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STUDY OF SERUM ZINC AND COPPER IN PATIENTS HAVING PREMATURE CANITIES

Clinical Biochemistry

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ABSTRACT

Introduction Premature graying of hair is the early appearance of gray hair before the usual age of onset, typically before 20–25 years in Caucasians, 25–30 years in Asians including Indians, and before 30 years in Africans. Copper is a key cofactor for tyrosinase, an enzyme essential for melanin production. Zinc also contributes to healthy hair growth and pigmentation. Therefore, this study was undertaken to assess the role of these minerals in premature graying of hair. **Aims & Objectives of the Study** To evaluate serum copper and zinc levels in premature graying of hair. **Materials And Methods** This comparative cross-sectional study included 42 students aged 17–20 years with premature graying as cases and 42 age and sex-matched students without premature graying as controls. Serum copper and zinc levels were measured by standard methods using the ERBA XL-640 autoanalyzer. Results were expressed as mean ± S.D. **Results** Serum zinc levels were significantly higher in cases than controls ($p < 0.001$). Serum copper levels were significantly lower in cases compared to the control group ($p < 0.001$). **Conclusion** Serum copper levels are significantly reduced in premature graying, suggesting it may indicate poor mineral and nutrient supply. Increased zinc levels also need evaluation, and supplementation strategies should be planned accordingly.

KEYWORDS

premature canities, deficiencies, copper, zinc.

INTRODUCTION

Premature graying is the appearance of depigmented hair earlier than expected for a population. It is defined as graying before 20 years in Caucasians, before about 25–30 years in Asians including Indians, and before 30 years in individuals of African descent [1,2]. Hair graying, or canities, is a natural aging process mainly due to a gradual decline in the number and activity of melanocytes, the pigment-producing cells in hair follicles [3,4].

Although graying is normal with aging, premature graying occurs much earlier and may cause psychological distress because of its association with old age [5].

Genetic predisposition is a major factor, but environmental and nutritional influences also contribute significantly [6,7]. While genetics cannot be changed, lifestyle habits and nutritional deficiencies are modifiable risk factors affecting the onset of premature graying. Copper and zinc are essential micronutrients for hair pigmentation and follicle health, and their deficiency or imbalance may lead to pigmentary changes and hair loss.

Copper is a key cofactor for tyrosinase, required for melanin synthesis [8]. Zinc has antioxidative properties and supports enzymatic processes important for healthy hair growth and pigmentation [9,10]. Deficiency of these minerals may impair melanocyte function and accelerate graying. Since research on this topic is limited, this study was undertaken.

AIMS & OBJECTIVE

This study aims to investigate the serum levels of zinc and copper in individuals with premature graying. By analyzing these micronutrients, the study seeks to understand their potential role in the development of premature canities, contributing to better preventive measures and treatments for this condition.

MATERIAL & METHODS

This cross-sectional study was conducted over two months (September 2024–November 2024) on consecutive cases of premature graying of hair among first-year medical students of a Medical College in Central India. After Institutional Ethics Committee approval, 42 randomly assigned subjects aged 17–20 years with premature canities and >10 gray hair locks were included.

42 age and sex-matched healthy controls, who were colleagues of these students, were selected irrespective of risk factors (HTN, DM, smoking, alcohol intake), but with no past or present premature graying or clinical evidence of grey hair locks. Subjects with a history of vitamin B12 or mineral supplementation in the past 6 months and those with vitiligo were excluded.

After informed consent, 5 ml venous blood was collected in a plain tube using aseptic precautions and sent immediately to the laboratory. Samples were centrifuged at 2500 rpm for 10 minutes, and serum was stored in clean, dry, sterile vials. Serum zinc, and copper levels were analyzed on the same day using respective kits on ERBA XL-640 fully automated biochemistry analyzer.

Serum copper levels <65 µg/dL in males and <59 µg/dL in females indicated copper deficiency, while zinc excess was defined as serum zinc >170 µg/dL.

Statistical Analysis

Data were entered in Microsoft Excel and analyzed using SPSS software. Quantitative variables were expressed as mean ± standard deviation, and qualitative variables as percentages. Student's unpaired t-test compared means between groups, while Chi-square test compared proportions. A p-value <0.05 was considered statistically significant.

