

# A Comprehensive Review on Trichogram and Trichoscopy in Dermatology

FARZAN MOODI<sup>1</sup>, ELHAM BEHRANGI<sup>2</sup>, MASOUMEH ROOHANINASAB<sup>2</sup>, AFSANEH SADEGHZADEH-BAZARGAN<sup>2</sup>, SEPEHR KHOSRAVI<sup>3,4\*</sup>, AZADEH GOODARZI<sup>2</sup>

<sup>1</sup>MD, School of Medicine, Iran University of Medical Sciences, Tehran, Iran

<sup>2</sup>MD, Department of Dermatology, Rasool Akram Medical Complex, Iran University of Medical Sciences, Tehran, Iran

<sup>3</sup>MD, Student Research Center, School of Medicine, Iran University of Medical Sciences, Tehran, Iran,

<sup>4</sup>MD, Universal Scientific Education and Research Network (USERN), Tehran, Iran

Correspondence to: \*Azadeh Goodarzi, MD, Associate Professor, Address: Department of Dermatology, Rasool Akram Medical Complex, Niayesh Street, Sattarkhan Avenue, Tehran, Iran, ORCID ID: 0000-0002-1249-4429, Mob: +989123882448; Email: [goodarzi.a@iums.ac.ir](mailto:goodarzi.a@iums.ac.ir) & [azadeh\\_goodarzi1984@yahoo.com](mailto:azadeh_goodarzi1984@yahoo.com),

Postal code: 1445613131; Phone number: 02166514001

## ABSTRACT

**Background:** We reviewed the literatures focusing on trichogram and comparing it with other newly introduced trichologic diagnostic methods (to be specific trichoscopy).

**Methods:** This is a narrative review. We searched PubMed, Scopus, EMBASE and the Web of Science for most relevant and English publications using the terms 'trichogram' or 'phototrichogram' or 'trichoscan' or 'unit area trichogram' or 'trichoscopy'. The results were then screened by two independent reviewers and discrepancies was reviewed by another author. The text and data related to these terms were then selected out of each included study and discussed with all authors for inclusion in this study.

**Results:** There are many hair disorders with diagnostic clues of trichogram such as Alopecia areata, Androgenic alopecia, Anagen effluvium, Telogen effluvium, Trichotillomania, Pemphigus, Psoriasis, and Loose anagen syndrome. Trichoscopy have become a widely used non-invasive practical diagnostic tool for evaluation of many immune-mediated or non-immune mediated dermatologic disorders with involvement of hair. Trichoscopy is also commonly used for following up and evaluating the therapeutic responses in affected hair-bearing area.

**Conclusion:** Trichogram is a valuable diagnostic method for complicated hair disorders but the trend is toward less aggressive and more sensitive informative methods like trichoscopy and trichoscan.

**Key words:** Trichogram, Trichoscopy, Phototrichogram, Trichoscan, Unit Area Trichogram, Dermatoscopy, Dermoscopy, Hair, Alopecia, Scalp, Diagnoses

## INTRODUCTION

Most common hair and scalp disorders could be diagnosed by clinical features and physical examination. However, when diagnosis is not straightforward appropriate therapeutic or prognostic approaches could be of serious importance.[1-3] Trichogram has been found of help in situation with facing difficulties in making the diagnosis.[1-5]

Methods of hair evaluation divides into 3 major groups:[1-3] first is non-invasive including history, physical and laboratory examination, Pull test (+: >10% of grasped hair, lower than it considered as physiologic shedding, global hair count, trichoscopy[2, 3, 6-8] and phototrichogram[2, 3, 9-12] (modified form of trichogram which follows one small area of affected scalp in total or during treatment, counts hairs and anagen/telogen ratio (A/T ratio), also compares A/T ratio and growth rate of different scalp regions (frontal, temporal, parietal and occipital) (manual or digital (trichoscan)). Second is semi-invasive methods such as unit area trichogram[13] and trichogram (evaluating hair root, hair shaft diameter and abnormalities, A/T ratio, hair growth rate, monitoring response to treatment and interpreted based on hair cycle). Lastly is invasive methods such as biopsy (usually in two 4 mm punches for horizontal and vertical sections; which assess rapid counting of hair follicle, hair grouping, hair diameter and hair morphology in horizontal samples and inflammatory process also type of cells and alopecia in

vertical ones), are another ways for further hair assessment.

