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INTAKE OF ^{226}Ra IN OSTEOPOROSIS PREVENTION AND THERAPY WITH "GRAN-WHITE" DOLOMITE AS CALCIUM SUPPLEMENT

B. R. S. Pecequilo and M. P. Campos
Instituto de Pesquisas Energéticas e Nucleares - IPEN-CNEN/SP
Caixa Postal 11049 – Pinheiros- 05422-970, São Paulo
brigitte@net.ipen.br, mpcampos@net.ipen.br

ABSTRACT

A ^{226}Ra average specific activity of 4.3 $Bq.kg^{-1}$ was determined by passive high resolution gamma-ray spectrometry in six samples of "Gran-White" dolomite. The committed effective dose and committed equivalent dose at bone surface were calculated through the AnaComp code, using ^{226}Ra intake and radium metabolic model from ICRP 67. The doses were calculated for patients submitted to osteoporosis prevention and osteoporosis therapy.

Key words: ^{226}Ra intake, gamma ray spectrometry, internal dosimetry

RESUMO

Uma atividade especifica média de 4,3 $Bq.kg^{-1}$ foi determinada por espectrometria gama passiva de alta resolução em seis amostras de dolomita "Gran-White". As doses efetiva comprometida e equivalente comprometida na superficie do osso foram determinadas por meio do programa AnaComp a partir da quantidade de ^{226}Ra incorporada e do modelo metabólico do rádio descrito no ICRP 67. As doses foram calculadas para pacientes submetidos aos tratamentos preventivo e terápico da osteoporose.

Descritores: incoporação de ^{226}Ra, espectrometria gama, dosimetria interna

INTRODUCTION

Bones are living tissues, constantly remodeling themselves. During the growth years and up to age 25–30, the bone mass is continuously builded up and achieve peak. There is a relatively short period of time between the end of bone building and the onset of bone loss (30 to 40 years old). Starting at age 40–45, both men and women lose bone slowly, but women lose bone mass rapidly around the menopause and for about 10 years after. The disease, which characterizes this loss, is called osteoporosis and results on a shrinkage of the stable portion of bone characterized by stable bone mineral. The effects can include several back pain, stooped postures, lost independence and medical complications from fractured hips, spine and wrists [1].

Osteoporosis, a condition of decreased bone tissue that increases the likelihood of fracture, is a silent disease that often remains asymptomatic and undetected until bone fracture occurs, becoming a significant health problem for perimenopausal and postmenopausal women from ages 51 to 75 [2].

Estrogen deficiency is the most dominant factor in the pathogenesis of this disorder, but inadequate calcium intake is one of the causes of low bone mass. In assessing the role of calcium, it must be pointed that calcium is not the cause of bone health, but simply a necessary condition for it. Calcium is not a substitute for estrogen, but a high calcium intake will prevent calcium-deficiency bone loss and an adequate combination of estrogen replacement therapy, exercise and calcium intake can be a good strategy for the prevention of bone loss [2], [3], [4].

The calcium requirement for postmenopausal women is about 1000 to 1500 mg a day. Foods often supply calcium and other crucial nutrients, vitamins and minerals, but, even with a good diet, women typically fall 500 to 1000 mg short of their recommended allowance each day. Clearly, those women need to consider calcium supplements, typically pills having 500 or 600 mg of calcium [5], [6].

There are four main varieties of calcium supplements [5]: calcium carbonate (by far the most common type), calcium citrate, calcium lactate and calcium gluconate. The body absorbs calcium from all four forms about equally well, but calcium carbonate is the most concentred form. It contains a far higher percentage of elemental calcium that other forms do, so the pills are generally more economical and one or two tablets per day are sufficient.

Calcium carbonate is often made from pulverized oyster shells or mined from limestone deposits. As nowadays, people are more and more concerned with polluted oysters, limestone is becoming a very interesting alternative solution.

A special pure (Calcium oxide – 32.8% and Magnesium oxide – 19.9%) and so-believed energized dolomite, so-called “Gran-White”, is extracted in Iporanga, São Paulo State, Brazil, by the “Minervale” company and grinded at Mesh-325 [7].

Brazilian physician had successfully prescribed the naturally energized “Gran-White” dolomite as an economical calcium supplement for osteoporosis prevention and therapy and observed that in osteoporotic patients, daily supplementation with 3g led to significant increase of spinal bone mass density [8].

However, the “Gran-White” Dolomite is calcium-magnesium carbonate mined from limestone deposits, which can be associated with trace-element radium [9].

When radium is taken into the body, its metabolic behavior is similar to the calcium one, and an appreciable fraction is deposited in bone. More that 70% of the radium in the body is contained in bone, the remaining fraction being distributed rather uniformly in soft tissues [10]. As radiation is harmful to human health and ^{226}Ra is one of the critical radionuclides, it is very important the knowledge of radium content of the “Gran-White” dolomite, in order to assess the risk of ingestion when “Gran-White” is used in the prevention and therapy of osteoporosis.

The risk of ingestion of the “Gran-White” dolomite was evaluated by calculating the committed effective dose and committed equivalent dose due the ^{226}Ra content.

MATERIALS AND METHODS

The “Gran-White” dolomite, sampled the same pattern that commercialized, was provided by the “Minervale” manufacturer. A total of 6 samples, of 1.5 $g.cm^{-3}$ apparent density, were hermetically sealed in 100 mL polyethylene flasks and measured by passive high resolution gamma-ray spectroscopy after a 4 weeks ingrowth period.

