EFFECT OF CHOLINE STABILIZED ORTHOSILICIC ACID ON BONE DENSITY IN CHICKS

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Introduction

Function of silicon

Silicon (Si) was reported to be important for normal growth and for structural integrity of connective tissue in mammals and birds. Dietary deficiency experiments indicated a close relationship between the Si concentration and the degree of mineralisation of the young bone from chicks and rats. Si deficiency caused bone deformation, a thinner cortex and a less calicified bone matrix. The retarded growth and malformations were prevented by Si supplementation[1]. Seaborn showed that silicon deprivation in rats results in an altered bone mineral composition and decreased activity of acid and alkaline femur phophatases[2]. Silicon deficiency was also found to be associated with a reduction of the number of osteoblasts in bone matrix of chickens[3]. These experiments suggested an essential role of Si in bone mineralisation and the formation of connective components such as collagen and glycosaminoglycans.

Orthosilicic acid

Orthosilicic acid (OSA) is a monomeric form of silicic acid which is found in dilute concentrations (< 10^{-4} M) in beverages and water. It was found that OSA is readily available for gastrointestinal absorption but that its polymers are not absorbed[4]. The bioavailability of stabilized forms of OSA was found to be significantly higher compared to other silicon supplements[5].

Aim of the study

Broiler chicks on a normal diet (1.4 mg Si/g) were supplemented with choline stabilized orthosilicic acid (Ch-OSA) to investigate the effect of silicon on the serum calcium concentration and bone mineral content (BMC) and density (BMD) in the femur.

Methods

A group of 42,500 chicks was administered Ch-OSA (13.5 mg Si/100 kg bodyweight/2 days) in their drinking water for 6 weeks which increased the total dietary Si intake with less than 0.5 %. A control group of 42,600 chicks of the same age was started in parallel with identical feeding but without Ch-OSA supplementation. Samples of 30 randomly chosen chicks were taken in each group at the age of six weeks to analyze the serum calcium, magnesium and silicon concentration and the femura. Femoral BMC and BMD were analyzed by Dual Energy X-ray Absorptiometry. Scans were recorded for different regions of interest in the femur (see fig. 1). Differences between means were evaluated with a one-tailed Student t-test. A p level of 0.05 was considered to be statistically significant.

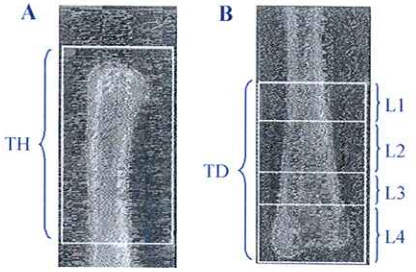

Fig. 1: Scanned areas of interest in the femur. (A) Left panel: total hip region TH. (B) Right panel: total distal region TD and 4 regions of interest (L1, L2, L3, L4).

Results

The femural bone mineral content (BMC) was significantly higher for supplemented chicks compared to the controls in all the scanned areas of the femur (fig.2). Total BMC was also significantly higher (+ 8.4 % for TD, p = 0.0163; + 10.1 % for TH, p = 0.0157) for supplemented chicks compared to the controls (fig. 2).

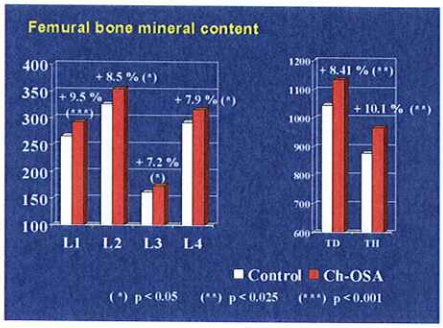

Fig. 2: Bone mineral content (mg) in femura of healthy chickens supplemented with Ch-OSA and non-supplemented controls.

The serum calcium concentration was significantly higher ($p < 0.05$) in supplemented chicks (74.85 ± 13.82 mg/ml, n = 60) compared to the controls (69.47 ± 15.99 mg/ml, n = 60).
The serum magnesium and silicon concentration were marginally higher in the supplemented group (table 1).

The mortality was lower in the supplemented group (1.5 %) compared to the control group (3 %). In addition, supplemented chicks had a marginally higher mean bodyweight compared to controls (Ch-OSA: 1920 g, controls: 1865 g).

The femural bone mineral density (BMD) was significantly higher at the midshaft (L1) (+ 4.25 %, p = 0.0209), the distal metaphysis (L4) (+ 4.88 %, p = 0.0102) and in the hip region (TH) (+ 5.6 %, p = 0.0136) for supplemented chicks compared to controls (fig. 3).