Trichogram is a simple, semi invasive, rapid and economic way to assess hair follicle activity, it examines hair shaft in proximal end (root) especially Anagen/Telogen ratio (A/T ratio) (Normal hair cycle includes, anagen 89% (66-99%), telogen 10% (2-18%) and catagen 1% (0-6%) hairs. Anagen phase could last for years depending on individual genetic characteristics and hair location, telogen phase could last about weeks-months in acute form and months to years in chronic form, and also catagen last for weeks [2, 3] and also distal end (tip).

It is a complementary method for hair evaluation accompanying with clinic, other diagnostic and physical examinations. It could be also used as a method to monitor treatment responsibility. Its results depend on sampling area, previous washing and brushing and seasonal variations. Technique of trichogram varies by its aim of assessment. First with a Kocher rubber-sheathed forceps a tuft of 15-20 units is plucks.[1, 2]

Recently trichogram and trichoscopy has been proposed for further evaluation of specific dermatologic disorders like pemphigus[14] and psoriasis[15, 16] also their characteristic features in hair disorders are of diagnostic value.[2, 7]

Trichogram is an objective diagnostic, prognostic and monitoring method implemented for approaching various types of hair problems [1-3, 5, 17]; however—with regard to the interpretation—characteristics of normal trichogram

also seasonal variations and differences, based on age, gender, geographic and racial properties, should be considered.[4]

Studies on various demographic, epidemiologic and clinicopathologic aspects of trichogram in normal population and in patients with different hair and scalp disorders could be of great value. We reviewed the literatures focusing on trichogram also comparing it with other more newly introduced trichologicdiagnostic methods.

## METHODS AND MATERIALS

**Search Strategy and Study Selection:** We searched PubMed, Scopus, EMBASE and the Web of Science up to October of 2020 for English publications using the terms 'trichogram' or 'phototrighogram' or 'trichoscan' or 'unit area trichogram' or 'trichoscopy' and finally reviewed studies with different designs regarding these entries. The results of this query were entered into the endnote X6 and sent to two independent reviewers.

**Inclusion and exclusion criteria:** This study includes RCTs, Cohorts, Prospective and Retrospective Studies that met these Inclusion criteria: 1. Have used trichogram or phototrighogram or trichoscan or unit area trichogram or trichoscopy as modality for diagnosis or follow up of any hair disorders

The exclusion criteria were: 1) case report and case series on less than 10 patients, 3) animal studies, 4) reports written in the languages other than English and 5) studies which only the abstract was available.

**Data Extraction:** We collected the data of studies, worked on a special diagnostic method in different types of hair disorders, and compared these diagnostic methods with conventional trichogram.

Two review authors, review search results according to their titles and abstracts in order to identify eligible studies. Two review authors have been found the full text of eligible studies and then they have been reviewed for any exclusion criteria. Any potential discrepancy regarding the eligibility of studies will be resolved through discussion meetings and by the decision of a third review author. Two review authors were independently proceeded the data extraction from included studies and data and texted gathered from included studies is then discussed in session with presence of all authors for writing the final version of included data presented in this study.

