Trichoscopy criteria for diagnosing female androgenic alopecia.

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ABSTRACT

Differential diagnosis of chronic hair loss remains a challenge in dermatology. The aim of the study was to evaluate the value of a new scalp visualization technique, trichoscopy, in differential diagnosis of hair loss. Trichoscopy was performed in 131 females (59 with androgenic alopecia, 33 with chronic telogen effluvium, 39 healthy controls).

Based study results, a standardized trichoscopy report was developed and diagnostic criteria for female androgenic alopecia were established. Major criteria: increased number of yellow dots and thin hairs, as well as decreased average hair thickness in frontal area. Minor criteria: increased frontal area to occiput ratio of single-hair units (>2:1), vellus hairs (>1,5:1) and follicles with perifollicular discoloration (>3:1) Fulfillments of 2 major criteria or 1 major and 2 minor is diagnostic for female androgenic alopecia with a 92% specificity.

In conclusion, trichoscopy is the first method which allows differential diagnosis of hair loss and establishing the diagnosis of female androgenic alopecia.

INTRODUCTION

Chronic hair loss frequently affects female patients, but there is little or no objective technology available to aid the dermatologist in setting a proper diagnosis and in monitoring treatment efficacy.[1] In particular, it may be difficult to differentiate between female androgenic alopecia (FAGA), a subtype of female pattern hair loss, and chronic telogen effluvium (CTE).[2] Common coexistence of these two diseases makes the diagnosis an even bigger challenge.

Telogen effluvium is a self-limiting process and almost never causes obvious baldness,[3] whereas FAGA progresses in time, leading to a significant decrease in hair thickness, which over time may become cosmetically unacceptable and psychologically frustrating.[4] Differences in natural history, prognosis and emerging new therapeutic possibilities [5] make differential diagnosis and early diagnosis of FAGA especially important. Currently the diagnosis of FAGA is usually based on anamnesis and clinical findings, such as pattern of increased hair thinning, retention of the frontal hairline, and the presence of miniaturized hairs.[6,7] The semi-invasive technique of hair root analysis (trichogram) has a decreasing number of advocates among dermatologists. It is considered poor indicator of FAGA and it's severity.[8] Additionally, the test should be performed 5 days after shampooing, what is unpleasant for patients.

A scalp biopsy examination is performed usually to confirm the diagnosis of FAGA in clinically doubtful cases.[2,3] Histopathology findings in FAGA include a decrease in terminal/vellus hair ratio and decline in mean total follicle count with increasing grade of hair loss. This method also has limitations in everyday practice. Typically, punch biopsies are taken for vertical and horizontal embedding. These are 7-12mm2 in size and contain only a small number of hair follicles. Thus, some authors suggest

performing multiple biopsies for representative sampling, what increases the invasiveness of this diagnostic technique and makes it even less useful for monitoring of treatment efficacy.[8]

Trichoscopy [9,10] is newly developed method of hair image analysis, based on videodermoscopy of hair and scalp. The method allows visualization of hair shafts at high magnification and performing measurements, such as hair shaft thickness, without the need of removing hair for diagnostic purposes. It also allows in vivo visualization of the epidermal portion of hair follicles and perifollicular epidermis.[11,12] Several reports raise the issue of potential usefulness of this technique in diagnosing hair and scalp disorders, such as androgenic alopecia,[13,14] alopecia areata,[15,16] lipedematous alopecia,[17] pediculosis [18] or inherited hair shaft abnormalities,[19] but the metod has not been standardized yet and no criteria for diagnosing acquired diseases of hair and scalp have been established.

The aim of the study was to establish a standardized method of trichoscopy in acquired hair loss and to establish trichoscopy criteria for diagnosing FAGA.

A total of 131 female patients were included into the study, 59 with clinically evident FAGA, 33 with CTE confirmed by trichogram and 39 healthy volunteers.

The mean age was 36.2 (18-59) years in patients with FAGA, 32.2 (18-56) years in patients with chronic telogen effluvium and 37.8 (19-58) years in healthy controls. The differences were statistically not significant.

RESULTS

Statistical analysis was performed with the use of t-Student test for paired samples and with analysis of variance (ANOVA). The Classification and Regression Tree

technique was used to establish diagnostic criteria. The study design was approved by the ethical committee.

Hair thickness

Both, in the healthy controls, as well as in patients with chronic telogen effluvium, the thickest hairs have been observed in the frontal area, whereas the thinnest in the occipital area. In the healthy control group mean hair thickness was 0.061 mm±0.008mm in frontal area vs 0.058±0.007mm in occipital area ($p<0.001$). In telogen effluvium the values were 0.056±0.007mm vs 0.053±0.009mm respectively ($p<0.001$). In the FAGA the smallest average thickness of hair roots has been observed in the frontal area with 0.047±0.007mm compared to 0.052±0.008mm in the occipital area ($p<0.001$). In patients with FAGA average hair thickness in the left temporal area of was 0.05±0.009mm and in the right temporal area 0.051±0.008mm (Figure 1).

Differences between left and right temporal area were statistically not significant. No significant differences in results between the left and right temporal area were established in any of the investigated parameters. Thus, results for only one (left) temporal area are presented in figures.

In all assessed areas the smallest average thickness of the hair roots has been noted in patients with FAGA. Compared to healthy controls, hair thickness of patients with FAGA was significantly reduced in the frontal ($p<0.001$), occipital ($p=0.002$), left temporal ($p<0.001$) and right temporal area ($p<0.001$). Detailed results are presented in Figure 1.

The largest average percentage of thin hairs (below 0,03 mm) was observed in FAGA in frontal area (20.9±12%) and it was significantly different compared to patients with telogen effluvium (10.4±3.9%) and healthy volunteers (6.15±4.6%, $p< 0.001$). An

increase in the percentage of thin hairs was accompanied by an increase in the proportion of medium-size hairs and a simultaneous decrease in the proportion of thick hairs. As the process occurred, the shift towards an increase of vellus hairs has been also observed in the occiput of FAGA patients.

