

Correlation between Serum Ferritin and Haemoglobin Level in Females with Hair Fall Count in Females with Chronic Telogen Effluvium

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ABSTRACT

Background: Excessive hair shedding among child-bearing women has been linked to low iron store. Despite this, multi-studies looked at this connection have yield inconsistent results. ferritin

Aim: To compare hemoglobin and ferritin level of childbearing women with telogen effluvium and those in otherwise good health. To evaluate the link between iron store level and amount of hair shed.

Patients and Methods: The case-controlled study included 74 women with telogen effluvium and 22 age matched healthy women recruited from Al-Salam Teaching Hospital in Mosul. Participants underwent an assessment of hair fall count using a standardized hair fall count in 60 seconds. Five ml of blood was drawn to assess the iron status (hemoglobin and ferritin). Difference in iron status between groups were compared by t-test and their link with amount of hair fall was assessed by Pearson correlation and regression tests. P-value <0.05 is significant.

Results: Alopecia patients were 27.81±9.63 years old on average. The difference in hemoglobin levels between Alopecia patients and the control group were not-significantly (11.83±4.59 gm/dl vs. 12.72±0.88 gm/dl) while differences in ferritin level was highly significant (27.84±22.06 ng/ml vs. 57.75±19.75ng/ml). Strong inverse linear were detected in the number of hair falls and ferritin (r=-0.53, P 0.0001). Regression analysis revealed that changes in hemoglobin accounts for only 9% of variation in the total number of hair falls, while ferritin accounts for 28% of them. Two prediction equations based on hemoglobin and ferritin were created for predicting hair fall count in 60 seconds.

Conclusions: The study provides additional evidence for the role of low iron stores reflected by ferritin level in hair fall count in women with chronic telogen effluvium. A nonanemic iron deficiency is probably responsible for unexplained non-specific symptoms like diffuse hair loss. The suggested regression equation provides dermatologists with a tool to predict the amount of hair fall based on estimated ferritin and hemoglobin.

Keywords: Diffuse hair loss, women, Case-controlled study, Hair fall count 60-S, hemoglobin, ferritin

قياس مدى الارتباط بين مستوى الهيموجلوبين والفيريتين في الدم مع كمية الشعر المتساقط عند النساء المصابات بتساقط الشعر الكربي المزمن

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الخلاصة

الخلفية: بالرغم من التزامن بين فرط تساقط الشعر عند النساء مع انخفاض مستوى مخزونهن للحديد , الا ان مراجعة المقالات السابقة التي عننت بدراسة هذا الارتباط أسفرت عن نتائج غير متسقة

اهداف الدراسة: مقارنة مستوى الهيموغلوبين والفيريتين عند النساء اللائي يعانين من تساقط الشعر الكربي المزمن مع مستواه عند النساء اللواتي يتمتعن بصحة جيدة. ولتقييم الارتباط بين مستوى مخزون الحديد (الهيموغلوبين والفيريتين) وكمية الشعر المتساقط

المرضى وطريقة البحث: أجريت الدراسة الضابطة على ٧٤ امرأة مصابة بتساقط الشعر الكربي المزمن و ٢٢ امرأة سليمة تم اختيارهن كعينة ضابطة من مراجعات مستشفى السلام التعليمي في الموصل. خضعت المشاركات لتقييم كمية الشعر المتساقط باستخدام مقياس عدد الشعر المتساقط في ٦٠ ثانية. تم سحب خمسة مليترات من الدم لقياس مخزون الحديد (الهيموغلوبين والفيريتين) لدى مجموعتي الدراسة. تمت مقارنة دلالة الفرق في مخزون الحديد بين المجموعتين باستخدام الاختبار التائي. وتم تقييم الترابط بين كمية الشعر المتساقط ومخزون الحديد باستخدام اختبار الارتباط والانحدار لبيرسون، تم اختيار الدلالة $> 0,05$ كدالة معنوية.

