USER MANUAL

TrichoScan Automatic Version 4.0

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Contents

Introduction

Background

Hair loss or thinning hair is a common complaint in clinical dermatology, but patients seeking advice for hair loss are not necessarily bald. In established cases of androgenetic alopecia (AGA) characteristic patterns are easily discernible. However, the clinician is often challenged by patients, especially females, with initial stages of AGA where hair loss is reported but alopecia is not visibly discernable, or where the effect of treatment attempts are hard to measure.

Numerous methods have been described to assess the rate of hair growth. The techniques can be classified as either invasive (e.g. biopsies), semi-invasive (trichogram, unit area trichogram) or non-invasive methods. However, while reviewing the capabilities of the different methods, the common theme emerges that most techniques are of little use to the clinician because they are time consuming, often costly, or difficult to perform. Therefore, an operator- and patient-friendly, inexpensive, validated and reliable method of quantifying hair growth is a rational need. TrichoScan is such a method, combining standard epiluminescence microscopy (ELM) with automatic digital image analysis, for the measurement of human hair.

Measuring method of TrichoScan

With the TrichoScan 4.0 version several different needs in hair science are met. Firstly, the most important parameters, such as hair thickness and hair count can be analysed within the same day. Secondly, the same target site can be used to calculate the number of anagen and telogen hairs by mathematical approximation. This handbook will guide you through the different possibilities.

There are two possible basic procedures that provide different modes with Trichoscan Automatic V 4.0:

A – TrichoScan Mode: Determination of hair thickness and hair density (hair have to be clipped to about 0.5 mm)

B – Trichogram Mode: Determination of anagen / telogen hair count.

The following table shows the main differences in the two modes.

Mode	Clipping length	Time of measurement	Anagen / telogen measurement
A	1.0 mm	immediately	no
B	0.5 mm	after 2 days	yes

TrichoScan - Definitions

A: TrichoScan-Automatic V 4.0 is suitable for the analysis of human scalp hair in androgenetic (pattern) alopecia.

B: TrichoScan is a tool to monitor the most important hair parameters during treatment.

C: TrichoScan-Automatic V 4.0 is able to monitor total, vellus, and terminal hair density and, by mathematical approximation, the telogen and the anagen hair count.

D: TrichoScan **is not** suitable for evaluating body hair or to monitor other hair diseases such as alopecia areata.

E: TrichoScan **is not** a diagnostic procedure.

F: TrichoScan-Automatic V 4.0 **is not** designed for clinical trials. It is made for the individual clinician in practice. We do not accept any responsibility when the tool is used for clinical trials.

G: The TrichoScan-analysis needs a clean and lightly pigmented skin to enable good contrast with dark colored hair. Any remnants of the hair dye, dark melanocytic moles or dark scalp skin will diminish the contrast to the hairs and the analysis will not be possible.

F. TrichoScan is a software program based on statistics and definitions of hair patterns. The software cannot diagnose telogen or anagen hair loss like a histopathologist. However, based on the biological behavior of those hairs, they can be differentiated by mathematical approximation.

TrichoScan-Procedures

Preparing the patient

There is no special recommendation. The patient may wash their hair before the analysis.

Choosing the optimal measurement site

The use of TrichoScan requires a representative area of the scalp to be shaved. To achieve a cosmetically acceptable result, the following should be observed.

Areas unsuitable for shaving are:

- The parting
- The occipital whorl

So that the hairs in close vicinity can be combed over the shaved area and thereby create an aesthetically satisfactory result, the shaving should take place two fingers width away from the parting (fig. 1), on the receding hairline of the fronto-temporal regions or on the vertex.

The mask is applied and hair in the selected area is pulled through the mask (figs. 2 and 3). The hair exposed through the mask is shaved (fig. 4) to leave a small neat spot (fig. 5).

Fig 1: The shaving mask is positioned about two fingers width away from the parting or any other suitable measurement site.

Fig 2: The hair in the area to be shaved is exposed with a curved hook or with pointed scissors.

Fig 3: Hair after exposure is clipped.

Fig 4: Exposed hair, should **not** be completely clipped down to the bare scalp. Best results are achieved by a speedy and gentle clipping process. Some stubble **must** remain.

Fig 5: After clipping, the clipped hairs can be removed with sticky tape.

The hair must not be clipped down to the scalp surface. Short hair shafts should remain visible. This is achieved by a diagonal shaving technique (fig. 4). The clipped hair length has to be set according to the mode, TrichoScan is used (mode TrichoScan or mode Trichogram, see above).

Dying the hair

Hairs do not normally contrast well enough with the scalp skin for digital photography and need to be dyed in advance of taking digital images. The dye product supplied with TrichoScan is best applied using a wooden spatula after having been mixed 1:1 with development cream (figs. 6-10). The dye is applied onto the clipped scalp area and must remain there for 15 minutes. Longer dying periods lead to dyeing of the scalp skin, shorter periods lead to inadequately dyed hair! Both results are equally unsuitable for subsequent evaluation.

