High Salt Diet Induced the Rapid Myopic Shift of Cataract Formation

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Abstract: Purpose: To report a 24 young female with hypernatremia and cataract formation with high high myopic shift in the left eye which happened suddenly within one month. **Methods**: Case report. **Results**: The young female complained about blurred vision for one month in this year. After series of studies, severe nuclear sclerosis (Grade 4) of lens of left eye was found under the slit lamp examination. The myopic shift increased about 10 D (from zero to -10D) within one month suddenly. Her bare visual acuity had decreased to 6/60. Thus, we had arranged the phacoemulsification combined with intraocular lens insertion at once. At the beginning of cataract surgery, we withdraw little anterior aqueous humor fluid for analysis. Sodium in the aqueous revealed 103 mmol/kg H_2O which is apparently lower than the normal range. At the same time, we checked the serum sodium and hypernatremia (Na^+ =151 mEq/L) was found. The mean blood pressure was about 150/95 mmHg and the patient had severe thirsty sensation. Because of the diagnosis of essential hypertension, she was suggested to receive further medical treatment. **Conclusion**: The causal relationship between high salt intake and high blood in established now. Besides, hypernatremia may also combine with the decreased sodium level in anterior aqueous humor. The sodium shifted into the lens would induce the osmotic swelling with lens fiber damage. The hyper-osmotic pressure may accelerate the formation of cataract. Because sodium in food was often derived from soy sauce, monosodium glutamate and miso soup in Taiwan, to inform and educate the public become very important.. To our knowledge, the very young age and the rapid change of refractive error within one month in our case had never been reported in the world.
[Chi-Ting Horng, You-Li Lee, Hsing-Chen Wu, Hsiao-Yun Lai, Jane-Yi Hsu, Chi-Wen Hsu, Kuang-Jen Chien, Wu-Hsien Kuo. **High Salt Diet Induced the Rapid Myopic Shift of Cataract Formation**. *Life Sci J.* 2014;11(5):396-399] (ISSN:1097-8135). http://www.lifesciencesite.com. 54

Keywords: High Salt Diet, Cataract, Mopic shift

1. Introduction

Cataract induced related loss of vision affected many adults today and become a health burden to many nations in the world（1）. It is well believed that the patients with cataract will increase to several million. In USA, cataract surgery was estimated to take up about 12% of medical budget（2）. In Taiwan, nearly one hundred thousand people receive the cataract replacement with synthetic lenses in each year. There are several factors contributing to cataract including congenital, age-related, trauma, UV light (especially the UV-B), cigarette, infection, poor nutrition, diabetes, oxidative stress, nutrition, occupational, genetic factor（3,4,5,6,7, 8, 9）and even psychotropic agents (including phenothiazines and atypical antipsychotics)（10）. However, diet may also play a important factor in the formation of cataract（11,12）. High levels of dietary sodium (consumed as common salt, or sodium chloride) are associated with raised blood pressure and adverse cardiovascular health. Sodium intakes around the world in excess of physiological need (i.e. 10-20 mmol/day) including Spain, Cameroon, Ghana, Samoa, Tanzania, Venezuela, and Uganda. Most adult populations have mean sodium intakes ＞10 mmol/day and for many (particularly the Asian countries including ROC(Taiwan)) mean intakes are ＞200 mmol/day（13）. The relationship between cataract, hypernatremia, and hypertension was mentioned by literature（14）. In this article, we will report a patient with hypernatremia and rapid progression of cataract formation within one month.

2. Case report

A 24-year-old young female suffered from suddenly blurred vision of left eye within one month

in this year (January, 2014). In the same time, the patient usually complained about terribly thirsty sensation. She went to our ophthalmic department for further evaluation. In the clinic, her bare visual acuity was 6/6 in the right eye, however, only 6/60 in the left eye which can be corrected to 6/6 by glasses (- 10 D). The axial length of both eyes was not apparently different (OD: 24.35mm; OS: 24.27 mm) by using A-Scan. According to her statement, the patient had excellent bare visual acuity one month ago and denied any trauma history. By the Ultrasound Bio-Microscopy (UBM), no lens dislocation or sub-luxation and zonular dehiscence distinctly were observed (Figure 1). Other ocular findings including normal intraocular pressure, brisk light reflex, clear cornea and normal fundus were found. It is very interesting to find out the relative deep anterior chamber in the left eye and nuclear sclerosis of cataract (Grade 4) under the slit-lamp biomicroscopy (Figure 2). There was no evidence of trauma, family or systemic diseases in the patient's history. Therefore under the impression of electrolytes imbalance, we checked the sodium and potassium in the serum. Five ml of blood was taken under aseptic technique and the higher serum sodium about 151 mEq/L (hypernatremia) was found. The female patient stated that she likes the soy sauce and monosodium glutamate while eating and cooking. Besides, she also favors the miso soup. We arranged the series of physical examination. The mean systolic and diastolic pressure greater than 150/95 mmHg and essential hypertension was highly suspected. Thus, she was referred to medical department for further evaluation. Due to the cataract formation of left eye and the ansiotropía (> 10 D), we arranged the cataract surgery to solve the poor steropsis.

