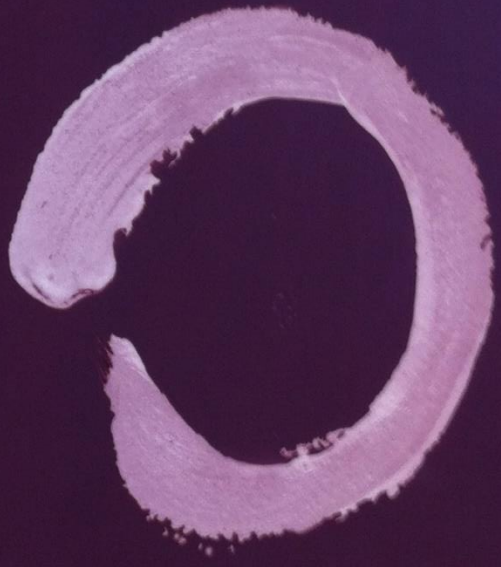
Volume 3

HAIR TRANSPLANT 360

ADVANCES, TECHNIQUES, BUSINESS DEVELOPMENT & GLOBAL PERSPECTIVES



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JAYPEE BROTHERS MEDICAL PUBLISHERS (P) LTD

New Delhi • London • Philadelphia • Panama

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46 The TrichoScan for Patient Selection

Jerzy Kolasinski, Kinga Jach-Skrzypczak

INTRODUCTION

While selecting patients for autogenous hair transplant the surgeon must be absolutely certain that the suggested therapy will prove successful. Beside obvious parameters, qualifying the patient for the procedure such as general health, emotional stability, and realistic expectations, the key element is adequate evaluation of the hair both in the donor and recipient areas. In examination of the recipient (balding) area the surgeon should correctly diagnose the cause for hair loss, condition of the scalp, and anticipated balding in the future. Crucially important is analysis of the scalp quality, hair growth parameters, and planned magnitude of the area in terms of its potential to yield adequate quantities of follicular units in order to meet the requirements of a planned reconstructive procedure. The person to make the ultimate decision about surgical treatment is the surgeon, as he is held responsible for the correct execution of transplantation of follicular units so that its effect is satisfactory for the patient. To achieve this goal, the surgeon must rely on his clinical experience, additionally supported by objective parameters of scalp examination. One of the latest tests developed to provide a number of objective data about scalp condition is the TrichoScan.

The process of hair loss at various stages of alopecia is reflected in changes of hair count in the scalp. An increased rate of shedding is observed in cases of loss of telogen hairs (telogen effluvium), loss of broken hairs (anagen effluvium) and loss of whole anagen hairs (anagen effluvium proper).[1] Apart from that, the balding process may be expressed as disturbances in hair quality [androgenetic alopecia (AGA)]. Additionally, changes in hair quality and hair count occur alternatively and are usually progressively correlated to the degree of the balding process. Hair loss may occur in various areas of the head depending on the type of alopecia. Also, hair loss is frequently accompanied by scalp pathologies; or just as frequently, pathological processes at various levels in the scalp skin may be its primary cause, bringing about changed structure, quality, or number of hairs.

The most frequently occurring condition is folliculitis, usually caused by *Staphylococcus aureus*, or less frequently by other microorganisms. Initially, the inflammation involves the ostium of the hair follicle—*ostiofollicullitis*, in the next phase it attacks the entire hair follicle—*follicullitis*, and then its surroundings—*perifolliculitis*. Primary eruptions are small individual or multiple inflamed papulae, transformed into conical pustules based on erythema, punctured by hair. In certain cases scarring may appear, especially when lesions involve deeper skin layers damaging follicles like in the case of lupoid sycosis. Frequently the crater-like defect heals, leaving a small atrophic scar, which irreversibly damages the follicle. Most types of mycoses situated in the scalp are caused by dermatophytes of the *Microsporum* species and appear as large single spots devoid of hairs, which are usually broken at identical height just above the skin surface, surrounded by gray sheaths. The surface of the lesions does not usually show any signs of inflammation although sometimes distinct erythema may appear. Small, flaky (furfuraceous) exfoliation may occur in infected areas resulting in deformation of growing hair.

Dandruff and psoriasis are conditions of the upper skin layers, also quite frequently occurring but not resulting in direct deformation of hair structure in its growth phase.