The mean proportion of thin, medium-size and thick hairs in occipital area of FAGA patients was 14.2±8.9%, 31.5±15.8% and 54±4.9% respectively. In the control group the respective proportions were 6±5.1%, 20.6±13.4% and 73.4±5.8%. In telogen effluvium the respective values were 11.9±3.9%, 29.7±15.9% and 58.6±8.5%. Detailed results are presented in Figure 2.

Image analysis showed that vellus hairs (hairs below 0.03 mm) differ in chronic telogen effluvium from FAGA by being short and sharp-ended (Figure 3C,D), as in regrowing hairs rather than longer and bluntly ended as in progressive hair follicle miniaturization (Figure 3 A,B). A number of five or more short and sharp-ended hairs in 4 fields of vision at 70-fold magnification in both the frontal and occipital or temporal area was found in 18/33 (54.5%) patients with CTE and in none of the patients with FAGA.

Pilosebaceous units

Hairs usually are present in groups of few hair roots growing from one follicular orifice. The number of hairs in pilosebaceous units has been evaluated by trichoscopy at the 20-fold magnification. The percentage of single-hair, double-hair and triple-hair units was evaluated.

In healthy controls and in chronic telogen effluvium the highest proportion of single-hair pilosebaceous units was observed in the temporal areas. The mean percentage of single-hair units in this area was 42±12% in CTE and 32±15% in healthy controls.

In patients with FAGA the mean percentage of single-hair pilosebaceous units was highest in the frontal area (65.2±19.9%). This was significantly more than in telogen effluvium (39.0±13.4%, $p<0.001$) and in healthy controls (27.3±13%, $p<0.001$). The smallest difference between these groups in the proportion of single-hair pilosebaceous units has been noted in the occipital region. The numbers for healthy controls, FAGA and telogen effluvium were 22.6±12.6%, 36.8±18.6% and 31±23% respectively. The difference between FAGA and healthy control was statistically significant at $p<0.001$. The mean proportion of single-hair units in the frontal area to occipital area was 2.56 in healthy controls, 3.4 in telogen effluvium ($p=0.01$) and 10.4 in FAGA ($p<0.001$).

Detailed results showing the proportion of single-, double- and triple-hair pilosebaceous units in healthy donors and FAGA are presented in Figure 4. Units with 4 hairs accounted for less than 1% of the total number of evaluated units and were omitted in this figure.

"Yellow dots"

“Yellow dots” were evaluated at 20-fold magnification and at 70-fold magnification. Results are given as total number of yellow dots in one field of vision (FOV) at 20-fold magnification and as total number seen in four FOVs at 70-fold magnification. In both calculation methods the number of yellow dots was significantly higher in patients with FAGA as compared to healthy controls or to patients with CTE. However, in general, the number of yellow dots per 1mc2 was on average 20% higher when evaluated at 70-fold magnification, as compared to 20-fold magnification. This difference resulted from better visualization of small trichoscopy structures at higher magnifications. Figure 5 shows the mean numbers of yellow dots in healthy controls, FAGA and telogen effluvium, when analyzed in four fields of vision at 70-fold

magnification. The highest number of yellow dots in patients with FAGA was noted in the frontal area (8.86±4.8/4 fields of vision at 70-fold magnification). The corresponding number in the occipital area was 1.59±2.0.

Perifollicular discoloration

The percentage of hair-containing units with perifollicular discoloration was evaluated at 20-fold magnification and in 4 FOVs at 70-fold magnification. Both methods yielded highly comparable results. Thus, results are presented for the 20-fold magnification only.

Perifollicular discoloration was found significantly more often in FAGA as compared to healthy controls or patients with CTE. The mean percentage of hair follicles with surrounding discoloration in FAGA was 32.4±4.7% in the frontal area and 6.6±2% in the occipital area ($p<0.001$).

Other parameters

Other parameters (white dots, cadaverized hairs, broken hairs, degree of desquamation, predominant type of blood vessels, presence exclamation mark hairs) were evaluated in accordance with the study outline presented in the Materials and Methods section and gave results which were non-significant for setting up criteria for diagnosis of FAGA. No differences in the frequency of their occurrence have been demonstrated between the respective areas of the scalp. These results are not presented.

Differences between the frontal and occipital area.

The two-tailed testing method with 95% confidence interval was used for comparing trichoscopy results obtained for the frontal area to the occipital area. These differences were most profound in patients with FAGA.

In healthy controls mean hair thickness was significantly lower in the frontal area ($t(38)=4.78$; $p<0.001$) and the percentage of single-hair units was significantly higher ($t(38)=2.56$; $p=0.01$) as compared to the occipital area.

Similar results were obtained in patients with telogen effluvium. Statistically significant differences were noted only in mean hair thickness ($t(32)=4.06$; $p<0.001$) and percentage of single-hair units ($t(32)= 3.40$; $p <0.001$). The frontal area in FAGA patients was characterized by a lower percentage of pilosebaceous units with three hairs ($t(58)= -5.18$; $p<0.001$) and two hairs ($t(58)= -8.19$; $p<0.001$), higher percentage of single-hair units ($t(58)= 10.40$; $p<0.001$) and vellus hairs ($t(58)= 5.70$; $p <0.001$). The frontal area in these patients was also characterized by a lowered percentage of thick hairs measuring more than 0.050mm ($t(58)= -6.15$; $p <0.001$) and higher percentage of follicles with perifollicular discoloration ($t(58)= 6.12$; $p <0.001$) or follicle ostia presenting as yellow dots ($t(58)=11.63$; $p<0001$) as compared to the occipital area. Mean hair thickness was significantly lower in scalp front as compared to the occiput ($t(58)= -6.86$; $p <0.001$).

