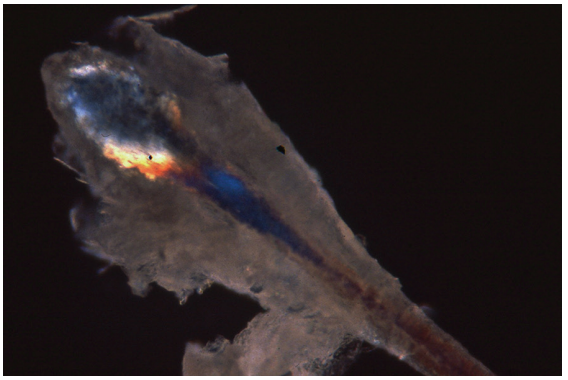


Figure 2.13 **Microscopic view of a telogen hair (in polarizing light).**

Figure 2.14 **Microscopic view of a catagen hair.**

Figure 2.15 **Dystrophic anagen hair visible in alopecia areata.**

Pathological changes on the trichogram

One can observe three types of abnormal hair cycle percentages:

- The telogen type in which the percentage of telogen is increased (>20%–25%); this is telogen effluvium.
- The dystrophic type in which the number of dystrophic anagen hairs is increased at the expense of normal anagen; this is anagen effluvium (e.g., in highly developed alopecia).
- The most common mixed dystrophic telogen type, in which there is an increase in both dystrophic anagen and dystrophic telogen (e.g., in androgenetic alopecia).

The trichogram is used to assess the diameters of the hair shafts and to highlight a decrease in the size of hair follicles, which shows the miniaturization characteristic of the androgenetic alopecia.

The goal of the trichogram

The trichogram has a role that is both diagnostic and prognostic. It is indicated in five situations:

1. In the case of any hair loss for physiological reasons, a normal trichogram can reassure anxious patients.
2. In case of any diffuse hair loss without alopecia, it can decide between telogen effluvium, androgenetic alopecia, and diffuse alopecia.
   a. Telogen effluvium (pregnancy, iron deficiency, acute infection, hemorrhage, accident, general anesthesia, weight loss, emotional distress, etc.) is characterized by the abrupt and synchronized passage of many follicles into the telogen phase, resulting in hair loss 2–3 months later. The trichogram shows at that time a large number of telogen hairs (>20% or 25%) in all regions of the scalp examined.
   b. Anagen effluvium (toxic or drug-induced, chemotherapy alopecia) is due to an abrupt halt in the growth of hair in the anagen phase without passage into the the telogen phase. The loss of hair occurs 4–6 weeks later. Thus, we find in the trichogram a high number of dystrophic anagen hairs. In alopecia areata, there may be a dystrophic form of hair cycle percentages, or a mixed dystrophic telogen type.
   c. In androgenetic alopecia, the formula for hair cycle percentages is normal on the occipital area, while the number of telogen hairs and therefore the anagen/telogen ratio decreases gradually as one moves toward the front area. In addition, the hairs have diameters of different sizes, with the presence of miniaturized hair. The trichogram has a prognostic value in androgenetic

alopecia: a very reduced anagen/telogen ratio and the presence of a large number of dystrophic anagen hairs have a poor prognosis.

3. In the case of localized alopecia, the trichogram can help distinguish trichotillomania. In both cases, one can see dystrophic hair and broken hair; however, in trichotillomania, there are no telogen hairs because they were all torn, and the trichogram is normal when performed on nonaffected areas. In some cases, only histology will decide.
4. In children with suspected hair dysplasia, the trichogram can contribute to the diagnosis, but examination in polarized light directed to a lock of hair that has been cut and not torn will specify the type of hair dysplasia (see Chapter 4). However, trichogram does confirm the hair dysplasia diagnosis of loose anagen hair syndrome in which a majority of anagen hair devoid of epithelial sheaths is observed.
5. The trichogram is used to assess the effectiveness of various treatments, particularly during androgenetic alopecia. By repeating it after 6 months or 1 year of treatment, where treatment is effective it will show a decreased percentage of dystrophic anagen and telogen, with an increase or normalization of the anagen/telogen ratio.

The trichogram may be subject to certain criticisms: the technique of sampling and examination of different bulbs can vary from one examiner to another, and it does not allow study of the density of hair coverage, which is a fundamental criterion for the assessment of the severity of alopecia. However, the trichogram deserves a place in clinical practice to confirm and quantify hair loss.

Trichoscopy (scalp dermatoscopy)

The usefulness of trichoscopy (scalp dermoscopy) has been reported for hair loss diseases (see Chapter 3).[6,8–10] Here, characteristic trichoscopic features of common hair loss diseases are described using a DermLite II pro or Epilight eight (Figure 2.16).

Using the dermatoscope in clinical practice

The dermatoscope can provide:

- An objective check of the efficiency of a treatment to prevent hair loss (in androgenetic alopecia).
- Monitoring of the effectiveness of treatment (in progressive scarring alopecia).
- Confirmation to undertake reconstructive surgery when there has been stability for over 6 months (in stabilized scarring alopecia).