The gamma-ray spectroscopy system has a high resolution 94 cm^3 HPGe detector (EG&G Ortec), with conventional electronics, coupled to 4K-channels memory EG&G Ortec 918-A ADCAM multichannel buffer and 476-8 multiplexer and 386 PC/AT computer. The measured energy resolution for the 1.33 MeV ^{60}Co energy is 1.7 keV.

The background distribution was obtained by measuring de-ionized water in the same sample geometry.

All spectra were analyzed by the MicroSAMPO [11] software for personal computer analysis of gamma-ray spectra from HPGe detectors. The self-absorption correction of the sample was achieved using a pre-determined standard efficiency calibration curve [12].

RESULTS

^{226}Ra Specific Activity. The ^{226}Ra specific activity for each sample was determined assuming radioactive equilibrium for the ^{226}Ra in the ^{238}U chain, as a mean value of the ^{214}Pb and ^{214}Bi activities. The ^{214}Pb activity was calculated considering the 295 keV and 352 keV gamma transitions. In the ^{214}Bi activity we considered the 609 keV, 1120 keV and 1764 keV gamma transitions. The “Gran-White” dolomite average specific activity of ^{226}Ra was calculated as the mean value of all samples. Table 1 shows the radium specific activity obtained as a mean value from the six samples of the “Gran-White” dolomite.

Table 1. ^{226}Ra Average specific activity of the "Gran-White" dolomite

Sample	^{226}Ra (Bq.kg^{-1})
Gran-White	4.3 ± 0.4

Committed Effective Dose and Committed Equivalent Dose. As almost all body radium intake goes to the bone, it is necessary to determine the committed equivalent dose in bone surface as well as the committed effective dose. The functions describing uptake and retention in a body tissue following its ingestion are quite complex. Therefore it is convenient to describe the transfer of radionuclides from diet to body by simple models which facilitate calculation and yet still allow sufficiently accurate dose estimates.

According to the metabolic model suggested by the ICRP 67 [13] of the radium absorbed to blood from the gastrointestinal tract, a considerable fraction leaving plasma passes into the intestines and is subsequently excreted in faeces. There is substantial deposition and retention in bone and some in soft tissues. A significant percent of the activity deposited in bone is returned to plasma within a few days or weeks, but a fraction is retained and is only slowly returned to plasma by bone remodeling and possibly other processes.

The recommended dosage [7] for the "Gran-White" dolomite is a daily supplementation of 2 g for osteoporosis prevention and 3 g for osteoporosis therapy, leaving respectively to an annual ^{226}Ra intake of 3.2 Bq and 4.8 Bq.
Using these informations and knowing the ^{226}Ra specific activity of the "Gran-White" dolomite, we calculated the radiation dose received by the patients.

The committed effective dose (E) and the committed equivalent dose in the bone surface (H_B) were calculated considering the ICRP 67 [13] radium biokinetic model and using the AnaComp code [14] for personal computers. The AnaComp code uses the MIRD (Medical Internal Radiation Dose) formalism to calculate the radiation doses through compartment models.

The committed effective dose and the committed equivalent dose due to the intake of the "Gran-White" dolomite for osteoporosis prevention and therapy are presented in tables 2 and 3, respectively.

Table 2. Committed effective dose (E) and committed equivalent dose at bone surface (H_B) received by patients having a daily supplementation with 2g of "Gran-White" dolomite (osteoporosis prevention)

E (Sv.y^{-1})	0.6x10^{-6}
H_B (Sv.y^{-1})	7.0x10^{-6}

Table 3. Committed effective dose (E) and committed equivalent dose at bone surface (H_B) received by patients having a daily supplementation with 3g of "Gran-White" dolomite (osteoporosis therapy)

E (Sv.y^{-1})	0.9x10^{-6}
H_B (Sv.y^{-1})	11x10^{-6}

Assuming a mean period of 50 years for osteoporosis prevention, patients would receive a committed effective dose of 30x10^{-6} Sv and a committed equivalent dose at bone surface of 350x10^{-6} Sv. For osteoporosis therapy, a mean period of 30 years would lead to a committed effective dose of 27x10^{-6} Sv and a committed equivalent dose of 315x10^{-6} Sv.

DISCUSSION

As it can be seen in table 2, the radiation doses received by the patients are low. Although this patients do not belong to the controlled group, in terms of radiation protection, we can compare the ingested radium with the annual limit of intake by workers of 9x10^{4} Bq [13]. Both the 4.8 Bq ingested in osteoporosis prevention and the 3.2 Bq ingested in osteoporosis therapy are below the value of 9x10^{4} Bq.

Also, although they are different quantities, the committed effective dose received by the patients treated with "Gran-White" dolomite, 0.9x10^{-6} Sv for osteoporosis therapy and 0.6x10^{-6} Sv for osteoporosis prevention, is much lower that the annual effective dose equivalent for internal irradiation from natural sources in areas of normal background estimated from the UNSCEAR 1988 [10] (1.6x10^{-3} Sv). If we consider intake periods of 50 years and 30 years for osteoporosis prevention and therapy, respectively, even so, the radiation doses received by the patients are low.

So, the osteoporosis treatment using "Gran-White" dolomite can be achieved with no radiological damage to the patients.

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