OBSERVATION & RESULTS

This study was conducted at a tertiary care centre and included 42 cases and 42 controls. Both groups consisted of first-year medical students aged less than 20 years. The mean age of cases was 19.14 ± 0.84 years, while the mean age of controls was 19.16 ± 0.76 years. The difference in mean age was not statistically significant ($p = 0.892$) between cases and controls **(Table 1, Figure 1).**

Table 1: Comparison Of Study Samples Based On Age Distribution

	Mean	SD	P-value Significance
Group A (Sample)	19.14	0.84	p= 0.892 (NS)
Group B (Control)	19.16	0.76	

p>0.05 – no statistically significant difference

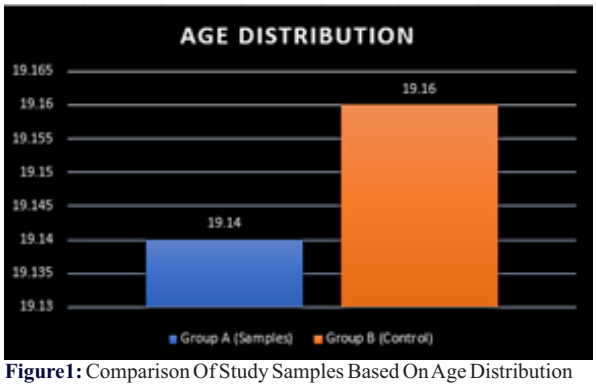

Figure1: Comparison Of Study Samples Based On Age Distribution

In the sample group ,23 participants (54.8%) were male and 19 participants (45.2%) were female. In control group, 24 participants (57.1%) were male and 18 participants (42.9%) were female. The p value was 0.826 (> 0.5) which was not significant. **(Table 2, Figure 2)**

Table 2: Comparison Of Study Samples Based On Gender Distribution

	Male N (%)	Female N (%)	P Value
Group A (Sample)	**23** (54.8%)	**19** (45.2%)	p= 0.826 (NS)
Group B (Control)	**24** (57.1%)	**18** (42.9%)	

p>0.05 – no statistically significant difference

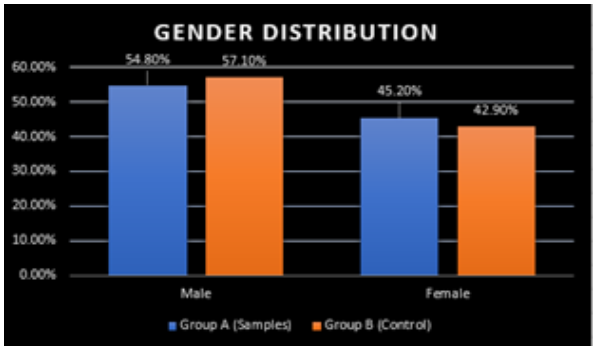

Figure 2: Comparison Of Study Samples Based On Gender Distribution

The mean serum zinc level in the sample group was 175.29 µg/dl (SD 27.89), while in the control group it was 137.1 µg/dl (SD 15.33). The difference was statistically significant (p < 0.001) between the two groups **(Table 3, Figure 3).**

Table 3 : Comparison Of Study Samples Based On Serum Zinc Levels

	Group A (samples) Mean (SD)	Group B (controls) Mean (SD)	P Value Significance
Zinc (µg/dl)	**175.2** (27.89)	**137.1** (15.33)	p< 0.001**

** P < 0.001 Highly statistical significant difference

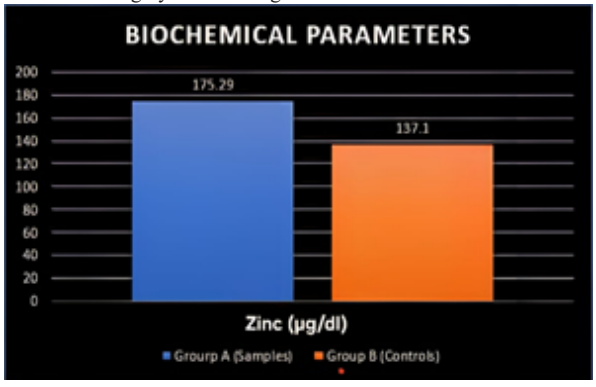

Figure 3: Comparison Of Study Samples Based On Serum Zinc Levels

The mean serum copper level in the sample group was 19.93 µg/dl (SD 0.31), while in the control group it was 20.59 µg/dl (SD 0.85). The difference was statistically significant (p < 0.001) between the two groups **(Table 4, Figure 4)**

