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Research Paper

Changes in Serum Alkaline and Acid Phosphataselevels in Relation to Ageing and Onset of Osteoporosis Among South Indian Rural Women

Home Science

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ABSTRACT

Bone modeling is an ongoing skeletal metabolic process involving a continuous formation as well as resorption of bone in human life cycle. Gradually as the child grows the osteoblastic activity increases and with the advancing age, the osteoclast activity predominates and leads to imbalance in bone turnover process. This increases porosity in bones and is the primary cause of osteoporosis in ageing population. The existing literature well defines serum alkaline phosphatase as bone formation marker and serum acid phosphatase as resortion marker.The present study aimed at studying the changes in these two enzymes with the advancing age and the onset of osteoporosis. The study is carried out in 260 South Indian rural women between 35 to 74 years of age. The results well demonstrated the elevation these two bone turnover markers with the progressive age and also as the bone density regressed from normal to osteopenia and to osteoporosis.

INTRODUCTION

Bone modeling begins with the development of the skeleton during fetal life and continues until the end of the second decade, when the longitudinal growth of the skeleton is completed. In the modeling process, bone is formed at locations that differ from the sites of resorption, leading to a change in the shape or macro architecture of the skeleton. Longitudinal growth of a typical long bone such as the tibia depends on the proliferation and differentiation of cartilage cells in the epiphyseal (growth) plate. Cross-sectional growth such as the increase in girth of the radial diaphysis occurs as new bone is laid down beneath the periosteum. Simultaneously bone is resorbed at the endosteal surface. Bone modeling may continue, but to a lesser extent during adult life when resorption at the end endosteal surface increases the mechanical strain on the remaining cortical bone, leading to the stimulation of periosteal bone apposition. This phenomenon, which increases with ageing, offsets in part the negative effects of bone resorption at the endosteal surface on mechanical strength. [1]

Biochemical markers of bone metabolism may be used to predict future bone loss and hip fractures in longer cohorts to select therapy for individual patients, to predict the therapeutic response in individual patients, to monitor therapeutic response and efficacy in and compliance of individual patients. Once the diagnosis of osteoporotic bone disease is made, biochemical markers of bone metabolism are useful tools in the further work-up particularly in identifying patients with high rates of bone turnover. Furthermore, patients with high bone turnover appear to profit from anti-resorptive treatments more than subjects with low or normal bone metabolism. The measurement of bone turnover may therefore not only be useful in therapeutic decision making but can also help to reduce costs by identifying those individuals who may not respond well to treatment. [2]

Alkaline phosphatase is an important component in hard tissue formation, highly expressed in mineralized tissue cells. The mechanism with which this enzyme carries out its function is not completely understood, but it appears to act both to increase the local concentration of inorganic phosphate, a mineralization promoter, and to decrease the concentration of extracellular pyrophosphate, an inhibitor of mineral formation. Any disease that damages bone can release alkaline phosphatase into the blood. Examples include primary bone cancer and metastatic bone cancers, a broken bone or osteoporosis. [3]

Acid phosphatases are a family of enzymes that are widespread in nature, and can be found in many animal and plant species. Mystery surrounds the precise functional role of these molecular facilitators, despite much research. Yet, paradoxically, human acid phosphatases have had considerable impact as tools of clinical investigation and intervention. One particular example is tartrate resistant acid phosphatase, which is detected in the serum in raised amounts accompanying pathological bone resorption. This observation suggests that serum acid phosphatase could be diagnostically useful as serological and histological markers of disease, and could also be of use in the investigation of the pathophysiology of the associated disease. [4]

The research clearly provides an evidence of increased bone resorption process with advancing age and simultaneously reflected by the increase in both bone formation and resorption markers. Serum alkaline phosphatase is known for its osteoblastic activity as bone formation marker and serum acid phosphatase for its osteoclastic activity as bone resorption marker. The current research is focused on studying the age-related changes in the two important enzymes in the serum and the effect of these with the onset of osteopenia and osteoporosis.

METHODOLOGY

The rural women who voluntarily participated in Bone Mineral Density (BMD) campaign and ready for biochemical assessment are included in the study. To study the ageing process women over the age of 35 to 74 years are chosen and categorized into young (35-44 years), middle (45-54 years), aged (55-64 years) and elderly women (65-74 years). The women are again divided into normal, osteopenia and osteoporosis women based on WHO criteria of osteoporosis by BMD T-scores. The bone density status is evaluated trough quantitative ultra-sound (QUS) bone densitometer measured at calcaneus bone

Simultaneously with the bone densitometry examination, the biochemical evaluation is carried out for estimation of serum alkaline phosphatase and serum acid phosphatase as per the standard procedures. The changes are analyzed in relation to age among four different age groups. The corresponding changes with the alteration in bone density are evaluated by calculated t-values between normal and osteopenia; normal and osteoporosis and between osteopenia and osteoporosis women in each age group.