النتائج: كان متوسط اعمار مرضى تساقط الشعر الكربي المزمن 28 ± 10 سنة , وأظهرت النتائج وجود تباين معنوي في مستويات الهيموجلوبين بين مجموعة المرضى والمجموعة الضابطة (11.83 ± 4.59 جم/دل مقابل 12.72 ± 0.88 جم/دل), وكان مستوى الفيريتين منخفض جدا عند المرضى بالمقارنة مع مستواه عند المجموعة الضابطة (27.84 ± 22.06 نانوغرام/مل مقابل 57.75 ± 19.75 نانوغرام/مل). وقد اظهرت النتائج ارتباط عكسي عالي المعنوية بين كمية الشعر المتساقط والفيريتين (معامل الارتباط = -0.53), واطهر اختبار الانحدار ان التغيير في مستوى الهيموغلوبين قادر على تفسير ٩٪ من التغيير في كمية الشعر المتساقط بينما مستوى الفيريتين قادر على تفسير ٢٨٪ من ذلك التغيير, وقد تم انشاء معادلتين تنبؤا قادرتان على تقدير كمية الشعر المتساقط بالاستناد على المستوى المقاس للهيموكلوبين والفيريتين.

الاستنتاجات: تقدم الدراسة الحالية دليلاً إضافياً على دور مخزون الحديد المنخفض متمثلاً بالفيريتين على كمية الشعر المتساقط عند النساء المصابات بتساقط الشعر الكربي المزمن , وربما تفسر حالة نقص الحديد غير الانيميا عن الأعراض غير الواضحة كتساقط الشعر واسع الانتشار. وتمكن معادلة الانحدار المقترحة التنبؤ بكمية الشعر المتساقط بالاعتماد على مستوى الفيريتين والهيموكلوبين المقاس.

الكلمات المفتاحية: تساقط الشعر الكربي المزمن، دراسة ضابطة، كمية الشعر المتساقط في ٦٠ ثانية، الهيموجلوبين، الفيريتين.

INTRODUCTION

Although hair is a non-vital organ, it has a major cosmetic concern, especially for women. Even clinically undetectable hair loss had a negative influence on women's sense of self and wellbeing¹. Many stressful events may cause premature termination of anagen and increase shedding of telogen effluvium (TE). Among these stressful events is the shortage of hair micronutrients². TE is usually self-limit condition, but, if continues beyond six months will be classified as a chronic TE³. The excessive hair loss will frighten the women making them worried about her hair⁴. The regular menses during the childbearing period deprive women from significant amounts of consumed iron⁵. Iron is an essential trace element that supports life in general and hair follicles in special⁶. Hair follicles are highly proliferative "mini-organs" with high need for blood and micronutrients⁷. As Iron functions as a cofactor of rate-limiting enzyme for DNA synthesis and as a multi-gene regulator, their absence may therefore interfere with the synthesis of hair⁸. Women more than men seek dermatologic consultation for managing their diffuse hair loss⁹. This may be attributed to their low iron store whether concealed (non-anemic Iron insufficiency) or overt (anemic iron deficiency)¹⁰. The body will attempt to restore levels of circulating iron by "borrowing" ferritin from less vital sources, such as

hair follicles¹¹. This makes ferritin level more accurate in predicting iron status. Low iron storage has been proposed as a probable cause of excessive hair shedding¹². Although numerous studies have attempted to examine the link between iron body status and diffuse hair shedding, but their result was inconsistent^{13,14}.

The goal of the current investigation is to compare the difference in iron store (hemoglobin and ferritin) between childbearing women with chronic telogen effluvium and otherwise healthy women. The second goal is to assess the relationship between iron store and hair fall count in 60 seconds.

PATIENTS AND METHODS

Seventy-four women (Age ranged from 14-52 years) with chronic telogen effluvium (hair loss > 6 months with positive pull test and absence of central part of hair follicle or miniaturization) who attended the dermatology outpatient clinic at Al-Salam Teaching Hospital from January 2021 to September 2021 were asked to participate in this case-controlled study. A control group of 22 age-matched healthy women were enrolled in the study. The study excluded participants who were using nutritional supplements had other systemic illnesses or infection, and positive C-reactive protein as inflammatory conditions may falsely raise serum ferritin. Patients who had given their

consent provided 5 ml of blood to estimate levels of ferritin, and hemoglobin.