Removal of hair dye

After 15 minutes the hair dye must be **completely** removed. This is best done with an alcoholic solution such as Kodan Spray™, a clean swab and some gentle pressure and rubbing of the measurement site.

Fig 6: A small amount of the dye supplied with the Trichoscan kit is applied onto a wooden spatula or similar utensil.

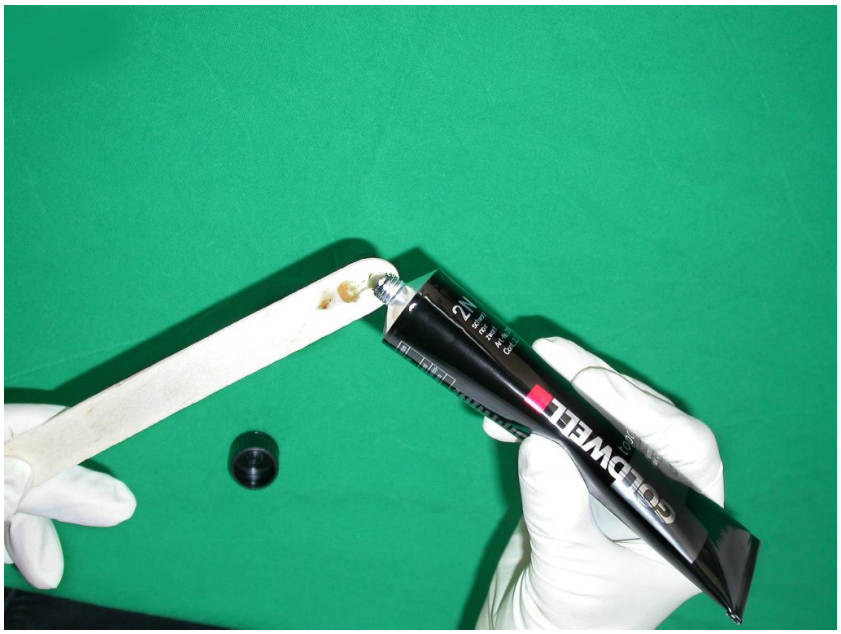


Fig 7: The same amount of dye development cream is applied to the spatula.

Fig 8: The dye and development solution are mixed together.

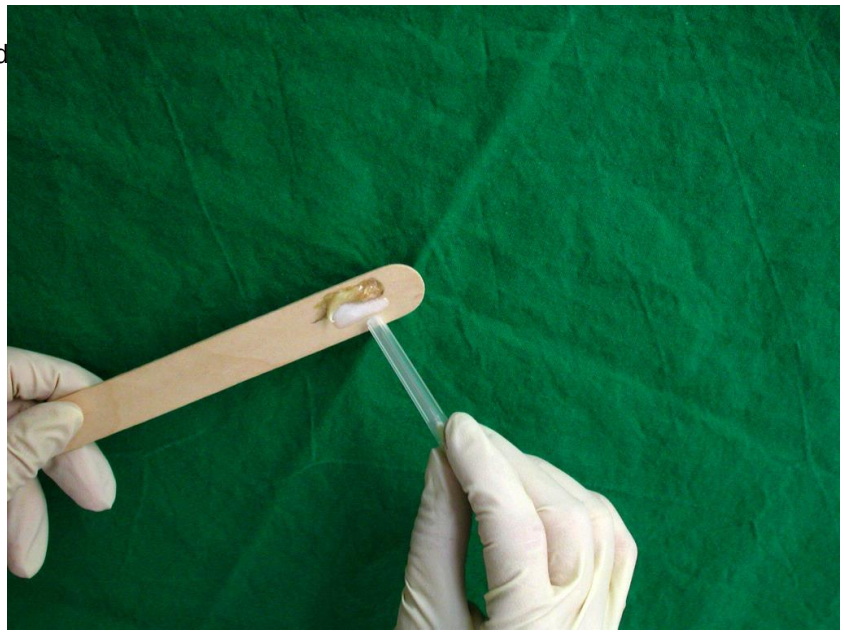


Fig 9: After mixing of the dye and development solution the mixture is ready for application to the clipped scalp region using the wooden spatula.