The ratio of vellus hairs in the frontal area to occipital area (calculated in four fields of vision at 70-fold magnification) was 2.21±1.28 (mean±SD) in FAGA, 1.40±0.59 in telogen effluvium and 1.43±0.83 in healthy volunteers. The difference between FAGA and either healthy controls or telogen effluvium was statistically significant at $p<0.001$ in both cases. The difference between healthy controls and telogen effluvium was statistically not significant.

Clasification and Regression Tree

Data obtained in this study were used to define diagnostic trichoscopy criteria for FAGA by employing a Classification and Regression Tree analysis. These allowed to

define 3 major and 3 minor criteria into an algorithm, which gave a 98% metod specificity for FAGA.

Major Criteria

1. More than 4 yellow dots in 4 images at 70-fold magnification in the frontal area.

2. Lower average hair thickness in the frontal area in comparison to the occiput (calculated from not less than 50 hairs from each area).

3. More the 10% of thin hairs (below 0.03mm) in the frontal area

Minor criteria

1. ratio of single-hair units percentage, frontal area to occiput > 2:1

2. ratio of number of vellus hairs, frontal area to occiput > 1,5:1

3. ratio of hair follicles with perifollicular discoloration, frontal area to occiput > 3:1

Fulfillment of 2 major criteria or 1 major and 2 minor criteria is required to diagnose FAGA based on trichoscopy.

In order to confirm this diagnostic model a linear regression analysis was performed in which the dependent variable was the diagnosis of FAGA and the diagnostic criteria were independent variables. An analytical model, which was constructed this way showed a potential diagnostic sensitivity of this method at the level of 72%.

Trichoscopy report

Based on results collected in this study we established a trichoscopy report form which contains most important trichoscopy findings in diffuse hair loss and diagnostic criteria for FAGA (Table 1). Elements, which were not found to be of diagnostic value in this or previous studies (Lacarrubba et al, 2004; Ross et al, 2006) were not included into this trichoscopy report form. These include trichoscopy results from parietal regions and results from magnifications which were less precise or significantly less comfortable to handle. We also found evaluation of distance

between pilosebaceous units not useful for diagnostic purposes. This trichoscopy report contains a simplified field for specific signs of inherited hair shaft abnormalities, cicatricial alopecia and alopecia areata.

DISCUSSION

FAGA, a disease in the spectrum of female pattern hair loss, is characterized by progressive miniaturization of hair follicles, mediated most probably by dihydrotestosterone within the follicle and may affect women with normal levels of circulating androgens.[20] The diagnosis is usually based on anamnesis and clinical findings, such as early age of onset, the pattern of increased hair thinning over the frontal/parietal scalp with greater hair density over the occipital scalp, retention of the frontal hairline, and the presence of miniaturized hairs.[6,7,21] Histologically, the disease is characterized by miniaturization of a proportion of follicles and an increased percentage of hair in telogen in the affected area.[7] In advanced stages of disease, when these features are obvious, the diagnosis is not problematic. However, in early disease and in patients, in whom other causes of hair loss coexist the diagnosis may be challenging.

In this study trichoscopy criteria were established, which allow to diagnose FAGA with 92% specificity. These criteria are based on findings, which have partly been known from clinical observations and other diagnostic methods, but could not be quantified before trichoscopy was developed. These findings relate to predominance of hair miniaturization in the frontal area compared to the occiput.

This clinical and histopathological observation has been identified and quantified by trichoscopy as lower average hair thickness in the frontal area in comparison to the

occiput, more the 10% of thin hairs (below 0.03 mm) in the frontal area and ratio of vellus hair number (frontal area to occiput) above 1.5:1.

A novel approach to quantify hair density in practical dermatology is evaluation of the number of hairs in one pilosebaceous unit. This was previously not possible with classical diagnostic method or the recently developed phototrichogram.[22] The number of hairs in one pilosebaceous unit varies from 1-3 in healthy persons. Occasionally a four-hair units may be found. Our results show that the number of single-hair pilosebaceous units is significantly increased in patients with FAGA and the number of single-hair units in these patients is significantly higher in the frontal area compared to the occiput. A ratio of single-hair units in frontal area to occiput above 2:1 was found to be highly indicative of FAGA. Hair thinning, decreased number of hairs in pilosebaceous units and predominant prevalence in the frontal area are main features distinguishing FAGA from most other hair diseases, especially alopecia areata.[11]

Clinically "patterning" in patients with female pattern hair loss may be with frontal accentuation ("Christmas tree" pattern), diffuse central or vertex/frontal (male pattern) with sparing of the occiput.[6] Recently, studies have demonstrated that in patients with FAGA changes observed in the occiput are similar to those in the frontal area, but less pronounced. Using the phototrichogram method, both Ekmekci[23] and Van Neste[1] showed decreased hair density and an increased percentage of thin hair roots (<0.04mm) in the occipital area of FAGA patients, compared to healthy controls. Our results confirm the occurrence of changes typical for androgenic alopecia also in other areas than those considered “androgen- dependent”. We have shown that in the occipital area of patients with FAGA average hair diameter is significantly decreased, the percentage of vellus hairs is increased and the number of single-hair

pilosebaceous units is higher than in the occipital area of healthy controls. Also other features of FAGA, such as yellow dots and perifollicular discoloration were found in the occipital area of patients with FAGA, but not in healthy controls. Assessment of these trichoscopy features in temporal areas gave intermediate values between results obtained for the frontal region and the occiput in both FAGA and chronic telogen effluvium. It may be concluded that trichoscopy of temporal areas may be ignored in dermatological practice. Trichoscopic examination of the frontal area and the occiput is sufficient for diagnostic purposes and to monitor disease progression. Interestingly, it has been observed in healthy controls that the temporal areas have the highest number vellus hairs and pilosebaceous units with only one hair, indicating that physiologically these areas have lowest hair density.