Quantitative evaluation of hair loss was done utilizing the standardized hair fall count in 60-seconds¹⁵. The method was conducted using a special comb provided to each patient. The patient asked to comb her hair rear to the front for 60 seconds prior to shampooing. Hairs on the comb or fallen on a white cushion were collected and tallied, broken hairs were discarded. The average of test was calculated using the average of three consecutive pre-shampooing hair count.

To examine the data, SPSS (version 26.0) statistical software was employed. Range, mean, and standard deviations were used to summarize the continuous variables (hemoglobin, ferritin, and hair count). Their normality was evaluated by the Kolmogorov-Smirnov test before proceeding with further analysis. A bivariate Student's t-test aid in assessment of significance of differences in hemoglobin and ferritin between both groups of study. A Pearson Correlation coefficient* was used to evaluate the direction and strength of iron status-hair fall count relationship. The linear regression analysis¹⁶ was used to predict the dependent outcome (hair fall count in 60 seconds) based on the estimated independent predictors (either hemoglobin or ferritin level), using the universal prediction equation [$Y = \alpha + \beta \times (X)$]. Where Y=outcome, α =intercept of best fit regression line, β =slope of the line, and X=

predictor. A threshold of α error of 0.05 or below was considered significant.

RESULTS

The ages of women with chronic telogen effluvium were ranging from 14-52 years with mean \pm SD of 27.81 \pm 9.63 years, while the age of the healthy control group was ranging from 15-41 years with mean \pm SD of 28.54 \pm 7.55 years and the difference was statistically not significant ($p=0.7$). The hemoglobin distribution of both studied groups is shown in fig 1. The hemoglobin of the studied patients was ranging from 4.20-14.50 gm/dl with mean \pm SD of 11.38 \pm 4.59 gm/dl (95% CI for mean 10.71-11.76), while the hemoglobin of the control group was ranging from 11.70-14.60 gm/dl with mean \pm SD 12.72 \pm 0.88 gm/dl (95% CI for mean 12.33-13.11). The average hemoglobin of alopecia group was less than normal group by 0.89 gm/dl (95% CI of the Difference -2.85-1.06), but the difference was not significant statistically ($p=0.3$). ferritin distribution of both studied groups is shown in fig 1(b). The ferritin of the studied patients was ranging from 2.58-89.60 ng/ml with mean \pm SD of 27.84 \pm 22.06 ng/ml (95% CI for mean 20.26-31.50), while the ferritin of the control group was ranging from 6-90 years with mean \pm SD 57.75 \pm 19.75ng/ml (95% CI for mean 48.99-66.50). The average ferritin of the study group was less than normal group by 29.90ng/ml (95% CI of the Difference-40.34 to -19.45) The difference is statistically significant ($p<0.0001$).

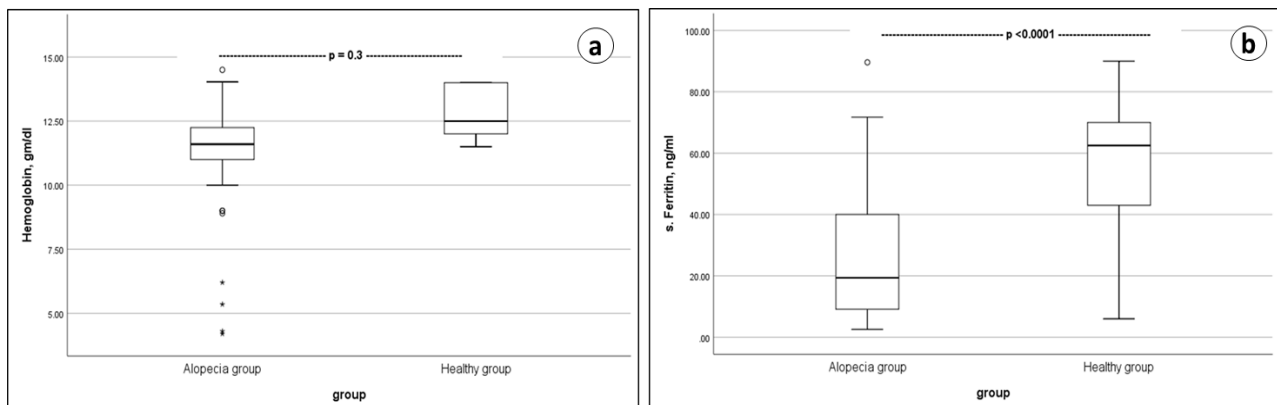


Figure 1. Box blot comparison of (a) hemoglobin and (b) ferritin between women with chronic telogen effluvium and healthy women.

