КРАТКОЕ СООБЩЕНИЕ

HIGH HAIR SELENIUM AS AN INDICATOR OF MOTHER TO FETUS PLACENTAL TRANSFER FROM BRAZIL NUTS (*BERTHOLLETIA EXCELSA*)

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ABSTRACT. A pregnant woman in the last trimester of gestation incidentally consumed a package of Brazil nuts (*Bertholletia excelsa*) over one week period. Two months after delivery of a healthy baby daughter, the hair multielement profile analysis revealed a grossly increased hair selenium concentrations of 2.70 in the mother and 9.74 $\mu g \cdot g^{-1}$ in the daughter. Adequate hair Se concentration of a Croatian women population range 0.08 – 0.63 $\mu g \cdot g^{-1}$. There is a substantial capacity of gastrointestinal absorption and trans-placental transfer of dietary Se from a pregnant mother to the fetus and Se accumulation in the hair of both mother and fetus..

KEYWORDS: Brazil nuts, hair Se, pregnancy, lactation, transplacental Se transfer, mother, fetus/infant.

INTRODUCTION

Selenium is an essential trace element indispensable for life (Schrauzer, 2008). The daily selenium requirements are well defined for adult persons, however, infant selenium requirements are the subject of expert consensus based on a selenium in milk concentrations (Institute of Medicine, 2000; National Institutes of Health, 2015). The aim of this communication is to show that substantial amounts of dietary selenium may be transferred *via* placenta from the mother to the fetus's hair during the late gestation.

SUBJECT (MOTHER AND DAUGHTER)

On April 12, 2014 a young 30 years old healthy white Caucasian woman (♀SB, 63 kg, 175 cm), Zagreb, Croatia, gave a natural birth to her healthy first baby daughter (♀KBM, birth weight 2670 g, birth length 46 cm, APGAR 10). Two months later, hair was collected from both mother and daughter for hair multielement profile analysis: the informed consent was given by the mother. Mother's long hair has been divided into two parts: (A-Proximal) some five cm up from the *protuberantia occipitalis externa on* the skull, and (B-Distal) the rest of the hair to the hair tips. Thus, Part A represents the younger hair whereas the Part B represents the older hair. Twenty-five elements were analyzed with the ICP-MS in every hair sample (the essential elements are underlined – Al, As, B, Be, Ca, Cd, Co, Cr, Cu, Fe, Hg, I, K, Li, Mg, Mn, Na, Ni, P, Pb, Se, Si, Sn, V, Zn), at the Center for Biotic Medicine, Moscow, Russia. CBM is an ISO Europe certified commercial laboratory for bioelement (major and trace and ultratrace elements) in different biological matrices, as described in full detail earlier (Momčilović et al., 2006). The highlights of the hair multielement profile analysis are shown in Table. Immediately, our attention was directed to the fact that selenium concentrations were quite different in Part A and Part B of mothers hair and exceptionally high in the hair of her daughter. Indeed, the Se concentrations of 0.870 $\mu g \cdot g^{-1}$ in the mother's hair Part B-Distal were within the expected adequate selenium status of the body (Momčilović et al., 2014b); however the Se concentrations in Part A-Proximal of the mother's hair were 2.70 $\mu g \cdot g^{-1}$ and 9.74 $\mu g \cdot g^{-1}$ in her daughters hair, respectively. The latter was, the highest hair selenium concentration we have ever observed in Croatia in either men or women. Adequate hair selenium concentrations of Croatian women population range from 0.08–0.63 $\mu g \cdot g^{-1}$ (Momčilović et al., 2014a).

Since Ms. ♀SB denied using any selenium containing supplements, ointment and/or shampoos, this initiated an extensive dietary recall task of what she was eating in the apparently last trimester of her pregnancy. Indeed, approximately 5 cm long hair sample would cover a period of about five months, i.e., in this particular case three months of pregnancy and two months of lactation. She regularly consumed just the usual mixed Mid European diet. Ultimately,

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we discovered that somewhere around her third trimester of pregnancy Ms. SB consumed a single pack of *Brazil nuts* (*Bertholletia excelsa*) weighing about 135 g, which nuts happened to be notorious for the exceptionally high selenium content of 2.550 $\mu g \cdot g^{-1}$ Se! This is a 3643% of a daily value recommended for this element (SELFNutritionData, 2014; National Institutes of Health, 2015).

Thus, with the tools of logical inference, we have identified the high selenium dietary source, i.e. Brazil nuts, as a cause of high selenium hair concentrations in the mother and her daughter. Recently, the potential role of Brazil nuts for human selenium supplementation has been recognized (Thompson et al., 2008; Colpo et al., 2013; Rita Cardoso et al., 2015).

Table 1. ***Changes of the hair multielement profile of a pregnant women in the last trimester of pregnancy and thereafter lactating mother and her 2 months old daughter after the high dietary intake of selenium from Brazil Nuts (Bertholletia excelsa). Mean of the 2 replicates ($\mu g \cdot g^{-1}$)***

Before the *Brazil Nuts*		After the *Brazil Nuts*			
Pregnant Mother (Hair B-Distal)		Lactating Mother (Hair A-Proximal)		Daughter	
B	0.37	B	0.36	B	5.35
Ca	658	Ca	2838	Ca	690
Co	0.004	Co	0.007	Co	0.01
Cr	0.020	Cr	0.04	Cr	0.11
Fe	5.25	Fe	5.82	Fe	15.12
I	0.30	I	0.57	I	3.53
K	74.13	K	90.67	K	3359
Li	0.005	Li	0.01	Li	0.22
Mg	63.63	Mg	166	Mg	70.05
Mn	0.05	Mn	0.06	Mn	0.48
Na	14.74	Na	20.94	Na	881
P	154	P	144	P	186
Se	0.87	Se	2.70	Se	9.74
V	0.003	V	0.005	V	0.01