Interpretating dermatoscopy in clinical practice

A small change in the number of hairs, of about 5%, is not significant and can reflect natural changes such as a seasonal variation or the natural loss of telogen hair. In addition, a loss of more than 5% of hair may indicate either a natural worsening or a lack of efficacy in the treatment:

1. *Alopecia areata:* Characteristic trichoscopic features of alopecia areata are black dots, tapering hairs (exclamation mark hairs) (Figure 2.17), broken hairs, yellow dots, and short vellus hairs.

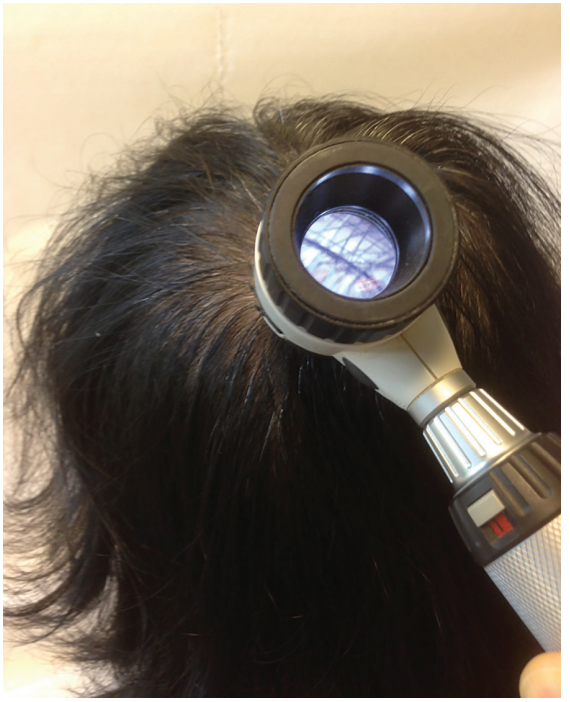


Figure 2.16 **Trichoscopy with the dermatoscope.**

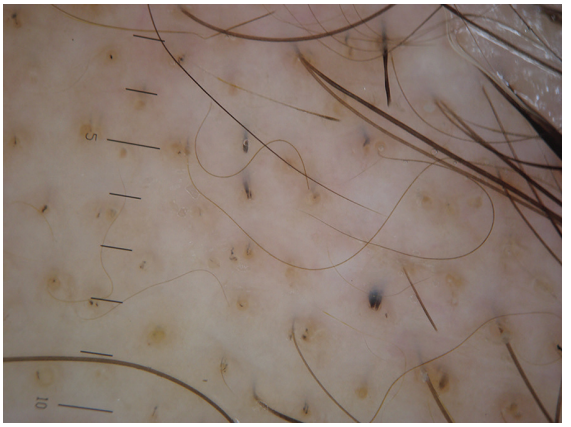


Figure 2.17 **Trichoscopy aspect of an alopecia areata. (Courtesy of Dr. Y. Bourezane.)**

Figure 2.18 **Trichoscopy aspect of an androgenetic alopecia. (Courtesy of Dr. Y. Bourezane.)**

2. *Androgenetic alopecia (AGA):* In AGA (Figure 2.18), hair diameter diversity (HDD), perifollicular pigmentation/peripilar sign, and yellow dots are observed. In all cases of AGA, HDD is more than 20%, which corresponds to vellus transformation.
3. *Telogen effluvium (Figure 2.19):* In telogen effluvium, the clinical examination may reveal the fact but dermoscopy shows <20% variability in hair diameter.
4. *Cicatricial alopecia (see Figure 2.20):* In cicatricial alopecia, the loss of orifices and the associated changes including erythema or scale and hair tufting are observed. Tosti et al. have recently reported that the follicular red dot pattern is a specific feature of active lupus erythematosus of the scalp.[11]

An algorithmic method for trichoscopic diagnosis of common hair loss disease has been recently proposed (see Figure 2.21). The algorithmic method is for trichoscopic diagnosis of common hair loss diseases featuring black dots, broken hairs, discoid lupus erythematosus, short vellus hairs, and tapering hairs.[12]

Figure 2.19 **Trichoscopy aspect of a telogen effluvium. (Courtesy of Dr. Y. Bourezane.)**

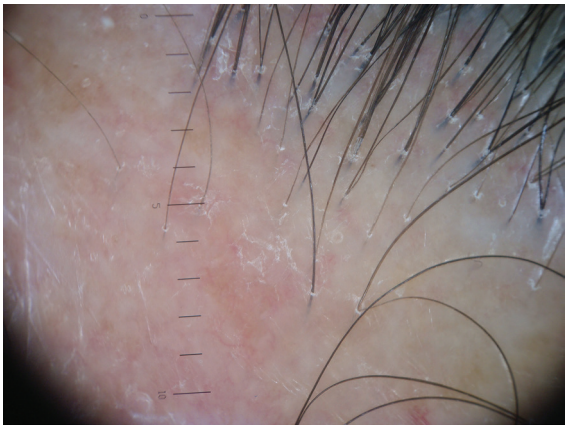


Figure 2.20 **Cicatricial alopecia due to lichen planopilaris with perpilar casts, white dots and absence of follicular openings. (Courtesy of Dr. Y. Bourezane.)**

The digital phototrichogram (DP)

The phototrichogram developed by Bouhanna in 1983 has many applications in clinical practice and in scalp surgery[13,14] (Figure 2.22a–c).