The correlation between hair shedding measured in 60 seconds and hemoglobin or ferritin is shown in figure 2. The results reveal highly significant inverse relationship with ferritin ($r=-0.53$, $r^2=0.28$, $P 0.0001$) and an inverse significant linear relationship with hemoglobin ($r =-0.29$, $r^2=0.09$, $P=0.01$). The regression test was performed to further evaluate these relationships, and found that unit the change in hemoglobin account for 9% of variation in the hair fall count while unit changes in ferritin account for 28% of these variation. The best fit line that best expresses the relationship between the points on scatterblot was created using the least squares method. The result reveal that interception of best fit line was (34.36 in ferritin graph and 24.32 in

hemoglobin graph) and their slop (1.41in ferritin graph and 0.2 in hemoglobin graph). These figures were used to construct two prediction equation models by which we can predict the amount of hair fall in 60 seconds as an outcome based on estimated hemoglobin or ferritin as a predictor as follows:

Eq. 1: Hair fall count in 60 seconds = 34.36-1.41 × (hemoglobin)

Eq. 2: Hair fall count in 60 seconds = 24.32-0.2 × (ferritin)

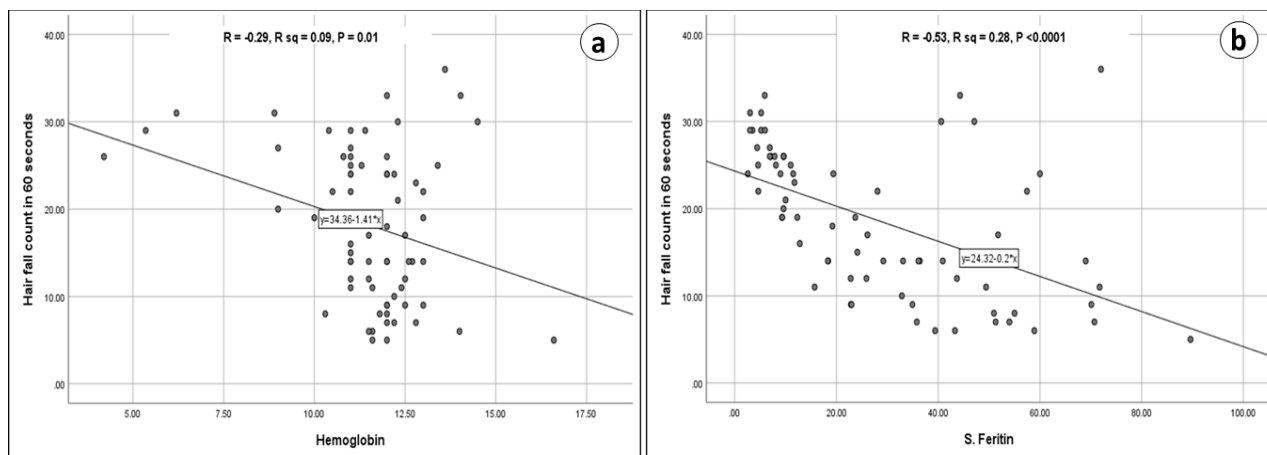


Fig 2. The correlation, linear best fit regression line, and prediction equation between hair fall count measured in 60 seconds and hemoglobin (a), and ferritin (b).