RESULTS AND DISCUSSION

The mean serum alkaline phosphatase levels in relation to age among four different age groups are presented in the table no-1. The calculated t-values among normal, osteopenic and osteoporotic women are also denoted in the same table. The data from the table reveal that the mean serum alkaline phosphtase levels seem to be within standard reference range of 30 to120 U/L (Farley (1995)). The important finding to be highlighted is the elevated serum alkaline phosphatase levels in osteopenic and osteoporotic women than the normal women. When the bone density status shifts towards osteopenia and osteoporosis from normal bone density levels, then rate of bone resorption markedly increased with the lowering of bone densities. The increase in the rate of bone turnover results in increasing levels of both formation and resorption markers. The serum alkaline phosphatase being the bone formation marker probably resulted in elevated levels in the conditions of osteopenia and osteoporosis due to increased rates of bone turnover process. This is much evidenced by the significant differences in the elevated levels of serum alkaline phosphatase in osteoporotic women against the normal women.

On the other hand, there is an increase in serum alkaline phosphatase levels with the advancing age. As the women ages around 45 years usually the menstruation ceases and results in menopausal stage. With the onset of menopause, estrogen deficiency status initiates and increases the rate of bone resorption by increasing osteoclastic activity. To overcome the increased levels of osteoclastic activity, there is an alternative compensatory mechanism results in bone formation marker either by increasing the osteoblast number or activity. This compensatory phenomenon may be the possible reason for the age-related increase in serum alkaline phosphatase, which is considered as one of the bone formation marker.

The crucial observation to note down is that serum alkaline phosphatase levels are elevated significantly both in osteoporotic women as well as elderly against normal healthy individual. Because osteoporotic bone is more porous due to increased number of osteoclast cells and the ageing process also increases osteoclastic activity, in both conditions, to fit the porous pits osteoblasts need to be considerably increased and probably responsible for increased levels of serum alkaline phosphatase in osteoporotic elderly individuals.

Similarly the mean serum acid phosphatase values in relation to age and bone density status are depicted in the table no-2 along with calculated t-values. The findings from the table represent that the mean serum acid phosphatase is raised with the advancing age as well as with the onset of osteoporosis similar to that of serum alkaline phosphatase as mentioned earlier. As the women reach on an average age of 45 years, many of them experience the condition of menopause. The menopausal increase in bone turnover is reflected both by resorption and formation markers with elevated levels on par with the advancing age. This high turnover state sometimes referred to as "coupled", though this term is somewhat inaccurate since bone is lost as a result of the net imbalance. The coupling process of bone remodeling may be related to the increase in the levels of both serum alkaline phosphatase and acid phosphatase as they found to be in bone formation and resorption and thus these markers are involved in bone remodeling process. [5]

The serum acid phosphatase being the resorption marker leads to elevated levels in osteoporotic women significantly which is much evidenced by significant differences between the mean serum acid phosphatase levels of normal and osteoporotic women irrespective of age . It is also found that the trend of increasing levels of mean serum acid phosphatase is observed from normal to osteopenia and to osteoporosis. The changes are very clear though significant differences are not noticed in all cases between normal Vs osteopenia and osteopenia Vs osteoporosis.

CONCLUSION

The findings of the study well demonstrated by the high bone turnover levels with the advancing age and with the onset of osteopenia and osteoporosis by elevated levels of both serum alkaline and acid phosphatases being bone formation and resorption markers respectively. As one cannot alter the physiological age-related changes, the alternative strategy is to minimize the risk of age-related bone loss by adopting healthy dietary and life style practices.

Table No-1

Mean serum alkaline phosphatase levels of select women groups suffering with osteopenia and osteoporosis - calculated t-values for the differences and level of significance

Age (Years)	BMD-Status & Mean serum alkaline phosphatase (U/L)			Calculated t-values		
	Normal Mean ± S.D	Osteopenia Mean ± S.D	Osteoporosis Mean ± S.D	Normal Vs Osteopenia	Normal Vs Osteoporosis	Osteopenia Vs Osteoporosis
35-44 (n=60)	64.66 ± (17.54)	70.95 ± (15.27)	86.56 ± (11.82)	1.27 NS	2.94**	2.26*
45-54 (n = 80)	69.10 ± (15.77)	77.17 ± (16.27)	90.21 ± (10.93)	2.05*	4.45**	2.63*
55-64 (n = 80)	73.97 ± (16.53)	80.57 ± (15.88)	93.42 ± (13.09)	1.49 NS	4.54**	3.27**
65-74 (n = 40)	Nil	85.92 ± (19.04)	99.63 ± (12.84)	Nil	Nil	2.00 NS

Table No-2

Mean serum acid phosphatase levels of select women groups suffering with osteopenia and osteoporosis - calculated t-values for the differences and level of significance

Age (Years)	BMD-Status & Mean serum acid phosphatase (U/L)			Calculated t-values		
	Normal Mean ± S.D	**Osteopenia Mean** ± S.D	**Osteoporosis Mean** ± S.D	Normal Vs Osteopenia	Normal Vs Osteoporosis	Osteopenia Vs Osteoporosis
35-44 (n=60)	2.66 ± (0.32)	2.86 ± (0.44)	3.32 ± (0.66)	1.89 NS	3.96**	1.95 NS
45-54 (n = 80)	2.83 ± (0.67)	3.09 ± (0.74)	3.43 ± (0.64)	1.47 NS	2.77**	1.44 NS
55-64 (n = 80)	2.93 ± (0.74)	3.14 ± (0.81)	3.66 ± (0.80)	0.95 NS	3.24 **	2.44*
65-74 (n = 40)	Nil	3.75 ± (0.36)	4.11 ± (0.46)	Nil	Nil	2.29*

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