

Altered Serum Micronutrient Levels in Female Alopecia Subjects with History of Prolonged Use of Cap/Scarf

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Abstract – The etiology of most types of alopecia is not fully understood. Excessive use of hat is believed to be a cause of alopecia, but the possible involvement of altered micronutrients (essential elements and vitamins) levels in cap\scarf- induced alopecia has not been explored. This study is therefore embarked on to identify if alteration in micronutrients levels exists in subjects who may have cap\scarf- induced alopecia. Forty female subjects each, constituted the alopecia and control groups, and were selected by random sampling technique. Each subject has a history of prolonged use of cap\scarf of over a period of 10 years. Results show that ALT, AST, ALP, GGT, bilirubin and globulin are not significantly different in alopecia subjects compared with controls ($p>0.05$) whereas nutritional indices; albumin, total protein, Zn, Cu, vitamins A & E are significantly decreased ($p<0.05$) compared with controls, although Mg and Mn are not significantly different ($p>0.05$). Renal indices; urea and creatinine are significantly increased in alopecia subjects compared with controls ($p<0.05$). The result of this study suggests that altered serum levels of micronutrients and total protein may exist in individuals who may have cap\scarf- induced alopecia.

Keywords – Alopecia, Micronutrients, Cap, Scarf, Female

1. Introduction

Constant covering of the head with cap or scarf is a common practice among many female adherents of different religious groups across Africa and Hwang et al. [1] have raised the possibility of an association between excessive use of cap and alopecia. Apart from use of cap, a number of other factors have been reported to induce alopecia in human subjects. These include zinc and iron deficiencies [2], [3]; chronic starvation as well as severe protein, fatty acid and caloric restriction [2]. Essential fatty acid deficiency is especially associated with diffuse telogen hair although the effect is not immediate [2]. Moreover, studies have shown that inadequate levels of many vitamins play a role in diffuse hair loss; examples being vitamin D and biotin [4]. Biotin deficiency though has been described to be a rare cause of alopecia [3].

Pathological states such as thyroid disease, malabsorption syndromes, pancreatic disease [2], systemic illnesses, and infections have been revealed to be causative agents. In women of African descent especially, alopecia commonly presents in those who use a variety of traumatic hair care techniques, such as chemical and physical straighteners [5] – [7], traction, braiding, hair extensions, hair gluing, and chemical curls. Rook & Dawber, 1982 [2] on the other hand could not establish a relationship between history of severe traction or harsh styling practices and alopecia, an indication that there may be some other underlying causes in women of African descent. Apart from use of thermal or chemical hair straightening, and hair braiding or weaving, genetic and environmental contribution may also play some roles especially in traction alopecia, trichorrhexis nodosa, and central centrifugal cicatricial alopecia usually associated with

African American women [8] – [10]. Earlier studies [5], [6] have revealed altered copper and zinc levels in the serum of chemical-induced alopecia subjects compared with controls as well as a possible association between duration of exposure and alopecia. The aim of this study is to determine micronutrient levels in alopecia individuals with history of prolonged use of scarves.

2. Methodology

2.1 Subjects

Forty female subjects (mean age; 41.36 ± 1.52) who admitted to rigorous use of scarf or cap for at least 10 hours per day over a period of 10 years constituted the alopecia group while forty age-matched (mean age; 41.68 ± 1.34) women without alopecia constituted the control group. Control subjects also use scarf or cap as head covering for the same duration as the alopecia group. The sample size was estimated to be forty subjects because most women from the locality from which the subjects were recruited are exposed to a number of other agents which are capable of causing alopecia and such women were excluded from the study. These subjects were apparently healthy participants, recruited at saloons in different locations within the Ibadan metropolis. The alopecia group had not been exposed to any hair product or treatment capable of inducing alopecia and each subject has had alopecia of not less than 5 years duration. None of the subjects had alopecia before the commencement of cap or scarf use. Exclusion criteria included conditions such as female pattern androgenic alopecia, family history of

pathologic alopecia, physiological or emotional stress and medical conditions (e.g. psoriasis, seborrheic dermatitis, or other hair infections) that may influence result outcome. Moreover, women with conditions capable of influencing serum trace element and vitamin levels were excluded from the study e.g. pregnancy, lactation, alcohol ingestion and vitamin and mineral supplementations. Due to the influence of socio-economic factors on micronutrient levels, all subjects recruited for the study were of the same socio-economic status; using factors such as income, education and occupation as criteria of selection. Simple random sampling technique was employed for the selection of subjects for both alopecia and control groups. The purpose of the study was described to the women, who gave their informed consent. Each subject provided information on her age, duration of cap/scarf usage, duration of alopecia, type of hair treatment/products and drug history. All procedures were carried out in accordance with revised Helsinki Declaration.