Hair growth parameters most frequently studied include the following:

- *Evaluation of anagen hair count*: Hair formed in the active growth stage lasting 2–7 years, characterized by a continuous hair growth by 1 cm per month on average
- *Evaluation of telogen hairs*: Nongrowing hair in resting phase which usually lasts 3 months
- *Evaluation of terminal hair*: Hair of usually over 40 μm in thickness that contributes to the overall coverage of the scalp skin. This hair is usually in anagen and telogen phases
- *Evaluation of small diameter hair*: Hair of usually below 40 μm in thickness, contributing only to a small degree to overall coverage of the scalp. They are miniaturized and vellus hair.

Thus, scalp-skin condition, hair-density evaluation, and determination of percentages of individual-hair types is of fundamental importance at all the stages of medical treatment such as the following:

- Correct diagnosis of the alopecia process
- Correct patient selection for either conservative or surgical treatment
- Precise monitoring of the effects of the treatment applied
- Comparative evaluation of various therapeutic methods.

So far the most frequently used methods of scalp evaluation have been as follows:

- Noninvasive methods such as visual evaluation—macroscopic test,[2,3] evaluation with a microcamera and visual analysis of magnified images—phototrichogram,[4-8]
- Semi-invasive methods such as trichogram[9,10] or microsopic analysis of hairs plucked from a selected scalp area
- Invasive methods[11,12] or examination of biopsied scalp-skin samples.

Digital diagnosis enables patients to observe in vivo the analysis of scalp—skin condition as well as of collected hairs with bulbs during the examination. It is possible to systematically to monitor the entire course of treatment. It is a safe and noninvasive diagnostic method.

Trichogram, a classic semi-invasive method, is used to evaluate the condition of the hair bulbs—roots of hair—in various phases of growth. In contrast to a digital trichodiagram, which does not require plucking, i.e., collecting hairs for analysis, a trichogram collects 100 hairs from individual patients for evaluation. In a correctly executed trichogram, anagen hairs in active growth phase make up 80%, catagen—transition phase—1%, and telogen hair approximately 20%. Dysplastic and dystrophic hair can account for several percent.

Videodermatoscopy as a noninvasive method carried out with a camera at magnification ranging from 20x to 600x allows to observe in vivo the surface of scalp skin, hair follicles, and the structure of the hair shaft. This method is used in differential diagnosis of many types of alopecia and various scalp-skin conditions. The obtained image is called a trichogram and used with a specific computer software to analyze the condition of the hair shaft makes it possible to assess hair density per square centimeter, hair growth rate, its diameter, vascularization, and condition of hair follicles or their possible plugging.

All these methods, albeit effective, have a fundamental shortcoming, namely their precision is mostly dependent on the experience, perceptiveness, and conscientiousness of the examiner.

Thus, we may categorize them as subjective, i.e., observer-dependent evaluation methods.

A totally new technique, which combines excellent optical technique with computer analysis, is the TrichoScan.[13-15] The method as described by Rolf Hoffmann makes use of computer processing of standard epiluminescence microscopy (ELM) images. The digital images are obtained at 20 times magnification using a digital epiluminescence microscopy system (Fotofinder DERMA, Teach-screen Software, Bad Birnbach, Germany). The TrichoScan

software (Tricholog GmbH, Freiburg, Germany) is employed for the analysis of hair measurements. The detection limit of the TrichoScan software is 5 µm in hair thickness. This method makes it possible objectively to assess in situ such hair-growth parameters as the following:

- Hair density (n/cm²)
- Hair diameter (µm)
- Hair growth grade (mm/day)
- Anagen hair count (%)
- Telogen hair count (%)
- Terminal hair count (%)
- Small diameter hair count (%)
- Ratio of anagen to telogen hair
- Ratio of small diameter hair to terminal hair (i.e., miniaturization grade)

TECHNIQUES AND METHODS

Choosing the Optimal Measurement Site

To carry out a complete examination, three pairs of two fields of 1.8 cm² each are selected (Fig. 46.1). In each pair, one field should be situated in the balding area (usually parietal and frontal regions) and the other in an area free from balding (usually in the occipital region). The areas under study should be situated in such a way that suitable camouflage could be applied post-examination. Therefore, the very crown region of the head should be avoided as well as areas directly

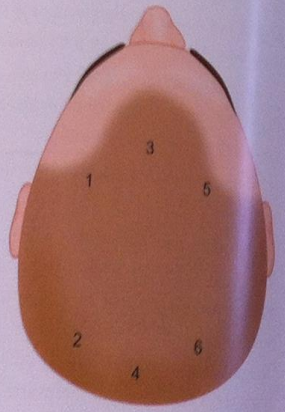

Figure 46.1
Choosing the optimal measurement site

adjacent to the parting. It is also recommended for patients to grow the hair a little longer. Each pair of the studied sites is used to evaluate different hair-growth parameters.