Adequate hair reference ranges ($\mu g \cdot g^{-1}$): // Ca ♀ 290–4400, Mg ♀ 40–450 (Momčilović et al., 2013); // I ♀ 0.15–2.06), Se ♀ 0.08–0.63 (Momčilović et al., 2014a; Prejac et al., 2014); // P ♂♀ 120–200 (SELFNutritionData, 2014); // K ♀ 20–500, Na ♀ 60–1400 (Momčilović et al., 2015); // CBM reference values for women: B (0.00–5.00), Co (0.006–0.200), Cr (0.15–1.00), Fe (10.0–50.0), Li (0.005–1.00), Mn (0.25–1.80), V (0.00–0.10) (Momčilović et al., 2006); □ – deficiency, ■ – excess.

Hair is growing at approximately 1 cm per month (Rook, Dawber, 1982; Robbins, 2012). As already stated, the 5 cm long segment of her (Ms. ♀SB) hair, would cover the time period from the third trimester of pregnancy till the end of the second month of lactation. As a matter of fact, the hair selenium acted as a naturally occurring time spike (*Zeitgeber*). According to this data of hair growth, the unadwarent exposure occurred in the last trimester of pregnancy and this event could be followed in the early lactation. Evidently, the mother can get her selenium from the diet whereas the fetus and breastfed infant can get it only from the mother.

DISCUSSION

For the first time, to our knowledge, it became possible to see what was an *in vivo* bioelement metabolism at the late stage of pregnancy and early stage of lactation. It should be noted that the absorption of many bioelements is also increased during the late stages of pregnancy. Evidently, high

pregnancy (third trimester) put a high toll upon mother to provide her baby with all the essential nutrients. All the elements in mother's hair, except boron and phosphorus, appeared to be increased after the termination of pregnancy, indicating that the fetal body growth put a huge metabolic demands upon the mother body than it was in the later two months of lactation when the infant girl ♀KBM was exclusively breast fed. The excessively high values of mother hair calcium probably indicate the massive calcium transfer from mother to infant by placenta and later by the mammary gland. We may comment that mother's iron status was low in both pregnancy and lactation and that such an imbalance may have an effect on other element transfer from mother to the fetus. Indeed, dietary requirement for some element may be specifically different in the first, second, and third trimester of pregnancy. Currently, such a data are not available and we have no clue why, e.g., boron, would be increased in a a two month old infant baby. Our results corroborate with the traditional pediatrician views that baby nutritional needs have a precedence over the mother's body nutritional requirements (Kliegman, 2012). Indeed, hair iron concentrations in the infant were in the observed normal adult iron range whereas those of the mother were definitively low. Also, this infant has a much better iodine status (Momčilović et al., 2014a) than her mother, providing that the rate of the hair uptake of iodine is the same between the mother and her infant. Perhaps some other elements may be also transferred via placenta into the infant to such extent that they may become toxic and that apparently was not the case in this study where a healthy infant was born.

CONCLUSION

The here presented results of an accidental nature experiment provides an insight in selenium metabolism in pregnancy, lactation, and neonatal period of life. Very high amounts of Se were absorbed by the pregnant mother and transferred via placenta into the infant. Hair multielement profile analysis offers a new possibility for the study of the trace element metabolism in gestation, lactation and the infant period of life in a non-invasive way and in full compliance with the current ethical considerations.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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ПОВЫШЕННОЕ СОДЕРЖАНИЕ СЕЛЕНА В ОБРАЗЦАХ ВОЛОС КАК ПОКАЗАТЕЛЬ ПОСТУПЛЕНИЯ ЧЕРЕЗ СИСТЕМУ МАТЬ-ПЛАЦЕНТА-ПЛОД ПРИ УПОТРЕБЛЕНИИ БРАЗИЛЬСКОГО ОРЕХА (*BERTHOLLETIA EXCELSA*)

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РЕЗЮМЕ. В последнем триместре беременная женщина получала бразильские орехи (*Bertholletia excelsa*) в количестве 1 упаковки весом около 135 г в течение одной недели. Данные орехи являются известным источником исключительно высокого содержания селена – 2,550 мкг/г селена. Это соответствовало 3643% от рекомендуемой суточной нормы поступления для данного элемента. Спустя два месяца после родов был проведен многоэлементный спектральный анализ (метод ИСП-МС) волос здорового младенца (девочки) и ее матери. По результатам данного анализа было выявлено очень большое содержание селена. Концентрация селена составила 2,70 мкг/г в образце волос матери и 9,4 мкг/г в образце волос ее дочери, соответственно. Адекватная концентрация селена в волосах женского населения Хорватии колеблется в диапазоне 0,08–0,63 мкг/г. Был выявлен значительный потенциал абсорбции селена в желудочно-кишечном тракте (ЖКТ) и его трансплацентарной передачи от матери плоду, а также оценено накопление селена в волосах как матери, так и плода. Полученные результаты данного исследования дают представление о метаболизме селена во время беременности, лактации и неонатального периода жизни. Очень большие количества селена всосались в ЖКТ беременной женщины и проникли через фето-плацентарный барьер. Предлагаемое проведение многоэлементного спектрального анализа волос дает новую возможность для изучения метаболизма микроэлементов в период беременности, лактации и младенческого периода жизни неинвазивным способом и в полном соответствии с действующими этическими соображениями.

КЛЮЧЕВЫЕ СЛОВА: бразильский орех, селен, волосы, беременность, период лактации, трансплацентарное поступление селена, мать, плод/младенец.