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TARTARATE RESISTANT ACID PHOSPHATASE AS A MARKER IN OSTEOPOROSIS AND BONE MALIGNANCY.

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ABSTRACT

Non prostatic tartarate resistant acid phosphatase(TRACP) is present in bone resorbing osteoclasts. Matrix degradation products together with TRACP are released from the osteoclasts into the blood circulation .Therefore this study is carried out to study TRACP as a marker for osteoporosis and bone malignancy. A total of 75 subjects were included in this study. They were divided into 3 groups. Group I included 25 diagnosed cases of malignant bone tumors between the age group 20 to 70 years of both sexes. Group II included 25 cases of osteoporosis and group III , the control group, included 25 healthy individuals of the same age groups and sexes. TRACP was estimated in the serum of all the subjects. TRACP levels were highly increased in both the osteoporosis and bone malignancy groups ($p<0.001$) . Therefore TRACP can be considered as a marker for bone resorption in osteoporosis and bone malignancy.

KEY WORDS: Acid phosphatase, Osteoporosis, bone malignancy.

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INTRODUCTION

Acid phosphatase (ACP) is an enzyme which removes phosphate groups from other molecules at acidic pH. It is basically a monoesterase stored in lysosomes. Different forms of ACPs are found in different organs and their serum levels are useful in the diagnosis of diseases(1,2). Elevated prostatic ACP levels may indicate the presence of prostatic cancer. Non prostatic ACP also known as tartarate resistant acid phosphatase (TRACP) is present in bone resorbing osteoclasts, alveolar macrophages and dendritic cells.(3,4,5,6). TRACP is a glycosylated, monomeric iron containing enzyme(4). TRACP has two distinct enzymatic activities. It can function as a phosphatase at acidic pH and as a generator of reactive oxygen species(ROS) at neutral pH . It has been shown that the two phospho-serine containing bone matrix proteins osteopontin and sialoprotein may be biologically relevant substrates for TRACP (7,8). The redox active iron of TRACP can facilitate generation of reactive oxygen species (ROS) through Fenton's reaction(9). ROS generated by TRACP have been suggested to participate in degradation of bone matrix components of osteoclasts and in degradation of foreign compounds in antigenic presentation route of macrophages(10, 11). Matrix degradation products are finally released from the osteoclasts into the blood circulation together with TRACP.(12,13,14). Based on this, this study is planned to study TRACP as a marker for bone resorption and malignancy.

MATERIALS AND METHODS

A total of 75 subjects were included in this study. They were divided into 3 groups. The test group I included 25 diagnosed cases of malignant bone tumors which includes both primary and secondaries. Care was taken in choosing patients who had not received chemotherapy, radiotherapy or both. The age group was between 20 to 70 years of both sexes. The test group II included 25 cases of osteoporosis who were admitted to the hospital with a history of trivial fracture, between the age group 45 to 70 years. The control group included 25 healthy individuals between 20 to 70 years of both sexes. The patients were selected from District Wenlock hospital Mangalore, Kasturba Medical College hospitals in Mangalore and Manipal ,Yenepoya hospital Mangalore. Patients with a history of chronic inflammatory diseases, diabetes mellitus, smokers and alcoholics were excluded from the study.

Sample collection

1ml of venous blood was collected in plain vacutainer under aseptic precautions from the patients and normal healthy subjects. Informed consent was taken from all the subjects included in the study. Serum was used for the estimation of TRACP by using Teco diagnostics kit.(15,16,17). The α- naphthol released from the substrate α-naphthyl phosphate by acid phosphatase is coupled with fast red TR to produce a colored complex which absorbs light at 405nm. The reaction can be quantified photometrically because the coupling reaction is instantaneous. L-tartarate inhibits prostatic acid phosphatase but does not interfere with the reaction mechanism. One international unit is defined as the amount of enzyme that catalyzes the transformation of one micromole of substrate per minute under defined conditions. Statistical analysis was done using Kruskal-wallis test.