Clear corneal phacoemulsification was performed. Topical anesthesia (proparacaine) was given at first. After three plan corneal incision at the temporal limbus was made, the diamond knife was used to enter the anterior chamber on the corneal side. Little aqueous humor (about 0.3CC) was withdrew for series of biochemical analysis. Followed by sodium hyaluronate 1.4% (Healon) injected into the anterior chamber space, continuous curvilinear capsulorhexis(CCC) was performed by the CCC forceps to create the round opening on the anterior capsule. Then hydro-dissection, deeper central sculpting, dividing the nucleus into four pieces, and phacoemulsification was done step by step. After the hard nucleus of cataract were removed, we aspirated the residual cortex. Then the corneal wound was enlarged, we inserted the intraocular lens (AMO) into the bag. At last, we sutured the incisional wound by 10-O nylon. The composition of the aspirated aqueous humor was analyzed, and relatively lower Na^+ level (103 mmol/kg H_2O) was found (Normal range is around 163 mmol/kg H_2O) (15).One week later, the bare visual acuity of her left eye had returned to 6/6 and normal depth of anterior chamber (ACD) was found.

3. Discussion

In 1990, the World Health Organization (WHO) reported that for 41.8 % of the 38 million blind people, approximately 16 million, the cause of blindness is due to cataract. Until 2020, the number of patients with blindness caused by cataract will reach nearly 40 million. It means that the amount of patients with cataract need the operation will increase to threefold (16). There are many impending factors contributing to cataract formation in previous studies. Recently the hypernatremia combined with hypertension was heatedly discussed. An increase in the sodium intakes of 100 mmol/day (equivalent to about 6 g/day) may raise systolic blood by 6 mmHg. This result revealed a correction between sodium intake and blood pressure (17). The DASH-Sodium Trial also demonstrated that sodium intake may influence the blood pressure, and that the lower sodium intake is associated with the lower pressure (18).

Even though not every patient with hypernatremia will develop into cataracts (27). We must pay attention to the possibility and their relationship carefully. For example, Mathur et al. had reported that high serum sodium levels was significantly found in the patients (age >50 years old) with cataract especially in the nuclear and mixed (cortical and nuclear) type (12). Their results are consistent with our report which showed nuclear sclerosis (Grade 4) and severe myopic shift (nearly 10 D change). However, the patient in our case is younger (only 24 years old). To our knowledge, the very young age and the rapid change of refractive error within one month in our case had never been reported in the world.

Clayton et al revealed that alternation in cation concentration of aqueous humor which is attributed to alternations in serum cation concentration, can be known as a risk factor for the cataract formation (19). In lenses, when K^+ is pumped into the lens, Na^+ is pumped out, generating a chemical gradient, and the mechanism, while regulating water content, allows the lens to act as a osmometer and contributes to the transparency of the lens (20). In cataratous condition, influx of Na^+ in the lens may attracts water ions, increase the impact on the osmotic balance in the lens environment (21). Due to the swelling lens, the myopic shit will be noted. In the meanwhile, we would found out the lower sodium level in the

anterior chamber fluid in our patient. Besides, some reports indicated that accumulation of Na^+ would lead to the impaired permeability of lens membrane and interfere with the synthesis of crystalline or soluble protein resulting in cataract formation〔22〕.

