). Osteoporosis is the condition that arises during increased bone resorption along with decreased bone formation due to imbalance in hormonal functions (22). Osteopenia is a pre-cursor of Osteoporosis where the bone mineral density is below normal values but may not be present with any sign or symptom (23).

According to Ayurveda, *Asthi Dhatu* (Bone tissue) undergoes *Kshaya* (loss/degeneration) due to *Vata* vitiating *Ahara* (diet) and *Vihara* (lifestyle). Absence of *Sneha* (oleation) and at the same time increase in *Ruksha* (dry), *Laghu* (light), *Sheeta* (cold) and *Chala* (rapid) *gunas* (properties) in the body leads to *Asthi Kshaya*. This loss in *Asthi dhatu* is presented not only in the form of *Asthishula* (pain in bones), *Asthi toda* (pricking pain in bones) but also *danta-nakha-kesha sadanam* (brittleness or breaking of teeth, hair and nails) as the same are *Mala*'s (by-products) of *Asthi*. Osteoporosis/Osteopenia can be correlated to the condition of *Asthi Kshaya* due to the common mechanism of loss in bone tissue and also presenting signs and symptoms (24,25).

Sedentary lifestyle, faulty dietary habits and premature ageing are the main causes of Osteopenia/ Osteoporosis (26,27). In the quest for tasty foods, majority of the people are consuming fast foods and processed foods like pizza, burger, French fries etc. which lack proper nutrients leading to conditions like Osteoporosis (28). The incidence is comparatively more prevalent in females than males with the ratio being 3:1. The increased risk can be attributed to the onset of menopause during which females undergo rapid physiological transitions due to hormonal imbalance (29).

Even though *Asthi Kshaya* and Osteoporosis are two different entities told by two sciences, their etiology coincides with the fact that both are involving deficiency of *Asthi dhatu* (bony tissue) either due to metabolic or degenerative causes. Factors like ageing, degeneration, nutritional deficiency etc. ultimately lead to *Vata* vitiation in the body accompanied by *Dhatu Kshaya* (tissue loss). Faulty dietary habits, obesity and sedentary lifestyle adversely affect *dhatu poshana* and *Utpatti* (tissue growth and metabolism) due to accumulation of *Meda* (adipose tissue) in the body leading to *Srotorodha* (obstruction of channels in the body). Hence it is evident that there is an etiological as well as pathological linkage between *Asthi Kshaya* and Osteopenia/Osteoporosis and the therapeutic approach to them also aims at correcting the deficiency and metabolic derangement.

Acharya Charaka has advised *Tiktka Ksheera Basti* where *Ksheera* (Milk) serves as *Sneha* whereas the *Tikta Rasa* acts as vehicle to deliver the *Sneha* to *Asthi Dhatu* due to its dominance of *Akasha* (Space) *and Vayu* (Air) *Mahabhoota* (Element) and property to reach the *Asthi dhatu. Tikta Rasa* also helps in faster absorption of the *Sneha* and does not cause *Agnimandya* (appetite loss), which may appear due to prolonged administration of *Sneha*. Additionally, milk also acts as a source of Vitamin D and calcium, thus supporting the conventional therapeutic approach too. The ingredients of *Praval Panchamruta Vati* are all basically made up of the same compound Calcium Carbonate. As per their classical properties, majority of the contents of *Praval Panchamruta Vati* are *Shoolaghna* (analgesic) and *deepana* (activating the digestive fire), making it a good therapeutic choice for *Asthi Kshaya*. Additionally, it also suffices the complimentary approach of supplementing oral calcium in Osteopenia/ Osteoporosis.

The result shows that *Panchatikta Ksheera Basti* along with *Praval Panchamruta Vati* in Group A showed better results than the Control Group B which was supplemented with Organic Calcium and Vitamin D. It also improved the functional and physical activities of the patient thus improving the daily lifestyle of the patient.