## RESULTS AND DISCUSSION

About 17.5% of dermatologic consultations are due to hair loss. [1] Various hair disorders requires different approaches [10] while proper diagnosis is not always straightforward which complicates therapeutic approaches. For instance we know that Female Pattern Hair Loss (FPHL) is the most prevalent cause of hair loss among adult women and in case of diffuse hair loss (telogen effluvium (T/E), chronic telogen effluvium [18], FPHL, and diffuse alopecia areata), T/E is the most prevalent, however, sometimes it is difficult to differentiate between CTE and FPHL.[2, 3, 10] Trichogram could be helpful in such cases.[1-3]

**Trichogram:** In evaluation of proximal end of hair shaft (root), central interparietal areas are most suitable for androgenic alopecia of males, also temporal and occipital

regions if secondary samples is needed could be used. In FPHL central and vertex of scalp is usually the choice for sampling. In any type of telogen effluvium and in scaring alopecia, sampling area selected retrospectively as central interparietal area or advancing border of alopecic patch. Forceps located in an area of scalp sized 1-2 cm<sup>2</sup> and plucks hair firmly and rapidly. Hair should be plucked firmly to avoid dystrophic hairs with frayed or broken roots as a result (especially in patients with short hair). In order to prepare sample for microscopic examination, parallel hairs should be located in a glass slide with aligned root and fixed by a clear adhesive tape. To avoid adhesive tape related artifact, adding few drops of balsam and coverage with Cover Slip could be done. Using polarized light enhances the quality of microscopic examination. In the cases of dystrophic hairs, which necessitate further detailed evaluation, scissors should be used to cut hairs in the level of scalp and then put them in a long glass slide. In the case of distal hair shaft examination, in long hairs, cutting them near to distal end and in the short ones plucking with an epilating forcepsis needed.

The aim of proximal hair shaft examination is to determine anagen, telogen, catagen, dystrophic and normal hairs. Anagen hairs usually are long, with uniform diameter and rectangular shape, slight distal end angle <20°, intense pigmentation of bulb and covered by sheaths and membranes. Telogen hairs are shorter and have higher roots compared to anagen roots; their root is club shape without any distal angle, absent or weak pigmentation of bulb and sheath is absent. Dystrophic hairs have tapering diameter like exclamation mark, irregular contour, distal angle >20° and without any sheath. Catagen hairs in trichogram are usually rare. Anagen/telogen ratio decreases during age (95%/5% in children, 83%/15% in adult male and 83%/11% in adult female). Therefore, trichogram depends on gender to a degree. Anagen/Telogen ratio >7/1 indicates normal, more than >20% telogen hairs indicates telogen effluvium and and >3/1 is considered in favor of androgenic alopecia like FPHL.[1]

Dystrophic hairs usually are related to improperly removed hairs under traction; also it is a common trichogram finding in androgenic alopecia. Keratin materials in the tip of hairs could be in favor of seborrheic dermatitis, psoriasis and folliculitis, and demodex in hair root is common in demodosis. In hair shaft examination uniformity, external damages like cosmetics (however scanning electron microscopy is the choice method) and substance depositions are evaluated. There are many specific signs in trichogram related to specific hair shaft abnormalities such as Monilethrix (beaded hair), Pseudomonilethrix, Pili torti, Trichorrhexis invaginata (bamboo hair), Trichothiodystrophic hair, Trichonodosis, Trichorrhexis nodosa, Bubble hair, Loose anagen hair, Pili annulati, Woolly hair and uncombable hair (pili canaliculi).[1]

Dystrophic hairs are the common trichogram findings of androgenic alopecia and usually are related to climate change and stress.

In distal end examination of hair shaft, after scissoring, there are 3 types of tips: Javelin tip (a sharp end without any cutting); paint brush tip (fracture of hair shaft

like Monilethrix; Alopecia Areata, and due to cosmetics); and clean-cut tip (cutting end like Trichotillomania).

Briefly, in alopecia areata there are narrowing and normal parts in hair shaft with paintbrush tip. In very narrow parts transverse fraction, pseudomonilethrix and trichoschisis could be occurred.

In male or female androgenic alopecia different diameters of hair shafts, progressive shortening of hairs, dystrophic hairs and increased telogen hair proportion, are diagnostic features.