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DISCUSSION

Telogen effluvium is a major dermatologic problem that affects many people. Setting priorities becomes crucial for identifying and handling stressful circumstances, especially those that concern women¹⁷. Despite the fact that Iron deficiency is the most frequently studied element in hair disorder¹⁸, yet the link is still debating issues from no clear association¹³ to strong link¹⁴. The current investigation offers additional proof that people with chronic telogen effluvium are more likely to experience excessive hair shedding when

their iron stores become low. Three facts are the foundation of this evidence: First, the patients have lower serum ferritin level compared to the control group's (27.84 ng/ml vs. 57.75 ng/ml, respectively); second, the frequency of iron deficiency anemia defined by ferritin level <15 ng/dL, was found in 24 (31.6%) of the study group. This figure is higher than the estimated prevalence of anemia among the general population of Iraqi not pregnant or lactating women (24.5%) (The figure is based on recently released nationwide representative polls carried out from 1996 to 2018 in Iraq)¹⁹; Finally, correlation analysis reveals an inverse highly significant negative link between hair fall count and serum ferritin (correlation coefficient $r=-0.53$).

The strong negative association between level of ferritin and hair fall count found in the current study is contradicting the conclusion of Bregy and Trüeb. They claim that a serum ferritin level <10 g/l is not connected with "hair loss" activity²⁰. A reason behind these contradictions may be attributed to using a different definition of hair problem. They used hair loss (permanent loss of hair that deteriorate with time), while the current study used hair fall (transient cyclical but physiological shed of hair that replaced by new hair in the same follicle). Additionally, Bregy and Trüeb used trichogram to estimate hair loss while the current study used hair fall 60-S test for counting hair fall²¹.

Shortage of Iron may be detected by hemoglobin, but it was confirmed by ferritin. The low level ferritin found in a study group with a normal hemoglobin concentration can be translated as

status of Iron deficiency without anemia, or the nonanemic iron deficiency, a term which was postulated by Hard for the first time in 1963²¹.

This status is probably responsible for the unexplained non-specific symptoms like excessive hair shedding. The presence of infection, inflammation, or neoplastic diseases, may raise ferritin concentrations and result in false conclusion. For this reason, a screening of C reactive protein level was used to exclude participant with positive test.

In a review of published literatures, Kaushik et al, recently developed a predictive regression model for assessing perceived hair breakage in Indian consumers²². Georgescu et al in their meta-analysis used the equation to predict the relation between number platelet-rich plasma therapy and hair density²³. To the best of our knowledge, the current study provides first attempt to assess mathematically the degree of correlation between quantitative measure of hair fall count estimated by standardized hair fall count in 60 and level of hemoglobin and ferritin. Furthermore, the study provides new prediction equations that can be applied to predict hair fall count as a dependent outcome can be predicted from the estimated hemoglobin and ferritin as independent predictors. It enables dermatologists to anticipate how the value of the dependent variable (hair fall count) will change in relation to the unit change in the value of the independent variable (hemoglobin or ferritin). The analysis reveals that the coefficient of determination (R^2) of the best fit line for ferritin was 0.29. In other words, a single unit change in ferritin will be able to account for 29% of variations in the rate of hair loss. However, there may be more factors that, if studied further, might account for 71% of changes in the amount of hair falling out. Using a single equation, the multiple regression technique enables us to extend simple linear regression by including several explanatory variables at the same time²⁴.

CONCLUSIONS

The study provides additional evidence for the role of low iron stores reflected by the strong negative relation between low ferritin level and hair fall count among women with chronic telogen effluvium. A non-anemic iron deficiency is probably responsible for unexplained non-specific symptoms like diffuse hair loss. The suggested regression equation provides dermatologist by a tool to predict the amount of hair fall.

Limitation

It is important to take into account the study's limitations. The infeasibility of more invasive technique like bone marrow aspiration for confirming the diagnosis of iron deficiency anemia is a significant constraint. Additionally, limiting the study to women may make generalization of the result to other gender difficult.

The research's strength stems from the homogeneity of all participants regarding residence, way of living, and ethnicity.

Statement of Ethics: The Ethical Committee of the college of medicine, University of Ninevah, Mosul-Iraq, verified the study. A consent was obtained from the enrolled subjects.

Conflict of Interest :No conflicts of interest exist, according to the conflict-of-interest statement.

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