The area to be monitored is selected on the least visible site possible:

- An area of 1 cm^2 is then clipped with a minishaver and the peripheral hairs are separated by gel.
- The shaved area is then cleaned of all hair debris and all scales, using a jet of compressed air, marked by one or two semipermanent tattoos, and photographed at high magnification.
- The photographs are made under immersion—a slide of glass smooths the surface, and a drop of oil placed between the skin surface and the slide improves the contrast and sharpness of the image.
- The hair is then counted in a circular area of 7-mm diameter centered on the marker.

Software for digital image and statistical analysis is as follows[15]:

- A specially developed software program allows these parameters to be automatically measured.
- The digital phototrichogram (DP) is able to analyze the biological parameters of hair growth:
  - Hair density (n/cm^2)
  - Hair diameter (μm)
  - Hair growth rate (mm/day)
  - Anagen/telogen ratio if two photographs are done at 2–3 day interval.
- The hair area needs to be shaved, dyed, and digitally documented at a ×30 magnification.

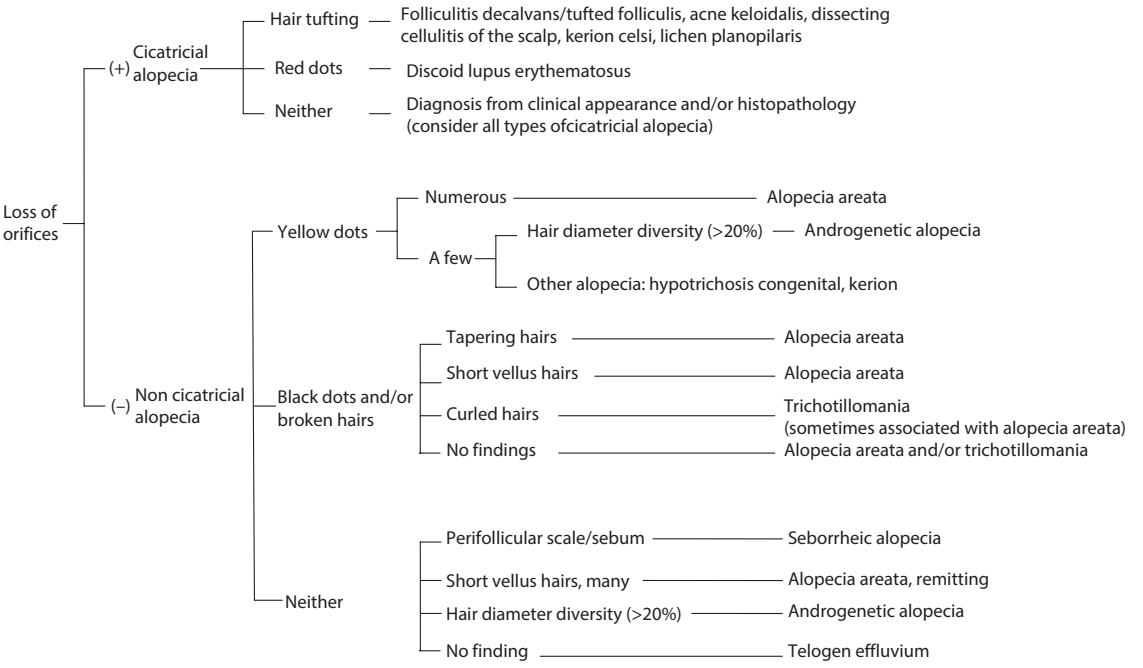


Figure 2.21 **An Algorithmic Method for Trichoscopic Diagnosis of Common Hair Loss Disease. (Adapted from Inui S. *J Dermatol*. 2011;38:71–75.)**

Figure 2.22 **Conventional phototrichogram in the 1980s with (a) the macrophotographic camera, (b) the location system, and (c) the located macrophotographic view for hair counting.**

- This procedure is painless and reproducible and allows for digital documentation.

Results

The total "hands-on" time for the digital phototrichogram operator is 15–20 minutes.

Effect of the hair dye

Analysis of white or gray hair produced only little contrast. Coloring the hairs increased hair detectability. The dye must be applied for 10 minutes.

Precision and sensitivity

Air bubbles, dust, scales, etc., are excluded. In doing so, only hairs are counted. Until now the analysis of the images has been a tedious and time-consuming process.

With the digital phototrichogram (DP), the images are taken with a video system.

The digital phototrichogram (DP) is highly validated with correlation between the same and different investigators.

The DP can be used for clinical studies for all hair colors to compare different capacities of different hair growth-promoting molecules.

The DP is able to measure significant changes in hair parameters even after 6 months of treatment (Figure 2.23). Therefore, it can be used for clinical studies for all hair to compare placebo versus active drugs or to compare different capacities of different hair growth-promoting molecules.

It can be used to evaluate AGA and diffuse hair loss and to study the effects of drugs (minoxidil, finasteride, cyproteron, spironolacton) or platelet-rich plasma treatment (Figures 2.24a–c and 2.25a and b).

It is used for the hair checkup before hair transplantation for a precise evaluation of the donor and the recipient area.