A major trichoscopy criterion of FAGA is the presence of yellow dots, which reflect hair follicle ostia lacking any hairs (“empty hair follicles”). It may be suggested that yellow dots in FAGA result from the presence of sebaceous lobules, which in histopathology appear large in relation to the miniaturized follicles.[24] We hypothesize that these sebaceous glands are still active after advanced hair follicle miniaturization and produce sebum which creates intraepidemal sebum lagoons. Theses sebum lagoons appear as yellow dots in trichoscopy. We found that the number of yellow dots is significantly increased in patients with FAGA and that in these patients the number of yellow dots is significantly higher in the frontal area compared to the occipital area.

Yellow dots have been previously described in alopecia areata[11,12] and have been recently suggested as indicative of alopecia areata incognita (Kligman's telogen effluvium) in patients with diffuse hair loss.[16] Our results show that yellow dots may be characteristic for a wide spectrum of hair diseases and they may also represent a

wider, than previously anticipated, spectrum of histopathological appeareances of follicle ostia and infundibula. Our results show that yellow dots are not only present in most patients with FAGA but also that they are one of the most important trichoscopy features distinguishing FAGA from chronic telogen effluvium.

Another important trichoscopy finding is perifollicular darkening (discoloration) of the skin. This feature, called by some authors "hiperpigmentation" or "peripilar sign" is according to Deloche [25] reflecting the presence of perifollicular lymphocytic infiltrates in early androgenic alopecia. Our results confirm the presence of perifollicular discoloration in androgenic alopecia. However, it is not specific for androgenic alopecia. Our results show that it may be present, in a minor degree, also in chronic telogen effluvium. Ross at al.[12] described presence of perifolllicular hyperpigmentation in some patients with alopecia areata.

Though, we found that in FAGA the percentage of hair follicles with this abnormality is significantly higher in the frontal area compared to the occiput. According to statistical analysis a ratio of hair follicles with perifollicular discoloration, frontal area to occiput higher than 3:1 is highly indicative of FAGA. Classification and Regression Tree analysis allowed to define trichoscopy criteria for FAGA.

Major Criteria are: 1. More than 4 yellow dots in 4 fields of vision at 70-fold magnification in the frontal area, 2. Lower average hair thickness in the frontal area in comparison to the occiput (calculated from not less than 50 hairs from each area), 3. More the 10% of thin hairs (below 0.03 mm) in the frontal area. Minor criteria are: 1. ratio of single-hair units percentage, frontal area to occiput above 2:1, 2. ratio of vellus hair number, frontal area to occiput above 1.5:1, 3. ratio of hair follicles with perifollicular discoloration, frontal area to occiput above 3:1. Fulfillment of 2 major criteria or 1 major and 2 minor criteria allows diagnosing FAGA with a 98% specificity.

A standardized trichoscopy report was developed to facilitate trichoscopy examinations and simplify evaluation of FAGA diagnostic criteria. This trichoscopy report also contains a separate field for specific signs of inherited hair shaft abnormalities, cicatricial alopecia and alopecia areata. The method is simple to use and may be applied as accessory tool in differential diagnosis of hair loss in dermatological practice.

It may also be applied in monitoring disease progression and treatment efficacy. Chronic telogen effluvium has no specific trichoscopy features, apart from an increased proportion of short, sharp-ended hairs. A number of five or more in 4 fields of vision at 70-fold magnification in both the frontal and another (occipital or temporal) was found highly indicative of CTE. Most likely these are regrowing hairs in early anagen stage and their increased number indicates an accelerated hair cycle, resulting in an intensive replacement of hair roots. However, chronic telogen effluvium may be rather a diagnosis made by exclusion of other causes of hair loss, than by direct fullfilment of specific trichoscopy criteria.

In conclusion, the results of our study indicate that the diagnosis of FAGA may be established based solely on trichoscopy criteria and this method seems to be the only which anables to confirm or exclude female androgenic alopecia.

METHODS SUMMARY

Trichoscopy has been performed with the Fotofinder II videodermoscope, which permits scalp visualization at 20-160-fold magnification. The device is equipped with software which allows to carry out measurements of structures visualized in magnified images and provides results in real scale. Images of the scalp were taken at a 20-fold magnification which allows high quality enlargement of $1cm^2$ of scalp

area to the size of a computer screen and at 70-fold magnification which magnifies in a similar manner an area of 9mm^2.

In each patient one image at 20-fold magnification and 4 images at 70-fold magnification were taken each of following four areas: frontal, occipital, right temporal and left temporal.

Hair thickness was measured at 70-fold magnification, in direct proximity to follicular orifices. Hairs have been identified as “thin hairs” (below 0.03 mm), “medium- size hairs” (0.03-0.05 mm) and “thick hairs” (above 0.05 mm).