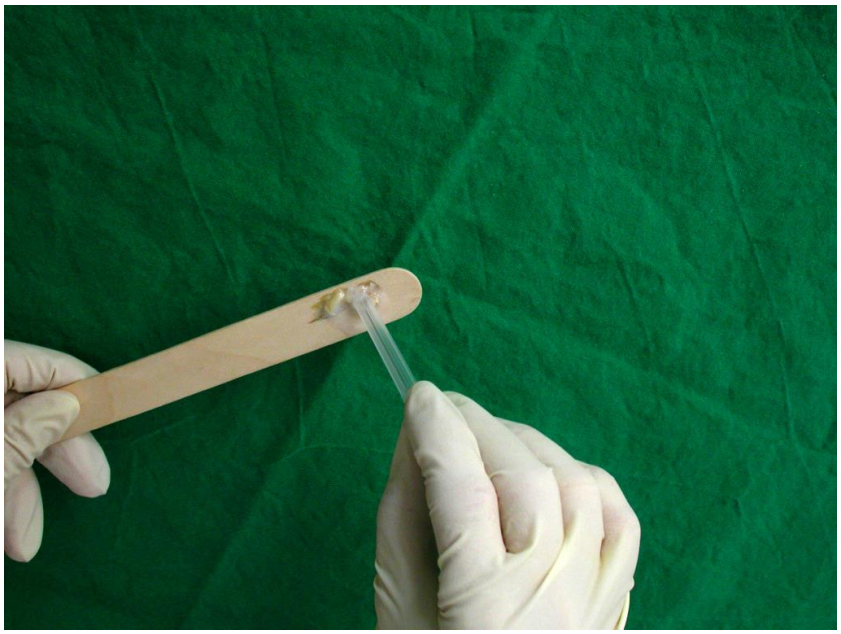


Fig 10: The dye must remain on the scalp for 15 minutes.

After dying the hair, the area should be thoroughly cleansed using an alcohol-based solution (Image 11 and 12).

Fig 11: Dye remnants should be removed by means of a swab and an alcohol solution.

Fig 12: The area should thoroughly be cleansed of **all** dye remnants.

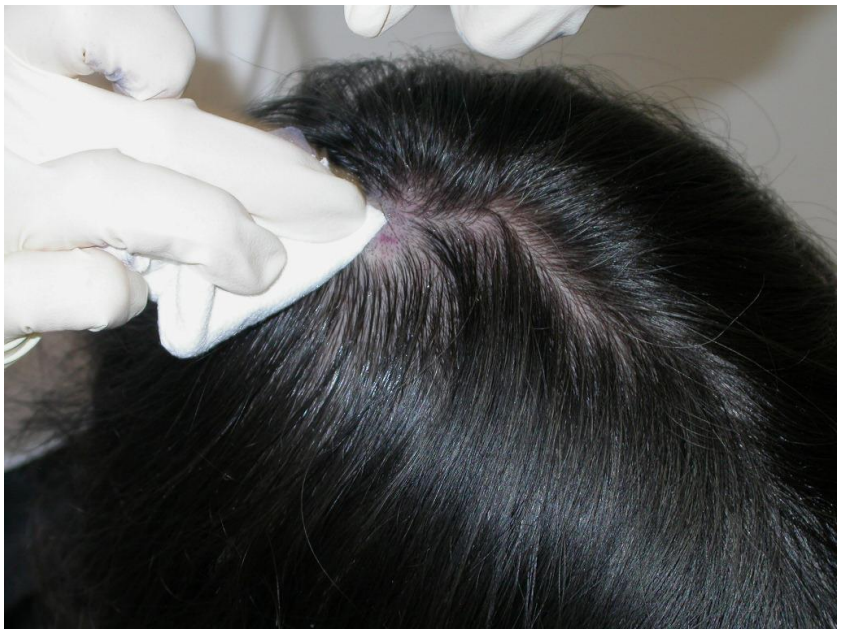


Fig ~~13~~13: Rules for best TrichoScan images:

1. No hair dye remnants should remain.
2. The target area should be wet from the alcohol spray.
3. Images should be taken without contaminating air bubbles present.
4. No hairs from the outside should cross the field of view.
5. Hair stubble of at least 0.5 mm should still be present.

Recording the images

For recording, the lens of the digital camera's optical attachment is pressed on the wet measurement area. Please use an alcohol spray or tap water to wet the area sufficiently. This obligatory procedure makes sure that no air bubbles are trapped between the scalp and the lens. Oil is not a suitable alternative to the alcohol spray or water.

Fig 1414: A perfect Trichoscan image.

Fig 1515: A perfect TrichoScan image.

Suitable Images for TrichoScan

As an automated image analysis tool, the TrichoScan results strongly depend on the image quality.

Suitable images include the following properties:

- Clean and sharp images with no hair dye remnants.
- Wet hairs without larger air bubbles present.
- In focus with no long hairs passing into the measurement site from outside.
- Hairs are evenly clipped and dark due to the hair dye.
- Hairs have a minimum length of approximately 0.5 mm to allow detection by the TrichoScan software. Stubbles that are too short will escape the analysis as the software algorithms define hair as being longer than 0.5 mm.
- Hairs that are straight. Avoid twisting the optics whilst placed on the measurement site and be sure that all hairs are evenly clipped.
- TrichoScan analysis is not possible in darker skin types or an area with dark melanocytic moles due to poor contrast between skin and hair.