In Anagen effluvium, there is an increased anagen shedding (golf club hairs) and in telogen effluvium, telogen hairs >20% (club hairs) and shorter hairs with uniform diameters.

In Trichotillomania, the proximal end of hair (root), which could be anagen or telogen, is normal. Middle hair shaft has variable structure based on disease or patient who has been treated, and distal end shows clear cut tip. There are many trichogram studies on normal population based on demographic properties and various disorders, like:

- Normal population: Normal trichogram has been evaluated to be used as a comparison to various disorders. There are studies which show different location of scalp hairs includes normal variation in density and thickness.[9]
- Alopecia Areata: In scalp alopecia areata, normal trichogram of alopecic and control non-alopecic patch indicates 80% and 85% good hair re-growth result after 1 year, respectively, but abnormal trichogram of alopecic and control non-alopecic patch predicts 62.5% and 19% of good hair re-growth result, respectively. Normal trichogram of control non-alopecic patch is properly indicative of desirable prognosis.[5]
- Pemphigus: Changes of trichogram observed as easily plucked anagen hairs without resistance with non-dystrophic and intact anagen root sheath. There are normal proportion of telogen hairs, since in early pemphigus we have early telogen hair loss and logically low proportion of telogens in established cases. Other than easily plucked hair areas; dystrophic hairs could exist in involved, uninvolved and even in the controls. Normal anagen effluvium considered as positive Nikolsky sign in scalp, due to acantholysis progression to outer root sheath of hair.[14]
- Psoriasis: In scalp psoriasis, large increase of dystrophic hairs and low increase in telogen hairs could be observed in regard to non-alopecic involved regions, without any evident effluvium or any relationship with gender, age, severity or duration.[16]
- Androgenic alopecia including FPHL : [2, 3] FPHL is not always easy to diagnosis clinically which necessitates future evaluation. Generally, approach to FPHL consists of taking appropriate history (general and gynecologic), physical examination (inspection: hair color, pattern and distribution of hair loss, hair density, estimate terminal/velus hair ratio, scoring like Ludwig or Olsen scale, palpation: assess Jacquet's and Sabouraud's sign, pull test: evaluating telogen or anagen effluvium, microscopic exam of root end,

ongoing activity and severity of hair loss, laboratory examination (CBC, Diff, Serum Ferritin, TIBC, Thyroid Function Tests, hormonal tests, etc based on history and physical exam), and sometimes further instrument aids assessments such as wash test (Robora), hair growth window, trichoscan, sebumetry and trichoscopy. (>20% diversity of hair shafts but unlike alopecia areata, there is uniform miniaturization. Based on definition many major and minor diagnostic criteria have been proposed. Practical use of trichogram in FPHL for ruling out anagen dysplastic effluvium or loose anagen syndrome and also early diagnosis of inhomogeneous hair shafts could be used.

\* Jacquet's sign: considered positive if there is absence of hair follicle in folds of hair loss area, in favor of androgenic alopecia.

\* Sabouraud's sign: after plucking of hair for trichogram, we can evaluate resistance to traction. Positive values are in favor of hair shaft changes and hair damage due to exogenous agents.

\* Robora test (wash test): after washing and hair brushing, we can assess hair loss considering root state and hair diameter: 1->200 hair and >3 cm in length, which is in favor of telogen effluvium (anagen is shorter than normal); 2->10% miniaturization in hairs >3 cm in length, which is in favor of androgenic alopecia (anagen progressively shorts); 3- Hair dominantly >5 cm in length which is in favor of anagen effluvium.

\* Hair growth window: hair growth rate evaluation in a marked area.