The tractiophototrichogram (TPTG)

The tractiophototrichogram is a variant of the phototrichogram.[16]

The goal is to evaluate with only one type of photography the rate of hair loss:

- An area of 1 cm^2 is located with two semipermanent tattoos. The scalp is unshaved for 3 days and is not combed before the examination.
- A pull-test is done on all the hair inside the delimited area of 1 cm^2, and the hairs are then counted.
- The same area is then clipped with a minishaver and the hairs are automatically counted in the same manner as with digital phototrichogram.

Multifactorial classification developed by Bouhanna

In contrast to existing static classifications such as the Hamilton–Norwood male androgenetic alopecia classification and the Ludwig female androgenetic alopecia classification (see Chapter 5),[17] this classification is dynamic and multifactorial. It allows the practitioner to combine measurable constants with the greatest accuracy, the better to define the medical, surgical, and cosmetic signs. It takes into account:

- The extent of bald and hairy surfaces (Figure 2.26).
- The degree of laxity of the scalp.
- The thickness of the scalp.
- The ability of the hair to cover the scalp according to the density, size, shape, length, and growth speed of the hair, as well as the color.
- The prospective evaluation of a male androgenetic alopecia according to the drawing of two axes (Figure 2.27).

This classification is useful in evaluating development of male and female androgenetic alopecia, under medical

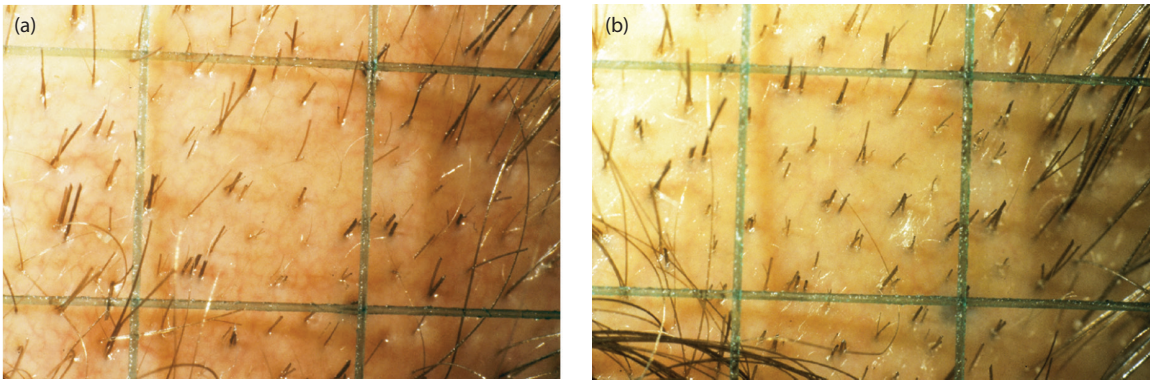


Figure 2.23 **(a) Phototrichogram of the same patient in Figure 2.6, before treatment, (b) phototrichogram of the same patient after 6 months of 2% minoxidil treatment. (The increase in the number and caliber of hair confirms with more precision the effect already visible clinically.)**

Figure 2.24 **(a) An area of 1 cm² is clipped with a minishaver and (b) the photograph is made. (c) Detail of the photograph of the area located with two red tattoos.**

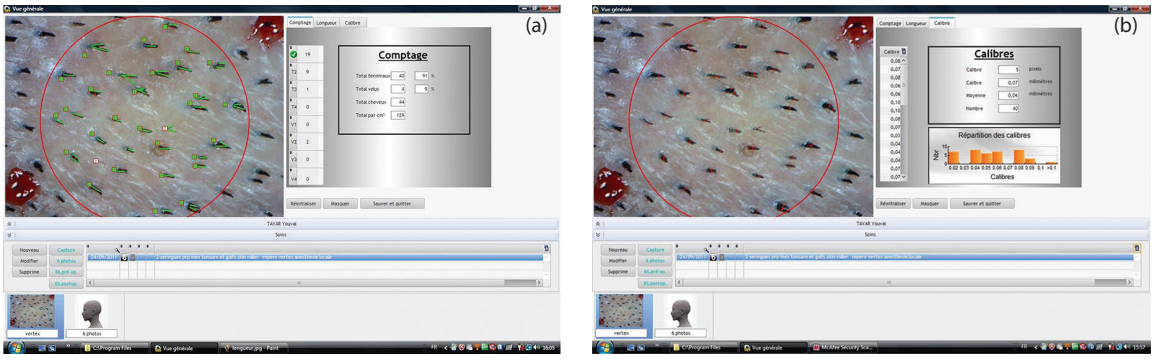


Figure 2.25 **(a) Hair density counting. (b) Hair diameter evaluation.**

treatment (minoxidil, hormones, finasteride) after hair transplantation and for the follow-up of evolutive cicatricial alopecia.

Examinations in special cases

Other tests are used to detect abnormalities of the hair or underlying pathologies for hair loss.[1]

Biopsy of the scalp

The histological study of combined vertical and transverse section is essential for the diagnosis of scarring alopecia (Figures 2.28 and 2.29).