The relation between diet especially in sodium intake and hypertension are relatively well established which indicates that the excessive intake are related to high blood pressure. For example, Miura et al. reported that the systolic blood pressure were higher in excessive salt intake group (especially in men) (23). Mirsamadi et al. reported that that the positive and significant correlation between the excessive sodium intake and cataract development (24). In general, the main sources of natural sodium in the daily diet were fish, egg, fruit, legume, milk and vegetables, constituting 60 % of the total amount. In Taiwan, salt added at home (in cooking and at the table) and soy sauce were the largest courses. At the same time, the excessive sodium from miso soup still can not be neglected. In eastern population (some Asian countries) including China, Korean, and Japan, 53% may come from cooking, 16% from soy sauce and 6 % from monosodium glutamate (MGS)〔16, 23,25〕. Choong et al. found that preference and intake frequency of high sodium foods and dishes among Malaysian subjects〔26〕. Tian et al. also had concluded that more educated men and women had lower intakes of salt and soy sauce, and higher intake of MGS. They also found that some Chinese women like the soy sauce very much (16). Besides, individual food habits are influenced by a host of social, cultural and economic factors. In European and Northern American countries, the major source of dietary sodium is processed foods. For example, cereals and baked food goods were the single largest contributor to dietary sodium intake in UK. Thus, how to educate individuals the importance of dietary salt in various foods for representing etiologic risk factors of cataract development becomes the serious problem today.

In conclusion, epidemiologic and interventional trials have been shown that an excessive intake of sodium cause hypertension and the development of cataract. Until now, there are no recognized treatments to reverse lens cataract once they have begun to form. Thus it is very important to assess intervention strategies that could prevent or delay lens cataract formation at an early stage of their development. Therefore, how to restrict excessive intake of sodium in daily diet is very important. It may not only decrease the incidence of cardiovascular disorders, but also prevent from the possibility of cataract formation.

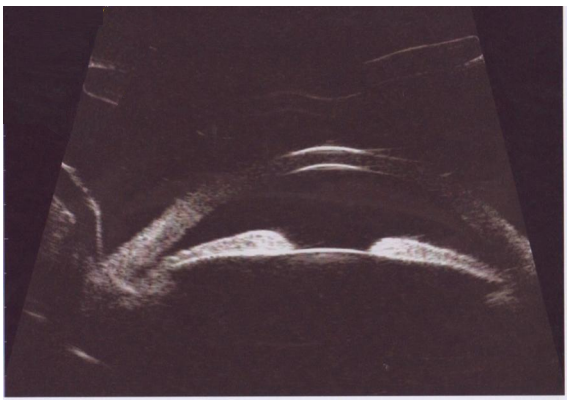

Figure 1. No apparent dislocation or subluxation and zonular dehiscence was found by Ultrasound Bio-Microscopy (UBM)

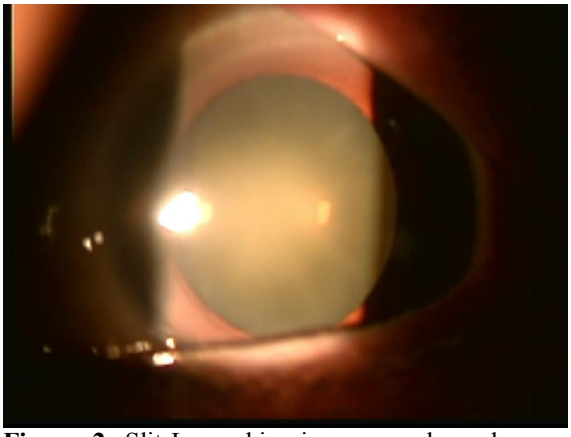

Figure 2. Slit-Lamp biomicroscopy showed severe nuclear sclerosis (Grade 4) of cataract in the left eye

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References

1. Chan AW, Ho YS, Chung SK, S.M. Chung. (2008). Synergist effect of osmotic and oxidative stress in slow-develioping cataract formation. Exp Eye Res ; **87**:454-61.
2. Steinberg EP, Javitt JC, Sharkey PD, Zuckerman A, Legro MW, Anderson CF, Bass EB, O'Day D. (1993). The content and cost of cataract and cost of of cataract surgery. Arch Ophthalmol; **87**:454-61.
3. Chatterjee A, Milton RC, Thyle S. (1982). Prevalence adn aetiology of cataract in Punjab. Br J Ophthalmol ; **66**：35-42.
4. Elmahdi EM, Kaballo AM, Mukhtar EA. (1991).