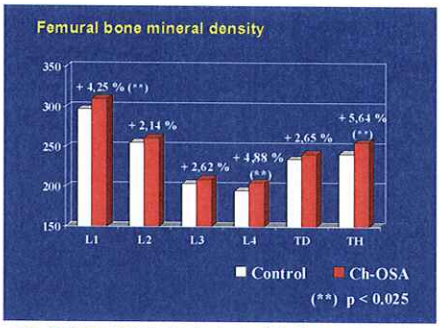

Fig. 3: Bone mineral density (mg/cm²) in femura of healthy chickens supplemented with Ch-OSA and non-supplemented controls.

Group	Calcium mg/ml (mean ± SD)	Magnesium mg/ml (mean ± SD)	Silicon µg/L (mean ± SD)
Controls (n = 60)	69.47 ± 15.99	2.54 ± 0.61	973 ± 477
Ch-OSA (n = 60)	74.58 ± 13.82	2.56 ± 0.44	992 ± 400
***p*, one tailed, Student-t**	*0.03*	*0.44*	*0.41*

Table 1: Serum concentration of calcium, magnesium and silicon in healthy chicks, supplemented with Ch-OSA and non-supplemented controls.

Discussion

Increasing the total dietary intake of broiler chicks with less than 0.5 % in the form of Ch-OSA resulted in a significant higher serum calcium concentration, a higher bone mass and a higher density in cortical and trabecular bone of the femur.
These results confirm earlier studies suggesting an essential role of silicon in bone[2] and collagen[6] metabolism. Ch-OSA was shown in previous studies to have a high bioavailability and to stimulate collagen synthesis[5,6]. The present results justify further evaluation of Ch-OSA as a bone stimulating product.

References

1. Carlisle (1970). Silicon: a possible factor in bone calcification. Science, 167, 279 - 280.
2. Seaborn & Nielsen (1994). Dietary silicon affects acid and alkaline phosphatase and calcium uptake in bone of rats. J. Trace Elem Exp Med, 7,11-18.
3. Carlisle (1976). In vivo requirement for silicon in articular cartilage and connective tissue formation in the chick. J. Nutr., 106, 478.
4. Reffitt et al. (1999). Silicic acid: its gastrointestinal uptake and urinary excretion in man and effects on aluminium excretion. Journal of Inorganic Biochemistry, 76: 141 - 147.
5. Calomme et al. (2000). Silicon absorption from stabilized orthosilicic acid and other supplements in healthy subjects. Trace Elem in Man and Animals, 10, ed. By Roussel et al., Plenum, p. 1111-1114.
6. Calomme et al. (1997). Supplementation of calves with stabilized orthosilicic acid. Biol Trace Elem Res, 56, 153-165.

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29th EUROPEAN SYMPOSIUM ON CALCIFIED TISSUES

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Group 1. But, the values of Group 4 was larger than that of Group 3, maintaining at the similar level as that of Group 1. At 15 days, the value of BV/TV of Group 3 was significantly reduced. BV/TV value of Group 4 reduced to the level of Group 3. While BFR/BS values of Group 4 maintained larger compared to Group 3, the value of Oc.N/BS significantly increased compared to the values of Groups 2 and 3. Bone marrow cell: At 8 days, The number of ALP positive CFU-f colonies of Group 3 reduced, and that of Group 2 increased compared to Group 1. In Group 4, the value also increased to Group 1. The number of TRAP positive cell developed from bone marrow cell culture of Group 3 did not differ, and that of Group 2 increased compared to that of Group 1. In Group 4, however, the value further increased compared to that of Group 2. These data clearly indicated that the bone mass increasing effect of intermittent hPTH administration reduced during the unloading of the skeleton. Intermittent hPTH injections increased osteogenic and osteoclastogenic activities in bone marrow cells, consequently leading to bone mass increase in the ground condition. But, during unloading, the increase in osteoclastogenic activity seemed to further increase with passage of time, leading to alleviate the bone mass increasing action of the agent.

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PREVENTION, EARLY DIAGNOSTIC AND MANAGEMENT OF OSTEOPOROSIS IN PERIMENOPAUSAL WOMAN IN FOUR MUNICIPALITIES OF SARAJEVO CANTON

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Goals: Evaluation of menopausal-dependent metabolic disorders in woman, determination of bone density in selected groups, therapeutic measures where is necessary, follow up of treated and borderline cases, development of prevention measures and early diagnostic procedures in prevention of complications and decreasing risk of fractures in topic group.

Patients and methods: We are targeting women of four Sarajevo Canton municipalities. Each of them will be announced to visit her gynecologist 3-6 months after spontaneous break of menstruation cycles (age 44-45). With each of them we plan to make a detail introductory conversation, clinical examination, and evaluation of factor of risk; in selected cases - bone densitometry and measuring of bone markers (osteocalcin and telopeptid), scintigrafy if necessary. Densitometry and bone markers will be realized in every case of two or more factors of risk, earlier fractures, and in cases where women can't or don't want to use hormonal therapy even if it is necessary (contraindications, lose of faith etc.).