This test will make the differential diagnosis between nonscarring alopecia (such as alopecia areata, androgenetic alopecia, diffuse alopecia etc.) and scarring alopecia

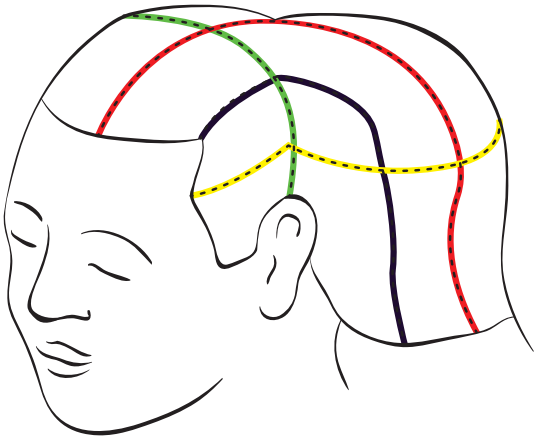


Figure 2.26 **Four fixed parameters that allow an evaluation of the extent of the bald and hairy surfaces: median sagittal distance (red); left and right paramedian sagittal distances (blue); transverse subauricular distance (green); anterior intertemporal distance (yellow).**

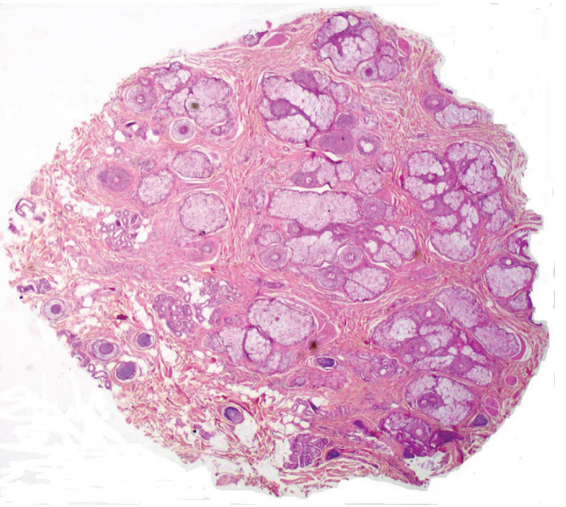


Figure 2.28 **Histological section observed under an optical microscope. (Courtesy of Dr. B. Cavelier.)**

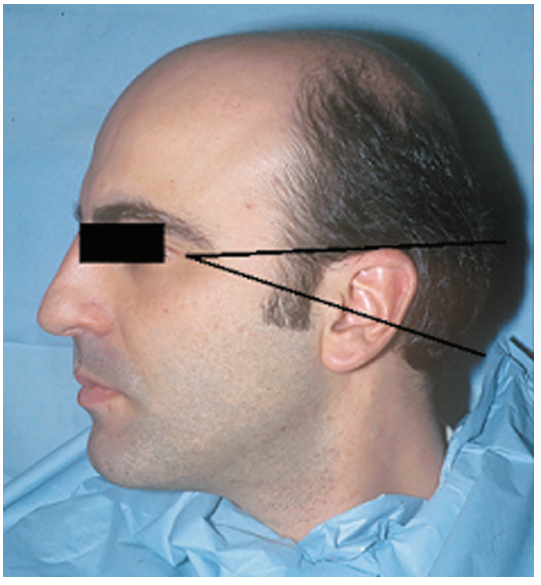


Figure 2.27 **Prospective evaluation of a maximum male baldness evolution through the drawing of two axes. (From Bouhanna P. *Dermatol Surg*, 2000;26:555–561. With permission.)**

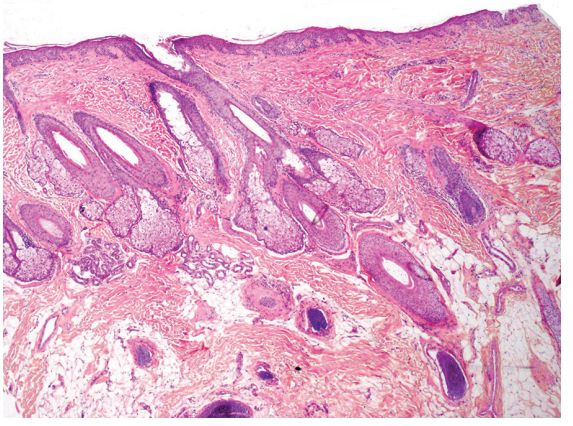


Figure 2.29 **Histological vertical section observed under an optical microscope. (Courtesy of Dr. B. Cavelier.)**

(such as peripilar fibrosis, follicular transformations, lichenoid infiltration, hair atrophy, etc.).

In males, a biopsy is hepful when the pattern is diffuse or resembles female AGA or when there are changes suggestive of cicatricial alopecia.

In females, a biopsy may be helpful when trying to exclude cicatricial alopecia, diffuse alopecia areata (cf chapter on cicatricial alopecia), and telogen effluvium (see Chapter 8).

The diagnostic specimens of choice are paired 4-mm punch biopsies from both involved (e.g., vertex or frontal) and uninvolved (usually occipital) regions of the scalp. A comparison of follicular size and number in two specimens will allow for a definitive diagnosis.