The images have been evaluated in accordance with the scheme:

1. Number of vellus hairs in one field of vision (FOV) at 20-fold magnification and in four FOVs at 70-fold magnification

2. Hair thickness:

- percentage of thin hairs (less than 0.03 mm)
- percentage of medium sized hairs (0.03 mm to 0.05 mm)
- percentage of thick hairs (above 0.05)
- mean hair thickness (mm)

3. Percentage of pilosebaceous units with 1,2 and 3 hairs calculated at 20-fold magnification

4. Number of yellow dots per FOV calculated at 20-fold magnification and in four fields ofvision at 70-fold magnification

5. Percentage of perifollicular yellow discoloration (hyperpigmentation) calculated at 20-fold magnification

6. Other:

- number of white dots (scarified follicular ostia), cadaverized hairs, broken hairs,
- type of blood vessels,

- presence of exclamation mark hairs

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TABLES:

Table 1. **Trichoscopy report scheme.**

		Frontal area	Occiput	FAGA criteria
Major Criteria	**Total number of yellow dots in four fields of vision***			**> 4 in frontal area**
	Mean hair thickness (mm)*			**Lower in frontal area**
	Percentage of hairs*: **1) thin hairs (<0,03mm)** **2) medium sized hairs (0.03-0.05mm)** **3) thick hairs (>0,05mm)**			**More than 10% thin hairs in frontal area**
Minor Criteria	Percentage of units in one field of vision** 1) single-hair 2) two-hair units 3) tree-hair units			Ratio of single-hair units, frontal area to occiput > 2:1
	Total number of vellus hairs in four fields of vision*			Ratio frontal area to occiput > 1,5:1
	Percentage hair follicles with perifollicular discoloration**			Ratiofrontal area to occiput > 3:1
	Other observations (i.e. exclamation hairs, cadaverized hairs, white dots)			

* 70-fold magnification, ** 20-fold magnification

FIGURE LEGENDS:

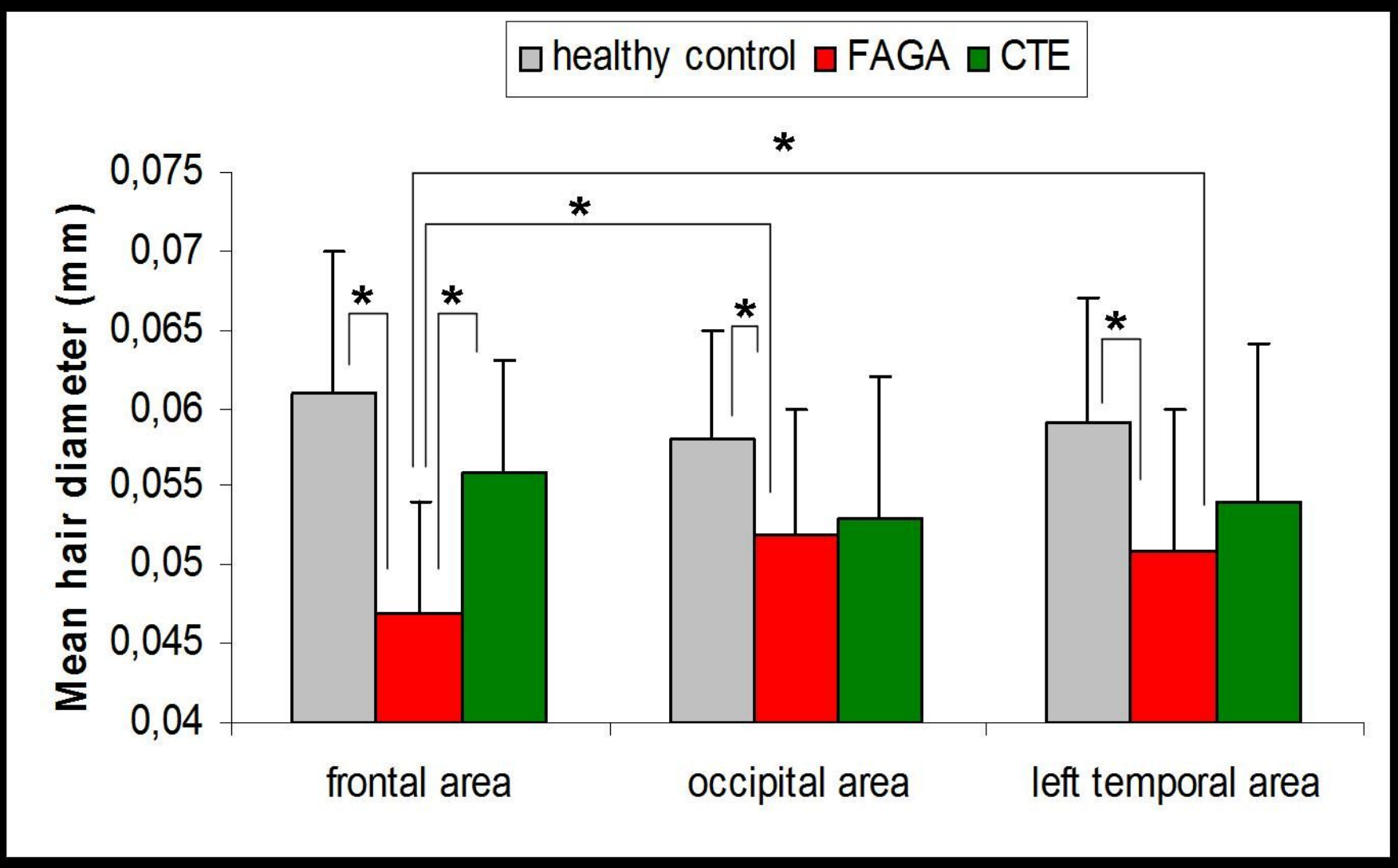
Figure 1. Mean hair diameter in frontal, occipital and left temporal areas of patients with female androgenic alopecia (FAGA), chronic telogen effluvium (CTE) and healthy controls. Asterix indicates the most important, statistically significant differences between ($p<0.001$).