Table 4: Comparison Of Study Samples Based On Serum Copper Levels

	Group A (samples) Mean (SD)	Group B (controls) Mean (SD)	p- value Significance
Copper (µg/dl)	**19.93** (0.31)	**20.59** (0.85)	P <0.001**

** P < 0.001 Highly statistical significant difference

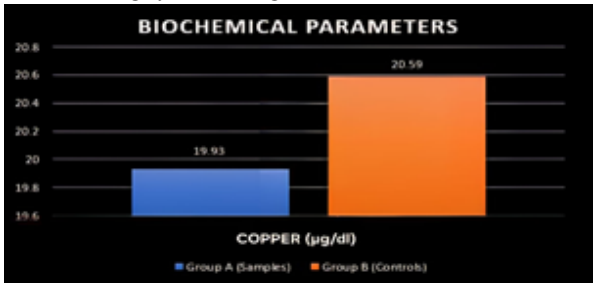

Figure 4: Comparison Of Study Samples Based On Serum Copper Levels

DISCUSSION

Hair is an important asset for human beings, reflecting beauty, age, and experience. Hair colour and texture strongly influence outward appearance. Loss of hair pigmentation, medically termed canities or achromotrichia, is a natural part of aging, though the onset varies among ethnic groups. Premature graying is usually defined as depigmentation before 20 years in Caucasians and before 30 years in individuals of African descent [10].

Children with altered micronutrient levels are more prone to premature canities. Therefore, this study was conducted to estimate serum zinc and copper levels in first-year students with premature canities at a tertiary care centre in Central India.

In the present study, the mean age of the sample group was 19.14 ± 0.84 years and of the control group was 19.16 ± 0.76 years, with no significant difference (p = 0.892). Male predominance was seen in both the sample (54.8%) and control group (57.1%), with insignificant differences (p > 0.05).

Mean serum zinc levels were significantly higher in the sample group (175.29 ± 27.89 µg/dl) compared to controls (137.1 ± 15.33 µg/dl), with p < 0.001. Farahnaz Fatemi Naieni et al [11] also reported higher zinc levels in cases than controls, though not statistically significant (p = 0.285). Similar findings were noted by Swagata Chakrabarty et al [5]. No studies have reported lower zinc levels in premature canities cases so far.

Mean serum copper levels were significantly lower in premature canities students (19.93 ± 0.31 µg/dl) than in controls (20.59 ± 0.85 µg/dl), with p < 0.001. These results align with Farahnaz Fatemi Naieni et al (11), who observed significantly reduced copper levels in cases compared to controls (90.7 ± 37.4 µg/dL vs. 105.3 ± 50.2 µg/dL; P < 0.05). Studies by Deepika Yadav et al [12] and Swagata Chakrabarty et al [13] also reported lower copper levels in cases, though not significant. No studies have shown higher copper levels in the case group.

Copper has a dual role as both antioxidant and pro-oxidant. As an antioxidant, it helps neutralize free radicals, reducing oxidative stress and cellular damage [14]. Copper is also essential for melanin synthesis as a cofactor for tyrosinase, a key enzyme in melanogenesis. Copper ions bind to the active center of tyrosinase, ensuring its proper function. Melanin formation also involves tyrosinase-related proteins TRP-1 and TRP-2 in melanosomes. TRP-1 supports tyrosinase stability, while TRP-2 converts DOPAchrome into DHICA and works along with tyrosinase and TRP-1.

Efficient TRP-2 activity requires metal ions such as zinc. Zinc also plays a vital role in hair physiology by supporting keratin synthesis, the structural protein of hair fibres. It helps maintain follicle health by

slowing regression and improving recovery, thereby promoting hair growth [15].

Thus, various minerals and nutrients contribute to premature canities, which were evaluated in the present study.

Limitation

Study included a small sample size and dietary habits were not considered.

CONCLUSION

Micronutrient deficiencies, particularly copper deficiency, play a significant role in premature graying of hair. Therefore, assessment of these micronutrients is essential for timely supplementation and effective prevention.

Conflict Of Interest

None.

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