The study of horizontal (Figure 2.28) and vertical (Figure 2.29) sections of scalp allows the assessment of all follicles at several levels of the scalp.[18–20]

A biopsy will reveal a mix of hairs with various bulb depths and shaft diameters. Terminal follicles produce a hair shaft greater than 0.06 mm in diameter and thicker than the follicle's inner root sheath. Besides the

Table 2.4 Normal Scalp Horizontal Section (4-mm punch = 12.56 mm²)

	Caucasian	Afro-Caribbean	Asian
Follicular unit	12–14 (*Headington*) 8 (*Jimenez*)	8–10	5–9
Hair follicles	20–30	20	13–20

Notes: Normal microanatomy of a horizontal cut with punch 4 mm (12.56 mm 2): Each follicular unit contains 2–4 follicles, sebaceous glands, and pilosebaceous arrector muscle attached to each follicle.[18,21,22] One follicular unit/mm². Shaft diameter: vellus <0.03 mm; intermediate: 0.03–0.06 mm; terminal 0.06–0.08 mm.

narrowing of the shaft diameter and the diminished time spent lengthening, the hair becomes progressively less pigmented, appearing nearly invisible.

Histologically, follicular miniaturization can be identified by follicular bulbs present in the mid-to-deep dermis and shafts narrower than 0.06 mm. Hair shafts less than the 0.06-mm diameter of terminal hairs, but greater than the 0.03-mm diameter of vellus hairs are termed *intermediate* hairs (Table 2.4).

- *Microscopic examination of the hair shaft in polarized light*: This technique observes the hair shaft using a polarized light, turning the incident light into red, yellow, and blue monochromatic beams to give a three-dimensional image (Figure 2.30). Study of the hair shaft in polarized light is essential in the diagnosis of hair dysplasia. With examination of the distal end of the hair shaft, one can detect split hairs (trichoptilosis) in trichorrhexis nodosa (Figure 2.31) (see Chapter 4).
- *Mycological examination*: Direct examination is most commonly used to identify the offending organism with a drop of potassium hydroxide (10%–30%), cultured on Sabouraud medium (Figure 2.32). Examination with a Wood lamp is used primarily for the diagnosis of ringworm due to the characteristic fluorescence produced by the ultraviolet (UV) light on hair infected by some dermatophytes.
- *Scanning electron microscopy*: Usually electron microscopy is not necessary in clinical practice. However, it is indicated in certain abnormalities of the hair shaft, which can go undetected in optical light. Scanning electron microscopy provides three-dimensional images of the hair so that its shape and surface can be studied. This technique is very useful to confirm the diagnosis of pilar dysplasia (monilethrix, trichorrhexis nodosa, invaginated trichorrhexis, and trichonodosis), congenital hair loss syndromes, ectodermal dysplasia, and adverse reactions to cosmetic agents.

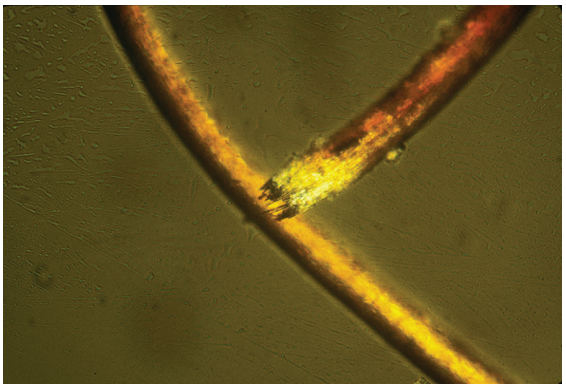
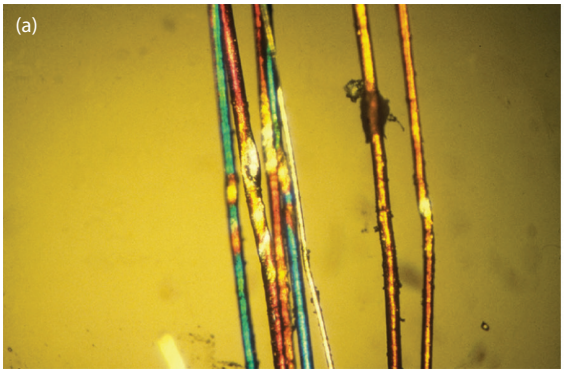


Figure 2.31 **Examination of the hair shaft under polarized light microscopy showing the split distal end of the peladic hair.**



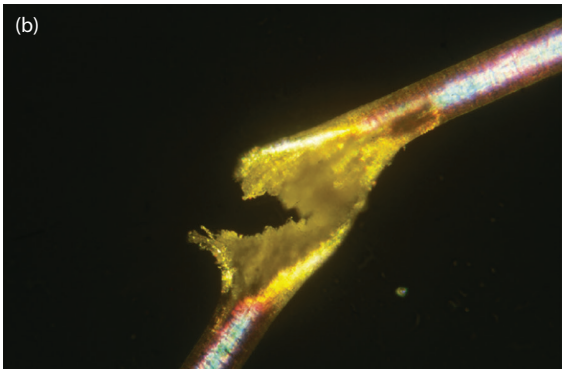


Figure 2.30 **Examination of the hair shaft under polarized light microscopy: (a) normal hair stems and (b) broken hair shaft.**