2.2 Biochemical determinations & statistical analysis

For uniformity, 10 ml of blood was collected from ante-cubital vein of subjects in both groups between 9:00 h and 11:00 h. Each blood sample was centrifuged at 3000 r.p.m. for 10 minutes to obtain serum which was preserved at -20°C until required for biochemical analysis. Serum levels of hepatic and renal indices such as alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), γ -glutamyl transferase (GGT), urea, globulin, creatinine, total protein, albumin and bilirubin were estimated. In addition serum micronutrient levels e.g. Zn, Cu, Mg, Mn, vitamins A & E were also determined. Serum concentrations of AST and ALT, ALP, total bilirubin and total protein were assayed according to the methods of Bergmeyer et al. [11], King and Armstrong [12], Malloy and Evelyn [13] and Lowry et al. [14], respectively. The trace element and vitamin levels were estimated using the atomic absorption spectrometry and high performance liquid chromatography respectively. Specifically, Buck Scientific 205 Atomic Absorption (Buck Scientific, East Norwalk, Connecticut, USA) spectrophotometer and Waters 626 LC SYSTEM were used.

Level of significant difference between the alopecia group and the control was determined using Student's *t* test. Pearson's correlation coefficient was employed to determine correlation among the variables. The SPSS package version 15 was employed for the statistical analysis. P value of <0.05 was considered significant.

3. Results

The results of indices used to assess both hepatic and renal functions are presented in Table 1 below. Hepatic enzymes; ALT, AST, ALP and GGT were not significantly different in the alopecia group compared with controls ($p>0.05$). Moreover, the results of other hepatic indices like bilirubin and globulin were also not significantly different ($p>0.05$), although both albumin and total protein were significantly decreased ($p<0.05$) in alopecia subjects compared with controls. Both urea and creatinine were significantly increased in alopecia group compared with controls ($p<0.05$). The mean \pm SEM of age and serum levels

of some micronutrients are presented in Table 2. The trace elements Zn and Cu as well as vitamins A and E were significantly decreased in alopecia group compared with control group ($p<0.05$) whereas, Mg and Mn were not significantly different ($p>0.05$).

Correlation study carried out among all the variables in alopecia group showed creatinine to be positively and negatively correlated with total protein ($r = 0.411$; $p = 0.041$) and ALP ($r = -0.633$; $p = 0.001$) respectively. Two hepatic enzymes; GGT and ALT were positively correlated with bilirubin ($r = 0.562$; $p = 0.003$) and negatively correlated with age ($r = -0.487$; $p = 0.014$) respectively. Total protein was found to be positively correlated with both albumin ($r = 0.399$; $p = 0.048$) and globulin ($r = 0.627$; $p = 0.001$). Mn was positively correlated with Cu ($r = 0.423$; $p = 0.035$) and negatively correlated with Zn ($r = -0.405$; $p = 0.045$) and duration of alopecia ($r = -0.551$; $p = 0.004$), another trace element, Cu was positively correlated with vitamin A ($r = 0.443$; $p = 0.027$). Duration of alopecia was found to be correlated with Zn ($r = 0.499$; $p = 0.038$) as well as duration of scarf/cap usage ($r = 0.548$; $p = 0.023$).

Table 1: Serum levels of hepatic and renal indices of alopecia and control subjects.

	Alopecia group Mean \pm SEM	Control Mean \pm SEM	P-value
Urea (mg/dl)	30.24 \pm 2.36 *	21.44 \pm 1.52	0.003
Creatinine (mg/dl)	0.78 \pm 0.04*	0.62 \pm 0.05	0.014
AST (IU/L)	15.92 \pm 1.61	15.48 \pm 1.33	0.834
ALT (IU/L)	16.80 \pm 1.09	16.00 \pm 0.85	0.563
ALP (IU/L)	52.36 \pm 3.56	51.44 \pm 2.77	0.839
GGT (IU/L)	18.00 \pm 1.51	16.56 \pm 1.07	0.439
Total Bilirubin (mg/dl)	0.43 \pm 0.04	0.48 \pm 0.03	0.371
Total Protein (g/dl)	6.54 \pm 0.16*	7.11 \pm 0.17	0.019
Albumin (g/dl)	3.24 \pm 0.14*	4.22 \pm 0.11	0.002
Globulin (g/dl)	3.17 \pm 0.16	2.87 \pm 0.15	0.094

- Significant difference at ≤ 0.05

Table 2: Mean \pm SEM of age and serum micronutrient levels in alopecia and control subjects

	Alopecia group	Control	P-value
Zn (μ g/dl)	94.60 \pm 6.19*	116.56 \pm 5.40	0.010
Cu (μ g/dl)	101.92 \pm 4.13*	115.44 \pm 4.78	0.037
Mg (mg/dl)	2.09 \pm 0.13	1.93 \pm 0.08	0.309
Mn (μ g/dl)	4.30 \pm 0.24	4.25 \pm 0.19	0.868
Vitamin A (μ g/dl)	42.88 \pm 2.91*	58.00 \pm 3.19	0.004
Vitamin E (mg/L)	0.90 \pm 0.08*	1.20 \pm 0.08	0.013
Age (years)	41.36 \pm 1.52	41.68 \pm 1.34	0.875
Duration of alopecia (years)	13.60 \pm 0.93		

- Significant difference at ≤ 0.05

4. Discussion

Alopecia or hair loss has been described as a factor capable of impacting tremendous emotional stress on both male and female subjects [15-16]; a disorder that cuts across different age groups [17] – [21]. Although there are a number of pathological causes associated with alopecia; in women of African descent especially, non-pathological causes have also been recognized to induce alopecia; examples being braiding, hair extensions, traction and hair gluing as well as chemical and physical straighteners [5] – [7]. Since not all women exposed to these traumatic hair techniques develop alopecia, there may be some other underlying causes. Results of this study revealed a probable coexistence of altered micronutrient levels with cap\scarf-induced alopecia.