More than 20% diversity of the hair shaft diameter in trichoscopy is in favor of FPHL, without any attention to degree of diversity, trichoscopy is more sensitive than trichogram. (72% vs. 62%)

- Seasonal: Based on cyclical growth pattern of hairs, increasing of telogen hairs and decreasing anagens have been shown in summer (vice versa in winter), which trichogram also confirms.[4]

- Loose anagen syndrome: Diagnosed clinically by easily and painlessly pulled anagen hairs from the scalp, trichogram shows ruffled proximal cuticle, hair root sheath absence and bent matrix. It results from abnormal cornification of the inner root sheath.[17]

Trichogram could be one of therapeutic follow up tools in dermatologic trials.[19]

Also there are many studies on other more newly emerged hair diagnostic method and comparing them with trichogram:

**Phototrichogram (Tricoscan):** Phototrichogram of women's androgenic alopecia shows lower hair density in mid-scalp than the occipital (vice versa in controls).[10]

Phototrichogram of normal people shows different distribution pattern, hair density, hair thickness and white hair percentage in the various areas of scalp. Aging hair pattern is different based on gender. Hair thickness tends to increase by 20 years of age, fixed between 20 and 50 years of age and decreases after 6<sup>th</sup> decade. White hair percentage increases significantly after 40 years of age.[9]

Trichoscan is of high value in differentiating androgenic alopecia and telogen effluvium.[11]

Most prevalent phototrichogram pattern of Japanese women with chronic hair loss, who mostly had clinical features of the androgenic alopecia, was hair density decrease but there were no changes in vellus hairs. For the hair pattern analysis and detection of little changes of hair shaft (especially in early phases of hair loss), it is beneficial to combine phototrichogram and a tool of hair diameter assessment.[12]

One of the valuable indexes for early screening, diagnosis and follow up of scalp psoriasis is Videodermoscopy Scalp Psoriasis Severity Index (VSCAPSI).[15]

Trichoscopy is a validated useful method for follow up and analysis of hair growth or re-growth in trials. It has the best results of hair growth assessment among other optical methods. There are many articles regarding its practical use in various types of alopecia in males and females like FPHL and psoriasis. Some studies believe that it may have some pitfalls in clinical practice especially in the case of telogen effluvium.[20, 21]

**Unit area trichogram:** Unit area trichogram is a qualitative method of hair assessment but not practical in large areas and large scale studies. Invasive nature of the trichogram and unit area trichogram (qualitative methods of hair assessment) makes them unpractical in large areas and large-scale studies; all means the superiority of phototrichogram. It should be notified that in a small area, similar reports of anagen and non-vellus hairs with both unit area trichogram, in phototrichogram, hair diameter results are unreliable, light hairs evaluation is harder and total hairs underscores, so it is not an appropriate method for Caucasian.[22]

Diagnosis of androgenic alopecia in women is more difficult than men. For reliable trichogram result at least 50 hairs is necessary. For trichogram, hairs should not be washed since few days earlier which makes it somehow difficult. Also due to operator-independency, lack of probable damage to hair roots and being non-invasive, phototrichogram is more reliable, sensitive and simpler method compared to trichogram.

Unit area trichogram is a technique of androgen dependent alopecia assessment, which shows the number of hairs >40 micrometer per cm<sup>2</sup> related to clinical appearance.[13]

**Trichoscopy:** Trichoscopy is a method to evaluate hair disorder and predict disease course. It could be also implemented for disease follow up and response to treatment, which is equivalent to dermoscopy of the skin, with using x200 magnification and polarized light, with many diagnostic characteristics related to each entity.[3, 8]

Among paraclinical diagnostic methods of hair disorder evaluation, trichoscopy have been shown to be more popular and successful especially in recent years.[23-31]

Kibar M et al studies demonstrated that trichoscopy could be a valuable method in diagnosis of scalp psoriasis and seborrheic dermatitis as well as other forms of non-cicatricial alopecias regarding 3 dermoscopic patterns, including HH (hidden hairs), SRV (signet ring vessels) and CV (comma vessels). In addition, they showed that there are new additional trichoscopic characteristics of alopecia areata, which helps, in better diagnosis and assessment of

the disease severity and activity. They showed that there is not any relationship between male or female pattern hair loss severity and trichoscopic findings.[25, 26]