Features of non-insulin-dependent diabetes mellitus(NIDDM) in the Sudan. Diabetes Res Clin Pract; **11**：35-42.
5. Hankinson SE, Willett WC, Colditz WC, Seddon JM, Rosner B, Sepizer FF, Stampfer MJ. (1992). A prospetic study of cigarrete smoking and risk of cataract in women. JAMM; **268**：994-8.
6. Zigman S. (2000). Lens UVA photobiology. J Ocul. Pharmacol Ther ; **16**:161-5.
7. Chan AWH, Ho YS, Chung SK, Chung SSM. (2008). Synergistic effect of osmotic and oxidative stress in slowing-developing cataract formation. Exp Eye Res.; **87**:454-61.
8. Doganay S, Duz C, Firat PG, Cankaya C, Kutuke D, Cigremis Y. (2013). The effect of apricots on the experimental cataract model by sodium selentie. Food Chem Toxico; **55** : 371-7.
9. Hammond CJ, Duncan DD, Snieder H. (2001). The heretability of age-related cortical cataract: the twin eye study. Invest Ophthalmol Vis Sci: **42** : 601-5.
10. Richa S, Yazbek JC. (2010). CNS Drug.; **24(6)**:501-26.
11. Ramana BV, Raju TN, Kumar VV, Reddy PUM. (2007). Defensive role of Quercetin against imbalances of calium, sodium, and potassium in galactosemic cataract. Biol Trace Elem Res; **119**:35-41.
12. Mathur G, Pai V. (2013). Comparison of serum and potassium levels in patients with senile cataract and age-matched individuals without cataract. Indian J Ophthalmol ; Apr 4. [Epub ahead of print].
13. Brown IJ, Tzoulaki I, Candeias V, Elliott P. (2009). Salt intakes around the world: implications for public health. Inter J Epidemiol; **38** : 791-831.
14. Rim TH, Kim MH, Kim WC, Kim TI, Kim EK. (2014). Cataract subtype risk factors identified from Korea health and nutrition exmination survey. BMC Ophthalmol; **14:4** doi:10.1186/1471-2415-14-4.
15. Macknight AD, MacLaughlin CW, Peart D, Purves RD, Carre DA, Civan MM. (2000). Formation of the aqueous humor. Clin Exp Pharmacol Physiol; **27(1-2)**:100-6.
16. Tian HG, Hu G, Dong QN, Yang XL, Nan Y. (1996). Dietary sodium and potassium, socionomic status,and blood pressure in a Chinese Population. Appetite ; **26**: 235-46.
17. INTERSALT Cooperative Research Group. Intersalt : An international study of electrocyte excretion and blood pressure. (1988). Results for 24-hour urinary sodium and potassium excretion. BMJ ; **297**:319-28.
18. Sacks FM, Svetkey LP, Vollmer WM, et al. DASH-Sodium Collaborative Research Group. (2001). Effects on blood pressure of reduced dietary sodium and the Dietary Approaches to Stop Hypertension(DASH) diet. N Eng J Med ; **344** : 3-10.
19. Clayton RM, Cuthbert J, Phillips CI, Bartholomew RS, Stokoe NL, Fytch T. (1980). Analysis of individual cataract patients and their lenses:A progress report. Exp Eye Res ; **31**: 533-6.
20. Pou H. (1974). The pathogenesis of subcapsular opacities of the lens (permeability- cataract). Doc Ophthalmol ; **379(1)**: 47.
21. Stanojevic-Paovic A, Hristic V, Cuperlovic M, Jovanovic S, Krsmanovic J. (1987). Macro and microelements in the cataractous eye lens. Ophthalmic Res; **19**:230-4.
22. Shinohara T, Piatigorsky J, Carper DA, Kinoshita JH. (1982). Crystalline synthesis and crystalline mRNAs in galactosemic lenses. Exp Eye Res ; **34**: 39-48.
23. Miura K, Okuda N, Turin TC, Takashima N, Nakagawa H, Nakamura K, Yoshita K, Okayama A, Ueshima H.(2010). Dietary salt intake and blood pressure in a representative Japan population: baseline analyses of NIPPON DATA80.J Epidemiol ; **20 (suppl 3)**: S524-30.
24. Mirsamadi M, Nourmohammadi I.(2003). Correction of human age-re;ated cataract with some blood biochmistry constituents. **35** : 329-34.
25. Choi UK, Jeong YS, Kwon OJ, Park JD, Kin YC. (2011). Comparative study of quality characteristics of Korean soy sauce with soybeans germinated under dark and light condition. Int J Mol Sci; **12**: 8105-18.
26. Choong SSY, Balan SN, Chua LS, Say YH. (2012). Preference and intake frequency of sodium foods and dishes and their correlations with anthropometric measurements among Malaysian subjects. Nutr Res Pract; **6(3)** : 238-45.
27. Ju HJ, Bae HJ, Choi DE, Na KR, Lee KW, Shin YT. (2013). Severe hypernatremia by excessive bamboo salt ingestion in healthy young woman. Electrolyte blood press; **11**: 53-6.

3/20/2014