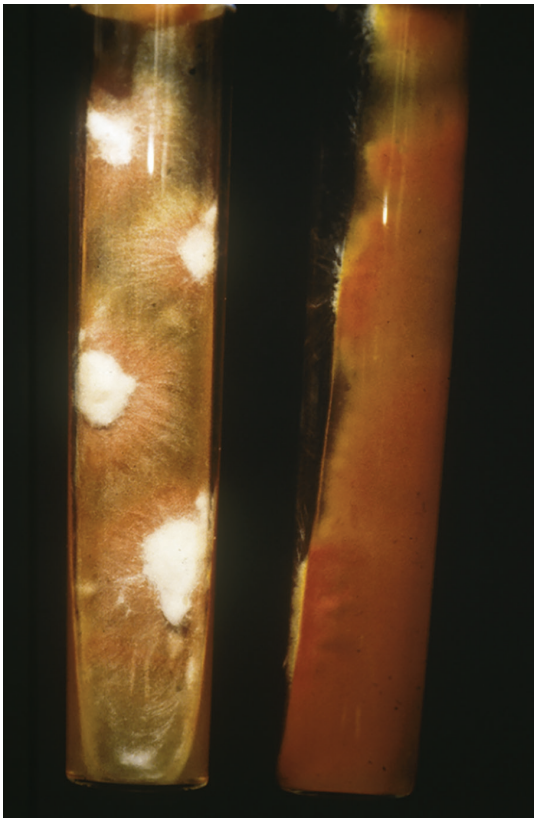


Figure 2.32 **Mycological examination by culture on Sabouraud medium.**

CONCLUSION

Hair loss is an intense psychological development generating several consultations with the hair and scalp specialist. A good clinical history, a thorough clinical examination of the scalp, and the use of different methods of exploration of the hair and scalp make it possible to establish the precise diagnosis of hair loss and eliminate the underlying causes. These different methods of testing will allow the scalp specialist to establish a medical or surgical treatment for every case of hair loss. In addition, they can be used to assess the effectiveness of medical or surgical treatment of the hair loss and the baldness.

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3 Trichoscopy

Lidia Rudnicka

INTRODUCTION

Trichoscopy is dermoscopy of hair and scalp. The method is used for differential diagnosis of hair and scalp diseases but may be also applied for evaluation of other body hair.[1] Trichoscopy may be performed with a handheld dermoscope or a digital videodermoscopy system.[2] The technique is based on analysis of structures, which may be visualized with a dermoscope. These basic structures may be divided into four major groups: (1) hair shafts, (2) hair follicle openings (dots), (3) perifollicular epidermis, and (4) blood vessels.[3]

HAIR SHAFTS

A classification of hair shaft abnormalities, which may be visualized by trichoscopy, distinguishes the following groups of hair shaft abnormalities: (1) hair shafts with fractures, (2) hair narrowings, (3) hairs with node-like structures, (4) curls and twists, (5) bands, and (4) short hairs.[4]

HAIR FOLLICLE OPENINGS (DOTS)

"Dots" is a common trichoscopy term for hair follicle openings.[5] Black dots represent pigmented hairs broken or destroyed at scalp level.[5] Yellow dots are hair follicle openings that contain keratosebaceous material.[5,6] There are two types of white dots: the fibrotic white dots and the pinpoint white dots. The fibrotic white dots represent areas of perifollicular fibrosis and are observed most commonly in lichen planopilaris.[3,7] Pinpoint white dots correspond to hair follicle openings and eccrine gland openings, observed within pigmented background. They are present in patients with dark skin phototypes, regardless of hair loss.[8,9] Red dots were described in discoid lupus erythematosus and are considered a good prognostic finding, indicating possible hair regrowth.[10] It has also been shown that empty hair follicles may appear as red dots in patients with pigmentary disorders such as vitiligo.[11] Regularly distributed gray or brown-gray dots are a characteristic finding in the eyebrow area of patients with frontal fibrosing alopecia.[12]

PERIFOLLICULAR EPIDERMIS

Abnormalities of scalp skin color or structure that may be visualized by trichoscopy include scaling, changes in color, abnormalities in skin surface structure, and the presence of discharge. A classification of these abnormalities has been established recently.[13] Briefly, this classification is based on observation of scaling (diffuse or perifollicular), the color of the evaluated scalp area (brown, white, pink, yellow, red, and violaceous-blue) and discharge (yellow, white, or red), and skin surface structure abnormalities.[13]

BLOOD VESSELS

The appearance of cutaneous microvessels in trichoscopy may vary in type, arrangement, and number depending on disease. Analysis of blood vessel arrangement is of special importance in differential diagnosis of inflammatory scalp diseases such as scalp psoriasis, seborrheic dermatitis, or discoid lupus erythematosus.[2,12] Some authors indicate that the arrangement of blood vessels in trichoscopy may be indicative of systemic diseases, such as systemic lupus erythematosus, systemic sclerosis, or cutaneous T-cell lymphoma.[10]

TELOGEN EFFLUVIUM

Trichoscopy findings in telogen effluvium (Figure 3.1) include the presence of empty hair follicles, predominance of follicular units with only one hair, perifollicular discoloration (peripilar sign), and upright regrowing hairs. Trichoscopy results do not differ depending on the factor that induced telogen hair loss.[10]

ANDROGENETIC ALOPECIA

Male androgenetic alopecia and female androgenetic alopecia (Figure 3.2) share similar trichoscopy features.