RESULTS

The serum TRACP level was significantly increased in both osteoporosis patients and bone malignancy group when compared to control subjects. The increase in the level of TRACP was statistically very highly significant ($p<0.001$) Table 1.

Table 1
Serum levels of TRACP in osteoporosis and bone malignancy groups compared to control subjects.

Groups	N	Mean	S.D.	p- value
Control	25	4.48	0.77	
Osteoporosis	25	10.98	1.37	<0.001
Bone malignancy	25	12.55	2.19	vhs

N = Number of subjects
S.D. = Standard deviation
p-value = Probability of chance of significance of difference between two means.
vhs = very highly significant.

DISCUSSION

Bones are living growing tissues that are in a constant state of change with the old tissue being broken down(resorption) and new tissue formed in its place(formation). The fine balance between bone resorption and bone formation is maintained by osteoclast cells which continuously demineralize old tissue and osteoblast cells which continuously form new tissue for growth (18,19). The osteoclast is the sole cell that resorbs bone and is central in pathologic situations, where bone destruction is intricately involved(20). Osteoclasts demineralize bones through extracellular bone dissolution, a process involving the secretion of hydrolytic enzymes (21). Osteoclasts contain enzymes that play a role in bone lytic activities such as acid phosphatase and collagenase. In our study we have found an increase in TRACP in patients with osteoporosis and bone malignancy. Since osteoclasts secrete TRACP into the circulation, it can be considered as a useful marker for bone resorption and bone malignancy. Metastatic tumors are the most common form of skeletal malignancy. Any cancer can spread to bone but in adults skeletal metastasis originate from cancers of the prostate, breast, kidney and lung. Metastasis may be purely lytic, purely blastic or mixed lytic and blastic. In lytic lesions, the metastatic cells themselves do not directly resorb the bone, but these secrete substances such as TRACP, prostaglandins, interleukins and parathormone related peptide which stimulate osteoclastic bone resorption.(22, 23). Since TRACP is highly increased in patients with osteoporosis and bone malignancy, it can be used as a marker . Moreover ROS are involved in the pathogenesis of several diseases(24). The redox active iron of TRACP can generate ROS through Fenton's reaction. ROS generated by TRACP have been suggested to participate in degradation of the organic matrix components of osteoclasts. Finally the matrix degradation products are released from the osteoclast into the blood circulation together with TRACP through a functional secretory domain in the basolateral membrane(13,14). Based on this, it could be assumed that secreted TRACP would be a marker for bone resorption and bone malignancy.

REFERENCES

1. Hallen JM, Altalo SL, Suominen H, Cheng S, Jhanckila AJ, Vaananen HK. Tartarate resistant acid phosphatase 5b : a novel marker of bone resorption. J. Bone. Miner. Res. 2000; 15: 1337-45.
2. Vaananem HK, Zhao H, Mulari M, Halleen JM. The cell biology of osteoclast function. J. cell. Sci. 2000; 113: 377-81.
3. Hayman AR, Macary P, Lehner PJ, Cox TM. Tartarate resistant acid phosphatase: identification in diverse human tissues and