- The first pair (field 1 and 2) enables evaluation of total hair density and the telogen/anagen ratio.
- The second pair (field 3 and 4) enables evaluation of anagen hair density and the anagen/small-diameter hair ratio.
- The third pair (field 5 and 6) enables evaluation of total hair density and terminal hair/small-diameter hair ratio.

Shaving

The mask is applied and the hair in the selected area is pulled through the mask (Fig. 46.2). The hair exposed through the mask is shaved or clipped with an electric razor (Moser, Type 1556, Germany) (Fig. 46.3) to leave a small neat spot (Fig. 46.4). The hair is clipped according to the following time schedule (Fig. 46.1):

- The first pair (field 1 and 2)—clipping carried out 3 days prior to examination, hair clipped to approximately 1.5 mm above skin surface
- The second pair (field 3 and 4)—clipping carried out 3 days prior to examination, hair is shaved off entirely to skin surface
- The third pair (field 5 and 6)—clipping carried out directly prior to examination, hair is clipped to approximately 1.5 mm above the skin surface.

Figure 46.2
Exposure of hair in the area to be shaved

Figure 46.3
The hair exposed through the mask is shaved with an electric razor

Figure 46.4
After shaving

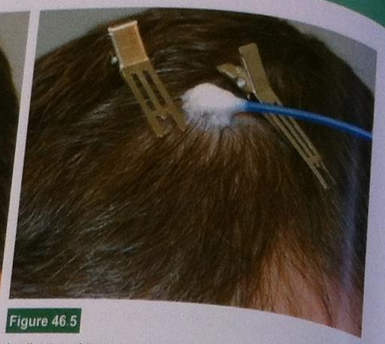

Figure 46.5
Application of the dye

Dying

Many of the hairs do not contrast well enough for digital photography and need to be dyed. The dye product supplied with the TrichoScan (KPSS-Kao Professional, Germany) is best applied using a wooden spatula after having been mixed with 2–4 drops of development solution (Fig. 46.5). The dye is applied onto the shaven scalp area and must remain there for 12 minutes. Longer dying periods lead to the blackening of the scalp skin, whereas a shorter period lead to inadequately dyed hair. Both results are equally unsuitable for later evaluations.

After dying the hair, the area should be thoroughly cleansed using an alcohol-based solution (Kodan Spray, Schülke & Mayr, Vienna, Austria).

Measuring

Photographs are taken with an epiluminescent camera ELM (Fotofinder DERMA, Teachscreen Software, Bad Bimbach, Germany). The photographed areas remained wet throughout the examination, and the right distance between the camera and the skin surface was maintained by a rigid contact lens (Fig. 46.6). The recorded photographs are loaded onto the TrichoScan Software (Tricholog GmbH, Freiburg, Germany), which automatically proceeds with the analysis (Fig. 46.7). According to the settings of the program, it may be necessary to click on the buttons "Trichogram" or "Score" to attain full results (Fig. 46.8). The detection limit of the TrichoScan software is 5 µm in hair thickness. On the automatic setting, the program recognizes every hair less than 40 µm in diameter as miniaturized hair.

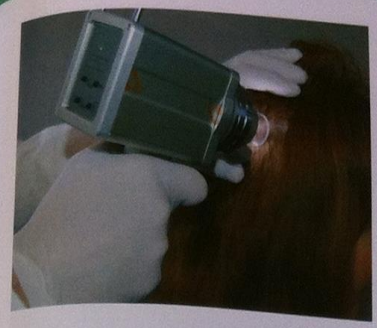

Figure 46.6
Photograph is taken with an epiluminescent camera epiluminescence microscopy (ELM)

Interpretation

A complete examination of the three pairs of fields (1–6) allows for the analysis of all hair-growth parameters such as the following:

- Hair density (n/cm²)
- Hair diameter (µm)
- Hair growth grade (mm/day)
- Anagen hair count (%)
- Telogen hair count (%)
- Terminal hair count (%)
- Small-diameter hair count (%)
- Ratio of anagen to telogen hair
- Ratio of small-diameter to terminal hair (i.e., miniaturization grade)

In the analysis of the first pair (field 1 and 2) 3 days after the hair was clipped to 1.5 mm, the program evaluates both total hair density per square centimeter as well as distinguishes the individual hairs for their lengths. It is accepted that anagen hair is characterized by constant growth, which results in its lengthening within 3 days as compared with telogen hair, which does not grow. The TrichoScan captures this growth difference between telogen and anagen hairs and presents the data in absolute numbers and in percentages. There are some discrepancies as to establishing precise norms for anagen hairs.[16-18] For practical reasons, however, the following interpretation of the results can be assumed:

- 90% of anagen hair—excellent score
- 80% of anagen hair—average score
- Less than 70–80%—score indicating increased effluvium.

Figure 46.7
Fotofinder DERMA with TrichoScan Software

An increased telogen hair count at the disadvantage of the anagen count strongly points out to a telogen type of alopecia. A comparative study of both fields makes it possible to compare areas affected by alopecia with control areas (e.g., occipital region). A significant difference between those two areas will confirm the presence of AGA, in which the parietal area shows an increased number of miniaturized hair and a reduced anagen count in comparison to the occipital area. This type of result fully justifies the procedure of autogenous hair transplant. Under such circumstances the donor area is a source of hairs with significantly better parameters than the recipient area (affected by alopecia).

If the percentage of anagen and telogen count is comparable in both areas, then this is a strong indication for diffuse patterned or unpatterned alopecia. Under such circumstances autogenous hair transplant does not have any justification, as the material collected from the donor area is not in perfect condition thus making the results of surgery poor and short-lived. Application of a TrichoScan examination improves communication with the patient and permits one to better justify performing or abandoning a hair-transplant procedure.

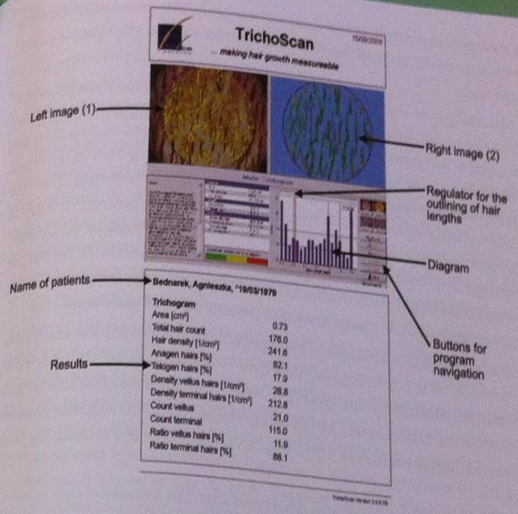

Figure 46.8
TrichoScan analysis

In the analysis of the second pair (field 3 and 4) 3 days after shaving off entirely to the skin surface, the program evaluates anagen hair density. Telogen hair is not analyzed by the program, as its length does not increase over the 3-day period. Also, as it does not even protrude through the skin surface, it is invisible to the program. It is possible, however, to evaluate the ratio of normal thickness (over 40 µm) anagen hair to the miniaturized hair (below 40 µm). An increased miniaturized hair count will signify intensified AGA. Also, there are discrepancies about normal values, but usually the following result interpretation is accepted:

- Up to 10% of miniaturized hair—excellent result
- 10–15% of miniaturized hair—good result
- 15–20% of miniaturized hair—sufficient result
- More than 20% of miniaturized hair—poor result.

A TrichoScan examination in those areas not only makes it possible to diagnose correctly but also enables the process of conservative treatment to be monitored. In early stages of AGA the hair is miniaturized gradually in typical scalp regions. Treatment with finasteride (Propecia) frequently reverses this miniaturization. A TrichoScan examination makes an early and objective evaluation of therapy results possible. A diminished miniaturization after 2–3 months suggests positive effects

of therapy and prompts continuation of treatment. Such a method of objective evaluation could be used for other therapies of intense effluvium like laser techniques.