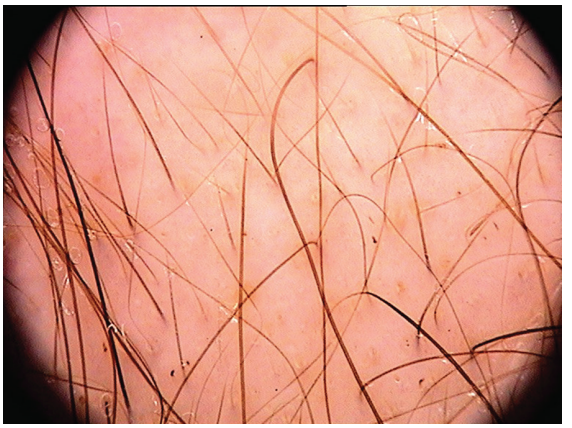

Figure 3.1 **Telogen effluvium. Multiple short regrowing hairs indicate a regrowth phase of telogen effluvium.**

Figure 3.2 **Female androgenetic alopecia. Concomitant presence of thick, intermediate, and thin hair shafts is called hair shaft thickness heterogeneity. This is a trichoscopy manifestation of nonsimultaneous hair miniaturization.**

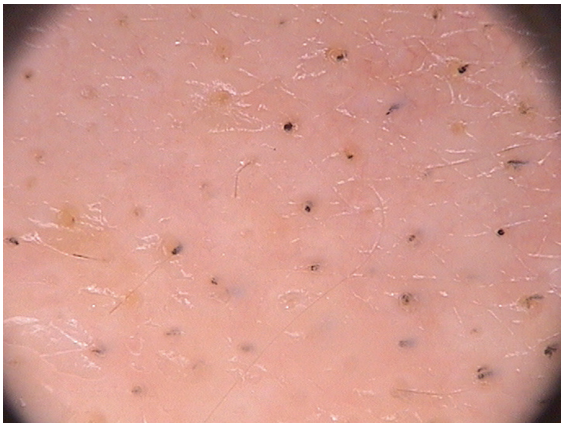

Figure 3.3 **Alopecia areata. Concomitant presence of regularly distributed yellow dots and black dots. The black dots reflect an active phase of disease.**

Hair shaft thickness heterogeneity, with simultaneous presence of thin, intermediate, and thick hairs, is the most characteristic feature of androgenetic alopecia. It has been shown that hair diameter diversity reflects follicle miniaturization in androgenetic alopecia.[14,15] Precise evaluation of hair shaft thickness in micrometers is not essential for clinical diagnosis but may be useful for monitoring treatment efficacy[16] and is indispensable for clinical trials.[10] Another trichoscopy feature of androgenetic alopecia is increased proportion of vellus hairs. The number of hairs in one follicular unit is decreased in androgenetic alopecia. Follicular units with only one hair predominate in these patients, especially in the frontal area.[17–19] The presence of yellow dots is a constant finding in androgenetic alopecia. These yellow dots mark mainly empty hair follicles with sebum.[17] These sebaceous yellow dots may be washed away by a vigorous hair wash. Thus, patients should not wash their hair directly preceding a trichoscopy examination. Brown perifollicular discoloration (peripilar sign)[20] is observed in 20%–66% of patients with androgenetic alopecia.[15,17] A proportion of about 30% of hair follicle openings is usually affected.[15,17]

Trichoscopy of senescent (senile, involutionary) alopecia shares with androgenetic alopecia a predominance of follicular units with only one hair, decreased hair shaft density with a honeycomb pattern pigmentation, and slight tendency to form brown perifollicular discoloration (peripilar sign).[12]

ALOPECIA AREATA

The most common trichoscopy features of alopecia areata (Figure 3.3) are regularly distributed yellow dots, exclamation mark hairs, tapered hairs, and black dots. Trichoscopy of alopecia areata may differ depending on disease activity, severity, and duration.[21] Lacarrubba et al.[6] identifi d three features of acute alopecia areata: micro-exclamation marks, black dots, and vellus hairs. Inui et al.[22] identifi d similar markers of disease activity (black dots, tapering hairs, and broken hairs) in another study. The experience of my team[3,23] shows that black dots and exclamation mark hairs are a constant marker of disease activity in alopecia areata.

Pohl-Pinkus constrictions and monilethrix-like hairs are observed in less than 5% of patients with alopecia areata.[24,25]

TRICHOTILLOMANIA

Trichotillomania (Figure 3.4) is a common and difficult differential diagnosis of alopecia areata.[26] Trichoscopy of

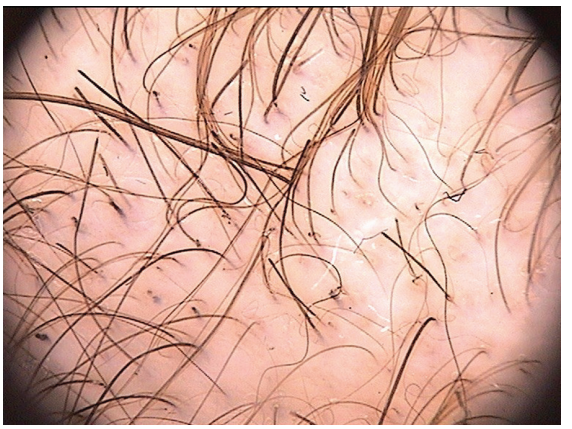

Figure 3.4 **Trichotillomania. The simultaneous presence of multiple hairs broken at different lengths (in the absence of exclamation mark hairs) may be indicative of trichotillomania.**