Conclusion

Basti (Medicated Enema) has been indicated by *Ayurveda* as the most effective intervention for vitiated *Vata* due to its holistic action on the *Koshtha* (gut) and *Dhatu* (tissues). *Praval Panchamruta* replenishes the *Asthi dhatu* in accordance with the dominance of *Prithvi Mahabhoota* through similar elements as all its contents are marine shell forms composed of Calcium Carbonate. The present study has established that *Panchatikta Ksheera Basti* and *Praval Panchamruta Vati* have an equal or better therapeutic potential (for some parameters) in *Asthi Kshaya* (Osteopenia/ Osteoporosis) in comparison to conventional approach. Association between Gastro-intestinal disorders and Osteoporosis is a known fact (30) and throws light on relation between gut health and bone metabolism. The action of *basti* on the hind gut and its holistic action in *Asthi Kshaya* is documented in Ayurveda but needs to be explored further with respect to its long-term outcomes and additional benefits.

There were no adverse events noted throughout the study. Although the cost of Ayurveda intervention is comparatively more than the conventional treatment for Osteopenia/Osteoporosis.

Limitations

The present work was a pilot study and hence had its limitations with respect to sample size and duration of the study and hence it is a challenge to draw a concrete inference.

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Conflict of interest

The authors declare that they have no known competing financial or personal interests that could influence the work for publication.

Declarations of generative Artificial Intelligence (AI) in scientific writing – The authors declare that No Artificial Intelligence was used during the scientific writing.