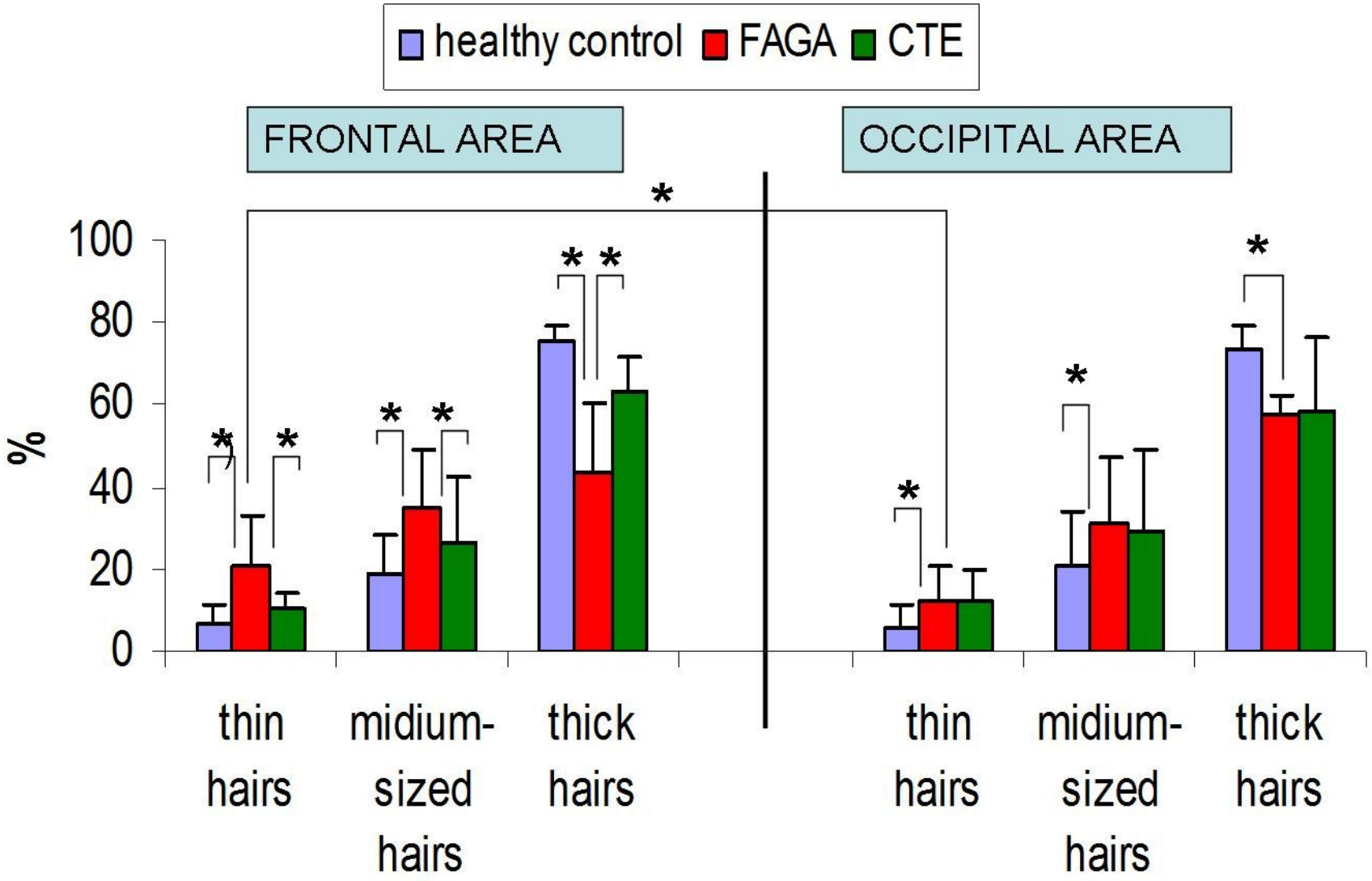
Figure 2. Percentage of thin, medium-sized and thick hairs in frontal and occipital areas in healthy controls, female patients with androgenic alopecia (FAGA) and chronic telogen effluvium (CTE). Statistically significant differences ($p<0.05$) in the distribution of hair thickness between the studied groups have been marked by an asterix.