Specifically, this study recorded a significant decrease in the level of serum zinc ($p < 0.05$) in alopecia group compared with control, just as it was previously observed by many workers for other different types of alopecia. For example, subjects with alopecia areata [22], [23], diffuse hair loss [20] and hair relaxer-induced alopecia [6] have been reported to present with decreased serum levels of zinc or some other minerals, although Mussalo-Rauhamaa et al. [24] did not observe any significant change in both serum and urine zinc levels in Finnish alopecia subjects compared with controls. Based on the physiologic function of zinc, an association between alopecia and zinc level can be postulated; zinc plays a role in the metabolism of collagen\keratin, important protein content of hair. In addition, zinc is an integral component of nearly 300 enzymes in different species of all phyla. It contributes to their catalytic roles as well as to the conformation and structural stability of these metalloenzymes, making its involvement in hair formation most probable. Moreover low hair zinc concentrations have been reported in Egyptian dwarfs as well as U.S infants and children suffering from acrodermatitis [25]; alopecia is a common feature of acrodermatitis.

The significant decrease in zinc level might have also affected the role of zinc in gene expression as well as in stabilizing the structure of proteins and nucleic acids, this is probable because researchers have identified that altered expression of a gene appeared to be responsible for hair loss in human subjects [26]. Apart from a possible contributory role of altered zinc levels, the involvement of prolonged use of scarf in inducing alopecia in these subjects also can not be ruled out since there was a correlation between duration of alopecia and that of use of scarves and cap- induced; moreover cap- induced alopecia has earlier been reported in women [1], [27].

Although a number of medical conditions have been reported to cause altered zinc status in female subjects, since these subjects are apparently healthy individuals, with no history of alcohol intake or any other condition capable of inducing low zinc level, nutritional factor i.e. mild malnutrition may be a probable cause of lowered zinc levels in the alopecia group compared with controls ($p < 0.05$), especially as many of the subjects are religious women with

the possibility of austere life-style, of prolonged fasting period, and consequent low level of food and fluid intake. The possible contributory role of altered micronutrients level in the development of alopecia in these subjects cannot be ruled out because vitamins A, & E as well as copper which are known nutritional indices and have not been widely reported to be associated with alopecia are also significantly decreased in these subjects compared with controls ($p < 0.05$). The importance of nutritional factor in hair loss had earlier been put forward by Rushton [21]. Specifically, Rushton, identified the role of the essential amino acid, l-lysine in hair loss, an observation which is in complete agreement with the result of this study, which revealed a significant decrease ($p < 0.05$) in the levels of both total protein and albumin, indices which are affected by the nutritional state of an individual [28]. The studies of Headington [10]; Rook & Dawber [2]; Goette & Odum [29] and Fiedler & Gray [3] have also identified the role of adequate nutritional intake in preventing alopecia. There are indications that low protein contents in the diet cause the body to save protein by shifting some of the body's hairs into the resting phase thereby leading to alopecia within two to three months after the commencement of such diet.

Although a number of hepatic conditions have been reported to be associated with alopecia in some subjects [26], there seems to be no hepatic involvement in this category of subjects as all hepatic indices; AST, ALT, ALP, GGT, total bilirubin were not significantly different ($p > 0.05$) in the alopecia subjects compared with controls. Moreover, in agreement with studies of Bhat et al., [23] & Mussalo-Rauhamaa et al. [24], a non significant difference was recorded for serum magnesium level. Results of this study showed that magnesium (Mg) as well as manganese (Mn) was not significantly altered in alopecia group compared with controls ($p < 0.05$), an indication that both Mg & Mn probably play no role in inducing cap\scarf induced alopecia.

In addition, the results of this study revealed a significant increase for both urea and creatinine ($p < 0.5$). These two are suitable indices for assessing renal dysfunction, especially renal dysfunction caused by a decreased glomerular filtration rate [30]. The austere life-style of the subjects, of prolonged food and fluid deprivation in these religious subjects might have been a cause of mild renal dysfunction, revealed by the significant increase in urea and creatinine levels in alopecia group compared with controls. Fluid deprivation correlates positively with renal dysfunction [30]. This assumption though was not supported by the result of Pearson's correlation study, since no correlation between any of the renal indices and duration of alopecia was observed.

5. Conclusion

Prolonged use of scarf or cap has been linked with alopecia but not all subjects who use either of these are prone to manifest alopecia, which led to us to study the nutritional status of these subjects. The results of this study suggest the possibility that malnutrition may be a contributory factor in these subjects as the outcome of our study showed significant decreases in many nutritional indices.

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