An analysis of occipital miniaturization, which usually serves as the donor area in hair-transplant procedures, allows for a more precise selection of patients for surgical treatment.[19,20] Based on our own experience[21] and on data from the literature[22] it can be assumed that the number of miniaturized hairs in the donor site that does not exceed 10% is a good prognosis, whereas observation of 10–15% of miniaturized hairs should indicate caution in selecting patients for surgical treatment; however, miniaturization exceeding 15–20%, especially in young men, should signify a "red flag" for surgery. Clear visualization of results in the TrichoScan also makes for much better communication between the doctor and patient. This is especially important in managing younger patients below 25 years of age.

In a comparative analysis of two areas under study it is also possible to evaluate the necessity of a hair-transplant procedure in a given patient.[21] If the level of miniaturization is high in both areas (more than 15%) and at the same time anagen hair density low in both areas, then all of these factors constitute sufficient grounds for abandoning the project of a hair-transplant procedure for fear of obtaining poor results.

Also, analysis of the donor area before and after hair transplants may prove to be extremely useful in everyday practice. In the treatment of areas with distinct miniaturization but with moderate hair density, as it is common in cases of AGA in females, it permits more precisely to observe the first results of the procedure. It often happens that a female patient complains at follow-up 4 or 5 months postsurgery about absence of hair regrowth. If the cautious surgeon carried out a TrichoScan test prior to the procedure and then 4–5 months postprocedure, then he will be able to easily and objectively demonstrate clear improvement in the treated area. Thus, a troublesome or even extremely unpleasant situation may be avoided at the same time improving the patient's level of satisfaction of the treatment. The TrichoScan as an objective test is unique in positively influencing patients.

Analyzing the third pair (field 5 and 6) directly after clipping the hair to a 1.5 mm length, the program evaluates the ratio of small-diameter hair to terminal hair (i.e., miniaturization grade). In a normal scalp there is approximately 91–95% of terminal hair and 9% of miniaturized hair.[23] For practical reasons this test is carried out most frequently in an emergency diagnosis prior to a conservative or surgical treatment. The result may be fraught with a certain level of error due to the presence of telogen hairs among terminal hairs; however, the ease of its application makes it a test of choice. The results are interpreted similarly like in the previous pair keeping in mind that the terminal hair count is higher than the anagen count

thus reducing percentages of miniaturized hair by 5% on average. Therefore, for practical purposes, the following standards can be accepted:

- Up to 5% of miniaturized hair—excellent result
- 5%–10% of miniaturized hair—good result
- 10%–15% of miniaturized hair—sufficient result
- More than 15% of miniaturized hair—poor result.

As mentioned earlier, the TrichoScan is usually applied in this version because the entire process of executing the test lies in the hands of the surgeon who cuts hairs to an appropriate length, stains, and then analyzes them. When patients live long distances from the clinic then hair cutting (para 1–2, 3–4) is done by untrained personnel, which may warp the results of the TrichoScan test 3 days later.

The TrichoScan test enables precise monitoring of the progress of the treatment. The examination starts with a photograph of the entire scalp, on which all of the analyzed fields are precisely marked. In this way it is possible to carry out subsequent examinations at determined time intervals, thus observing the principle of reproducible monitoring at the same locations. It is worth mentioning that the results of the TrichoScan tests are recorded in jpeg format thus allowing storage in most types of computer memories. A certain worry may be caused by magnification limited to 60x. In such advanced software, a far more developed optical system could easily be used to significantly expand the diagnostic potential of the device, especially in the diagnosis of scalp-skin conditions such as functioning, i.e., secretion of sebaceous glands, width of the follicular ostium—perifollicular features, sweat glands, thickness of crystallization, and number and location of blood vessels. In order to fully use the potential of the TrichoScan the number of light emitting diode (LED) points would have to be increased and a plastic cover around the lens would have to be removed. This alteration would allow for a better evaluation of the skin scalp on a patient with long hair.

CONCLUSION

The TrichoScan is an objective test, not relying on human efficiency, which can be applied in the diagnosis of hair-loss processes, in efficiency studies of various medications and laser techniques as well as in an efficiency study of surgical treatment. The TrichoScan may prove extremely useful in selecting patients for possible hair-transplant procedures.

However, result interpretation requires considerable experience from the surgeon. Therefore, this test should always be regarded as supporting medical treatment, and its results should always be confronted with the remaining clinical data.

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