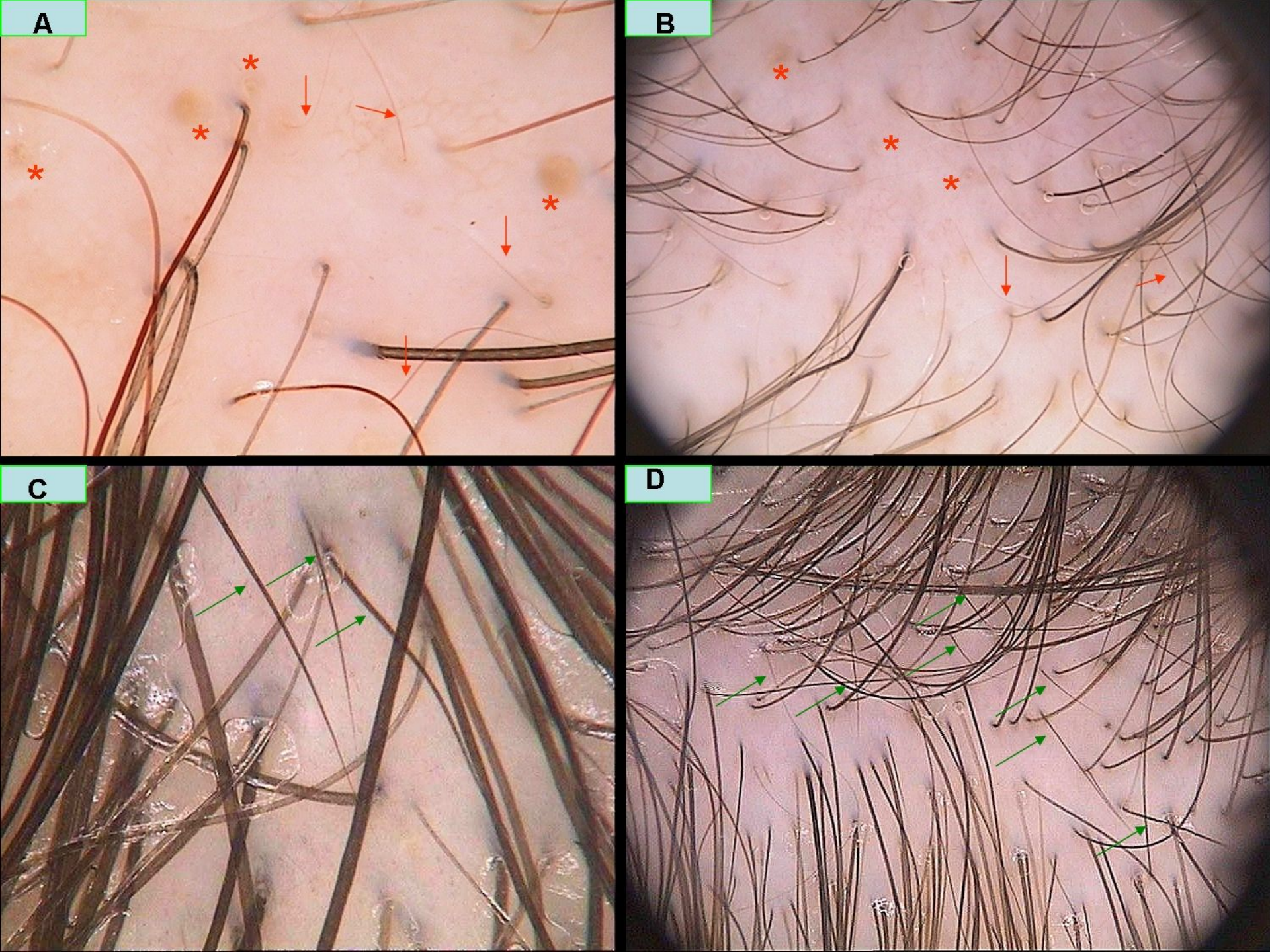
Figure 3. Trichoscopy of frontal scalp area in a patient with FAGA (A,B) and chronic telogen effluvium (C,D), presented in 70- fold (A,C) and 20- fold magnification (B,D). Red asterix points to yellow dots. Red arrows point to vellus hairs in FAGA, which are longer and bluntly ended compared to short and sharp-ended thin hairs in CTE (pointed by green arrows).

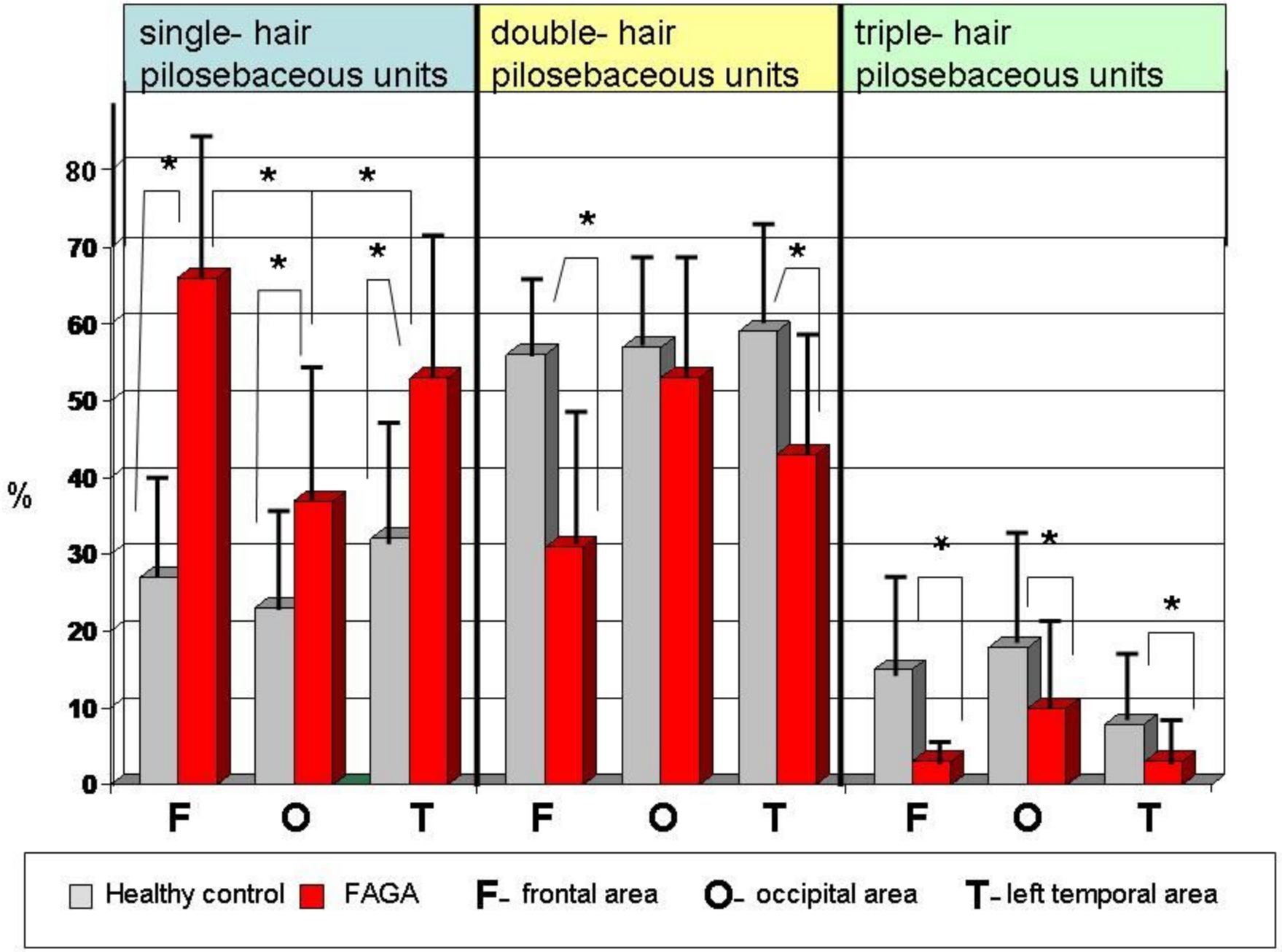
Figure 4. Percentage distribution of pilosebaceous units with one, two and three hairs. In chronic telogen effluvium (CTE) patients as well as in the healthy control the distribution was similar. Thus, only healthy control results and patients with FAGA are presented in this diagram.