dendritic cells. J. Histchem. Cytochem. 2001; 49: 675-684.
4. JussiHalleen. Tartarate resistant acid phosphatase 5b as a marker of bone resorption. Review series. Vol.3 April 2006.
5. Minkin C. Bone acid phosphatase :tartarate resistant acid phosphatase as a marker of osteoclast function. Calcif Tissue Int. 1982; 34: 285-290.
6. Efstratiadis T, Moss DW. Tartarate resistant acid phosphatase in human alveolar macrophages. Enzyme. 1985; 34: 140-143.
7. Ek-Rylander B, Flores M, Wendel M, Heinegard D, Andersson G. "Dephosphorylation of osteopontin and bone sialoprotein by osteoclastictartarate resistant acid phosphatase. Modulation of osteoclast adhesion in vitro". J. Biol. Chem. 1994; 269: 14853-14856.
8. Skaija H, Alatalo SR, Halleen JM, Lindqvist Y, Schneider G, Vaananen HK, Vihko P. Phosphatase and oxygen generating activities of mammalian purple acid phosphatase are functionally independent. Biochem. Biophys. Res. Commun. 2002; 292: 128-132.
9. Sibille JC, Doi K, Aisen P. Hydroxyl radical formation and iron binding proteins. Stimulation by the purple acid phosphatase J. Biol. Chem. 1987: 262: 59-62.
10. Halleen JM, Raisanen S, Salo JJ, Reddy SV, Roodman GD, Hentunen TA, Lehenkari PP, Kaija H, Vihko P, Vaananen HK. Intracellular fragmentation of bone resorption products by reactive oxygen species generated by osteoclastictartarate resistant acid phosphatase J. Biol. Chem. 1999; 274: 22907-22910.
11. Raisanen SR, Halleen J, Parikka V, Vaananen HK. Tartarate resistant acid phosphatase facilitates hydroxyl radical formation and coloclizes with phagocytosed staphylococcus aureus in alveolar macrophages. Biochem. Biophys. Res. Commun. 2001; 288: 142-150.
12. Janckila AJ, Parthasarathy RN, Parthasarathy LK, Seelan RS, Hsueh YC, Rissanen J, Alatalo SL, Halleen JM, Yam LT. Properties and expression of human tartarate resistant acid phosphatase isoform 5a by monocyte derived cells. J. Leukoc. Biol. 2005; 77: 209-218.
13. Salo J, Mestikko K, Palkangas H, Lehenkari P, Vaananen HK. Bone resorbing osteoclasts reveal a dynamic division of basal plasma membrane into two different domains. J. Cell. Sci. 1996; 109: 301-307.
14. Terpos E, dela Fuente J, Szydlo R, Hatjihrissi E, Viniou N, Meletis J, Yataganas X, Goldman JM, Rahemtulla. Tartarate resistant acid phosphatase isoform 5b, a novel serum marker for monitoring bone disease in multiple myeloma. Int. J. Cancer. 2003a; 106: 455-457.
15. Bergmeyer HV. Methods of enzymatic analysis. Weinheiam: VerlagChemie. 1984; P 92.
16. Varley H. Practical Clinical Biochemistry. 5thed. In: Determination of serum acid phosphatase. London: William Heinemann Medical Books Ltd. 1980; p913-915.
17. Benedicta D'Souza, RajeevalochanaParthasarathy, Sreekantha, Vivian D'Souza. Acid phosphatase as a marker in malaria. Ind. J. Clin. Biochem. 2011; 26: 396-399.
18. Vaananen HK, Zhao H, Mulari M, Halleen JM. The cell biology of osteoclast function. J. Cell. Sci. 2000; 113: 377-381.
19. Kumar, Cortan and Robbins. "Robbins pathologic basis of disease " Elsevier publishers. 7th edition. 2004; p 1274-1303.
20. Skubitz KM, D'Adamo D. "Sarcoma " . Mayoclin. Proc. 2007; 82: 1409-1432.
21. Nesbitt SA, Horton MA. Trafficking of matrix collagens through bone resorbing osteoclasts. Science, 1997; 276: 266-269.
22. Ljusberg J, Wang Y, Lang P, Norgard M, Dodds R, Hultenby k, Ek-Rylander B, Andersson G. Proteolytic excision of a repressive loop domain in tartarate resistant acid phosphatase by cathepsin K in osteoclasts. J. Biol. Chem. 2005; 280: 28370-28381.
23. Harry B. Skinner. "Current diagnosis and treatment". Lange medical books/ Mc.Graw

Hill publications 4th edition 2006; p 298-315.

24. Benedicta D'Souza, Michele P.Christian, Raviraja, Ashok Prabhu, Beena V. Shetty, Vivian D'Souza. Effect of atorvastatin on advanced oxidation protein products and malondialdehyde in dyslipidemic patients with and without diabetes. Int. J. Pharm. Bio.Sci. 2013; oct,4(4): (B) 559-563.