Trichoscopy would be useful for the rapid diagnosis of tinea capitis and alopecia areata. Trichoscopy also would be able to differentiate between early androgenic alopecia and telogen effluvium, cicatricial and non-cicatricial alopecia as well as scalp psoriasis and seborrheic dermatitis. Trichoscopy-assisted hair disorder diagnosis could prevent unnecessary biopsies or determine the best site for biopsy, and it could be a desirable monitoring method for therapeutic response.[25, 28, 31]

There are many disorders with diagnostic trichoscopic or dermoscopic pattern in dermatology that necessitates more focus on these practical entities. Some of these diagnostic trichoscopic clues are specific and exclusive signs like in tinea capitis (corkscrew hairs, broken and dystrophic hairs, comma and black dot hairs), alopecia areata (exclamation mark hairs, yellow dot and vellus hairs) or active lupus erythematosus (follicular red dot pattern).[23, 24, 27]

Videocapillaroscopy could be a good non-invasive diagnostic method for differentiating psoriasis and seborrheic dermatitis of the scalp. In most of the genetic and congenital hair shaft disorder, trichoscopy could be a worthwhile diagnostic method.[29, 30]

There are many racial differences in trichoscopic studies that should be considered in interpreting the study results.[29] Trichoscopy seems to be better than trichogram in diagnosis or following up FPHL.[2, 3]

Moreover, trichoscopy could be a valuable method for finding differential diagnosis, treatment planning and following up of some patients (especially children), with disorders of the hair shaft or scalp and any reasons such as infectious, acquired or congenital. There are many diagnostic clues for various entities, for example, Exclamation marks (alopecia areata, trichotillomania and chemotherapy induced), Pohl-Pinkus constrictions (alopecia areata, chemotherapy induced, blood loss and malnutrition), Comma and Corkscrew hairs, Flame hairs (trichotillomania) and Tulip hairs (trichotillomania, alopecia areata). Hair dysplasia is usually due to hair shaft abnormalities either genetically-congenitally or acquired-exogenous, which could be changing in color, length, density or structure of shaft. It should be notified that exact examination of nail, teeth, sweat and sebaceous glands are necessary when approaching hair shaft disorders.[6]

Trichoscopy of many congenital hair shaft abnormalities are characteristic like Netherton syndrome, monilethrix, woolly hair syndrome, pili torti and pili annulati; so in these cases, trichoscopy could be a valuable alternative of more invasive methods requiring hair plucking.[7]

Since trichoscopy is a precise non invasive hair assessment tool, its use and technical accuracy are rapidly growing during time. It is a practical diagnostic, evaluative and prognostic tool in a wide variety of hair disorders as hair shaft abnormalities, genodermatotic with hair involvement, immune mediated (T cell mediated or auto-antibody induced) inflammatory cicatricial or non-cicatricial hair disorder or alopecia, non immune mediated hair or scalp disorders like androgenic alopecia, seborrheic dermatitis,

trichotillomania, traction alopecia, psoriasis, pseudonits, casts, infectious disorders like tinea capitis or tinea of hair bearing area, pediculosis and even neoplastic disorder.[32-45]Trichoscopy is especially a very useful non-invasive evaluation for children with hair disorders.[43, 46]There are also many promising technical improvements in this regard.[47, 48]

Trichoscopic findings are among most recent hot topics regarding to approach many hair disorders including scarring and non-scarring alopecia[49, 51], and there are many facts and experiences yet to be reached in future toward better understanding and use of these diagnostic clues.

## CONCLUSION

In conclusion, although trichogram is a valuable diagnostic method for approaching complicated cases of hair disorder, it seems that the trend is toward less aggressive and more sensitive methods like trichoscan (digital phototrichogram) and trichoscopy.

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