References

1. Clynes M.A.et al., The epidemiology of osteoporosis. British medical bulletin, 2020.
2. Pouresmaeili F. et al., A comprehensive overview on osteoporosis and its risk factors, Therapeutics and clinical risk management, 2018. 14: p. 2029.
3. Organization W.H.O, Assessment of fracture risk and its application to screening for postmenopausal osteoporosis: report of a WHO study group [meeting held in Rome from 22 to 25 June 1992]. 1994: World Health Organization.
4. Hunter D.J. and P.N. Sambrook, Bone loss: epidemiology of bone loss. Arthritis Research & Therapy, 2000. 2(6): p. 1-5.
5. Kanis J et al., Long-term risk of osteoporotic fracture in Malmö. Osteoporosis International, 2000. 11(8): p. 669-674.
6. Mithal A et al., The Asia-pacific regional audit-epidemiology, costs, and burden of osteoporosis in India 2013: a report of international osteoporosis foundation. Indian Journal of Endocrinology and Metabolism, 2014. 18(4), p. 449.
7. Mithal, A. and P. Kaur, Osteoporosis in Asia: a call to action. Current osteoporosis reports, 2012. 10(4), p. 245-247.
8. Varacallo MA, Fox EJ. Osteoporosis and its complications. Med Clin North Am. 2014 Jul; 98(4):817-31, xii-xiii.)
9. Bhadada SK et al. , The Indian Society for Bone and Mineral Research (ISBMR) position statement for the diagnosis and treatment of osteoporosis in adults. Arch Osteoporos 2021; 16(1),102.
10. Harishastri Paradkara, editor, (Reprint ed.), Ashtanga Hrudayam by Vagbhata, Sootra Sthana ; Ayushkameeya : Chapter 1, Verse 13., 2014,Varanasi: Chowkhambha Orientalia, ;10.
11. Harishastri Paradkara, editor, (Reprint ed.), Ashtanga Hrudayam by Vagbhata, Sootra Sthana; Doshadi Vidnaneeya : Chapter 11, Verse 4, 2014, Varanasi: Chowkhambha Orientalia,183.
12. Jadavji Trikamji, editor, (Reprint ed.), Charaka Samhita by Agnivesha, Revised by Charaka and Dridhabala, Vimana Sthana; Srotos Vimana: Chapter 5, Verse 17, 2015, Varanasi: Chowkhambha Orientalia, 251.
13. Jadavji Trikamji, editor, (Reprint ed.), Charaka Samhita by Agnivesha, Revised by Charaka and Dridhabala, Sootra Sthana; Vividha Ashita Peetiya: Chapter 28, Verse 16, 2015, Varanasi: Chowkhambha Orientalia,179.
14. Harishastri Paradkara, editor, (Reprint ed.), Ashtanga Hrudayam by Vagbhata, Sootra Sthana; Doshadi Vidnyaneeya: Chapter 11, Verse 26-27, 2014, Varanasi: Chowkhambha Orientalia, 186
15. Harishastri Paradkara, editor, (Reprint ed.), Ashtanga Hrudayam by Vagbhata, Sootra Sthana ; Doshadi Vidnyaneeya : Chapter 11, Verse 19, 2014, Varanasi: Chowkhambha Orientalia, 185
16. Jadavji Trikamji, editor, (Reprint ed.). Charaka Samhita by Agnivesha, Revised by Charaka and Dridhabala, Sharira Sthana; Sharir Vichaya : Chapter 6, Verse 9-10, 2015, Varanasi: Chowkhambha Orientalia, 330-331.
17. Jadavji Trikamji, editor, (Reprint ed.), Charaka Samhita by Agnivesha, Revised by Charaka and Dridhabala, Sootra Sthana; Vividha Ashita Peetiya: Chapter 28, Verse 27, 2015, Varanasi: Chowkhambha Orientalia,180.
18. Gangadhar Shastri Gune. Aushadhi Guna Dharma Shastra (Marathi), Reprint. Delhi: Chaukhamba Sanskrit Pratishthana; 2017, Part 3, page 103
19. Parshurama Shastri, editor, (Reprint ed.). Sharangadhara Samhita by Pandit Sharangadharacharya, Uttara Khanda; Basti Vidhi : Chapter 20, Verse 323, 2012, Varanasi: Chowkhambha Orientalia, 323.
20. Delitala, A.P., A. Scuteri, and C. Doria, Thyroid hormone diseases and osteoporosis. Journal of clinical medicine, 2020. 9(4): p. 1034.
21. Farr, J.N., et al., Independent roles of estrogen deficiency and cellular senescence in the pathogenesis of osteoporosis: evidence in young adult mice and older humans. Journal of Bone and Mineral Research, 2019. 34(8): p. 1407-1418.
22. Yin, X., et al., Autophagy in bone homeostasis and the onset of osteoporosis. Bone research, 2019. **7**(1): p. 1-16.
23. Varacallo M, Seaman TJ, Jandu JS, et al. Osteopenia. [Updated 2022 Oct 24]. In: StatPearl [Internet]. Treasure Island (FL): StatPearls Publishing; 2022 Jan.

24. Saeedi P, Shavandi A, Meredith-Jones K. Nail Properties and Bone Health: A Review. J FunctBiomater. 2018 Apr 23;9(2):31. doi: 10.3390/jfb9020031. PMID: 29690604; PMCID: PMC6023356.
25. Tounta TS. Diagnosis of osteoporosis in dental patients. J Frailty Sarcopenia Falls. 2017 Jun 1;2(2):21-27. PMID: 32300679; PMCID: PMC7155378.
26. Park, J.H., et al., Sedentary lifestyle: Overview of updated evidence of potential health risks. Korean journal of family medicine, 2020. 41(6): p. 365.
27. Sharif, A., et al., Role of dietary pattern in prevention of osteoporosis in post menopausal females. Cell, 2017. 331: p. 4838518.
28. Fabiani, R., G. Naldini, and M. Chiavarini, Dietary patterns in relation to low bone mineral density and fracture risk: a systematic review and meta-analysis. Advances in Nutrition, 2019. 10(2): p. 219-236.
29. Watts, N.B., Postmenopausal osteoporosis: a clinical review. Journal of women's health, 2018. 27(9): p. 1093-1096.
30. Katz S, Weinerman S. Osteoporosis and gastrointestinal disease. Gastroenterol Hepatol (N Y). 2010; 6(8):506-517.

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