Results (what we expect): Osteoporosis was not problem of great interest in our Canton in last years. Ordinary, it was mainly surgical problem, without cooperation of other specialists. We didn't develop measures of early diagnostics and prevention. We expect bad results in all groups in the beginning of research, and good results with continually improvement in field of understanding and continually struggle in field of prevention of osteoporosis.

Late submissions

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Broiler chicks on a normal diet (1.4mg Si/g) were supplemented with choline stabilized orthosilicic acid (Ch-OSA) to investigate the effect of silicon on the serum calcium concentration and bone mineral content (BMC) density (BMD) in the femur.

A group of 42,500 chicks was administered Ch-OSA (13.5mg Si/100kg bodyweight/2days) in their drinking water for 6 weeks which increased the total dietary Si intake with less than 0.5%. A control group of 42,600 chicks of the same age was started in parallel with identical feeding but without Ch-OSA supplementation. Samples of 30 randomly chosen chicks were taken in each group at the age of six weeks to analyse the serum calcium concentration and femura. Femoral BMC and BMD were analyzed by Dual Energy X-ray Absorptiometry. Scans were recorded for both total femur and 5 regions of interest in the femur. Differences between means were evaluated with a one-tailed Student t-test.

The serum Ca concentration was significantly higher ($p<0.05$) in supplemented chicks (74.85±13.82mg/ml, n=60) compared to controls (69.47±15.99 mg/ml, n=60).

The BMC was significantly higher for supplemented chicks compared to the controls in all the scanned areas of the femur. Total BMC was also significantly higher (+8.4%, p=0.016) for supplemented chicks compared to controls.

The BMD was significantly higher at the midshaft (+4.25%, p=0.0209), the distal metaphysis (+4.88%, p=0.0102), and the hip region(+5.6%, p=0.014) for supplemented chicks compared to controls.

In conclusion, increasing the total dietary intake of broiler chicks with less than 0.5% in the form of Ch-OSA resulted in a significant higher serum calcium concentration and higher bone mass and density in cortical and trabecular bone of the femur. These results confirm earlier studies suggesting an essential role of silicon in bone (1) and collagen (2) metabolism.

(1) Seaborn et al. (1994). J. Trace Elem Exp Med, 7, 11.
(2) Calomme et al. (1997). Biol Trace Elem Res, 56, 153.

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RISEDRONATE BUT NOT ALENDRONATE SLOWS DISEASE PROGRESSION IN THE GUINEA PIG MODEL OF PRIMARY OSTEOARTHRITIS

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Most animal models of osteoarthritis involve chemical or surgical initiation of the disease, although the majority of human OA is considered primary. The Duncan-Hartley guinea pig is a model of primary OA and mimics human disease in many aspects. Cartilage lesions begin at about 3 months of age or 750g weight. They are bilateral and begin primarily on the medial tibial plateau (MTP). Chondrocyte cloning, osteophytes and tidemark duplication can also be seen. Disease severity progresses as the animals age and gain weight. This may be a useful model for testing potential structure modifying OA drugs.

Animals were randomized into the treatment groups shown in Table 1. The bisphosphonates risedronate (Actonel®) and alendronate (Fosamax®) or sterile isotonic saline (vehicle control) were administered via subcutaneous injection 5 consecutive days/week for 12 months. At sacrifice, the left tibia of the stifle joint was disarticulated and stained with Evan's blue dye. Joints were then placed in 10% neutral buffered formalin and digitally photographed. These images were analyzed using a BDS Image Analysis System (Oncor Image, Gaithersburg, MD). Lesion, MTP and osteophyte areas were manually outlined by a single blinded grader, and area calculated by the software program. A non-parametric Friedman's rank sum test was used to compare treatment groups to control. Median scores are reported.

Risedronate but not alendronate had a statistically significant effect on cartilage lesion and osteophyte size in the guinea pig model of primary OA. This is consistent with previous data (ASBMR:SA472, 2001) suggesting not all bisphosphonates are effective at slowing disease progression in this model. These data suggest risedronate may be efficacious as a structure modifying drug in OA.

Treatment & Dose	Lesion area		Osteophyte area	
(mg/kg)	mm2	%	mm2	%
Vehicle ---	8.3	35.2	12.1	42.8
Risedronate 0.004	8.6	36.1	9.5	41.1
Risedronate 0.012	8.4	28.4*	8.6	34.1*
Risedronate 0.03	6.2*	26.9*	7.2*	24.4*
Alendronate 0.005	11	43.2	12.4	47.1
Alendronate 0.012	9.6	36.8	11.7	40.1
Alendronate 0.03	12.2	41.1	11.7	41.5

*=p<0.05 vs vehicle, two sided test