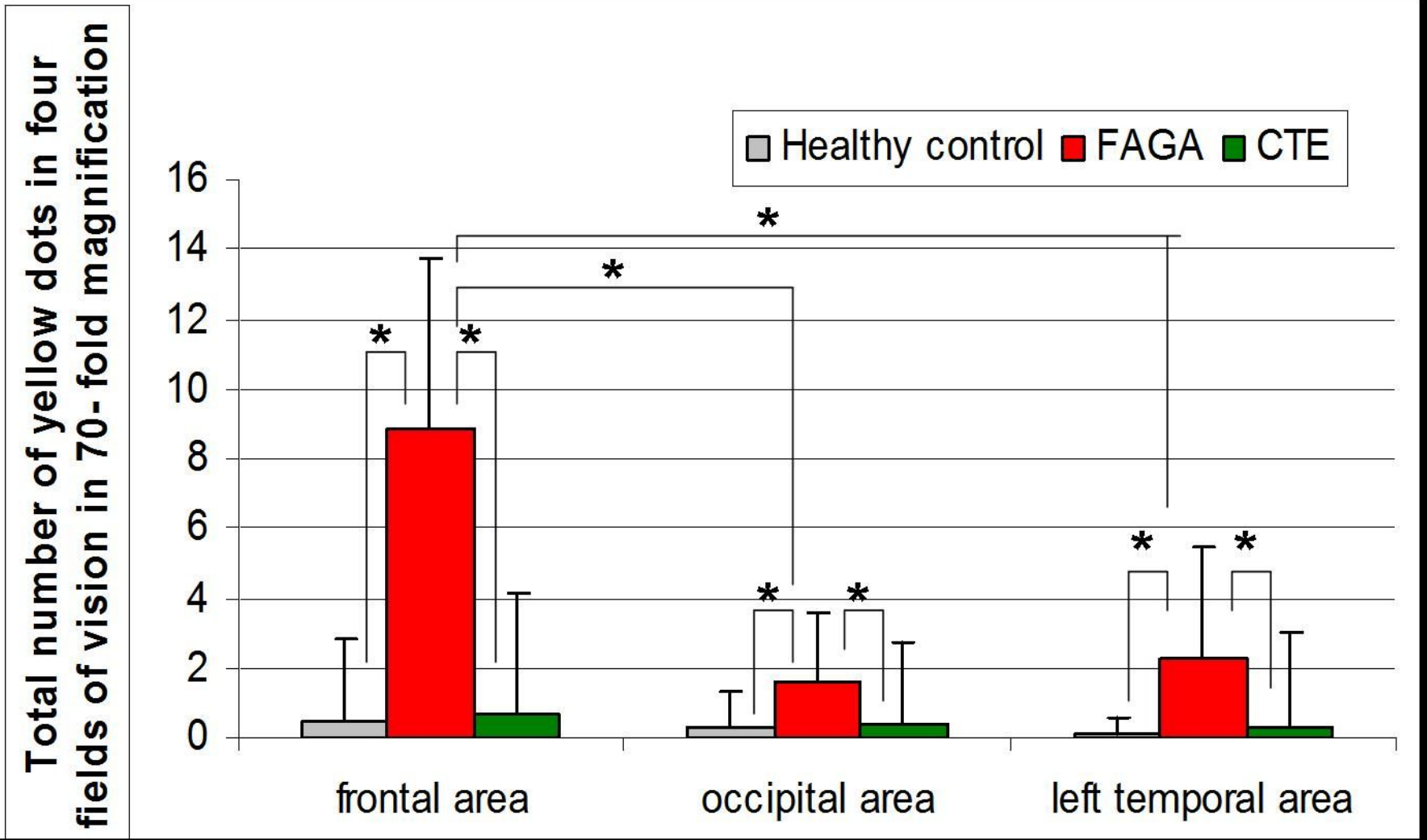
Figure 5. Yellow dots in frontal, occipital and left temporal area of all 3 groups ofpatients, presented as a number counted in 4 FOV`s at 70- fold magnifications. The highest number of yellow dots has been noted in patients with FAGA in the frontal area. Asterixs mark statistically significant differences ($p<0.001$).


healthy control
FAGA
CTE
Mean hair diameter (mm)
0,075
0,07
0,065
0,06
0,055
0,05
0,045
0,04
*
*
*
*
*
*
frontal area
occipital area
left temporal area


healthy control
FAGA
CTE
FRONTAL AREA
OCCIPITAL AREA
%
100
80
60
40
20
0
thin hairs
midium-sized hairs
thick hairs
thin hairs
midium-sized hairs
thick hairs


A
B
C
D


single- hair pilosebaceous units
double- hair pilosebaceous units
triple- hair pilosebaceous units
%
0
10
20
30
40
50
60
70
80
F
O
T
F
O
T
F
O
T
Healthy control
FAGA
F- frontal area
O- occipital area
T- left temporal area


Total number of yellow dots in four fields of vision in 70- fold magnification
Healthy control
FAGA
CTE
16
14
12
10
8
6
4
2
0
*
frontal area
occipital area
left temporal area