Then the image is ready for the TrichoScan analysis.

Mode Trichogram - Telogen hair

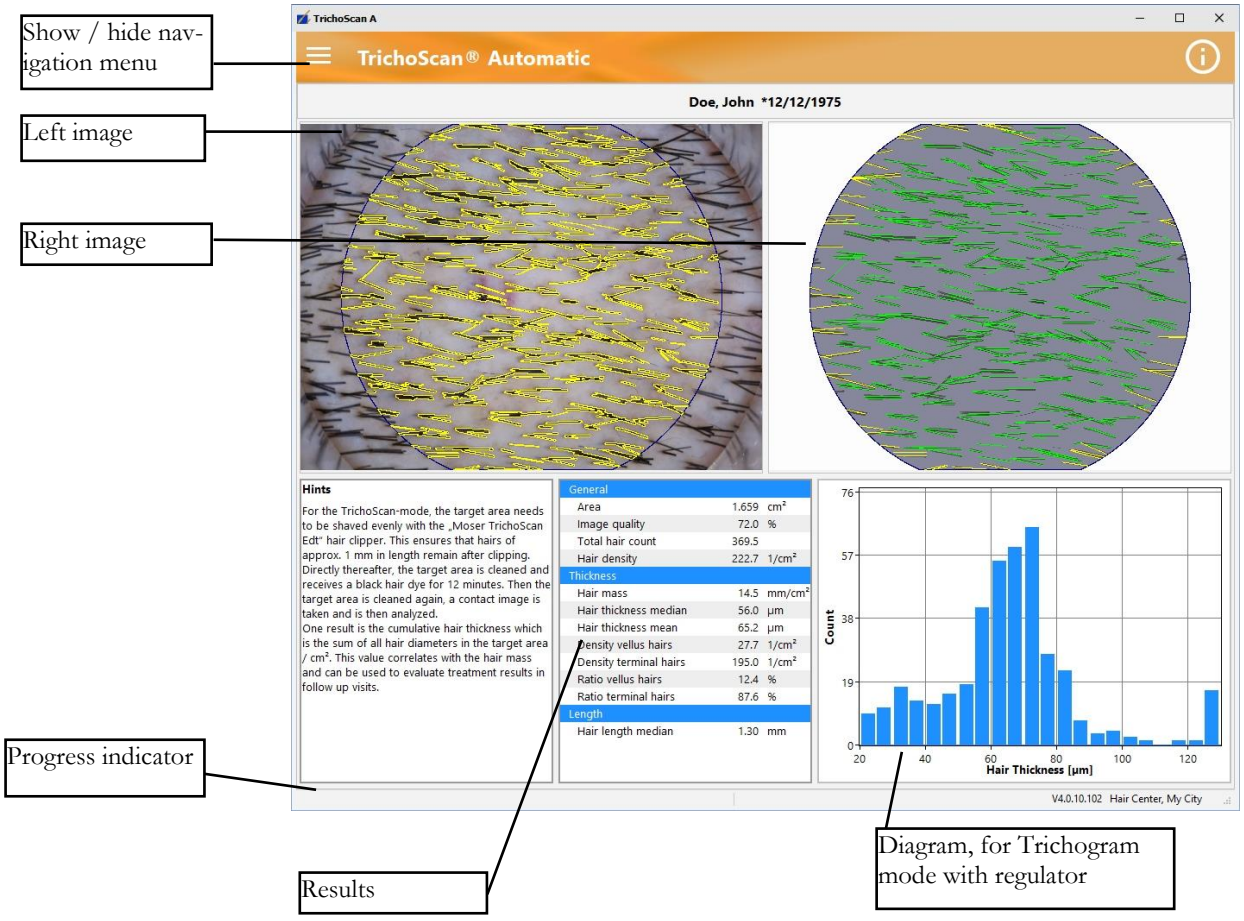
In the software sense a telogen hair is a non-growing hair. For this analysis the hair should be clipped as above (figs. 1-5) during the first office visit. The patient must return to your office 3 days after hair clipping and then the target area receives the hair dye as described (figs. 6-12) and an image is taken for TrichoScan analysis (figs. 13-15). The software will measure the length of all hairs and by statistical analysis will discriminate between growing versus non-growing hairs. Please note that catagen and exogen hairs also do not grow significantly within this time period and will also be judged as non-growing hairs. Therefore, the calculated telogen hair values will be a bit higher than may normally be expected. For this analysis to be accurate a very uniform hair clipping is mandatory to ensure the remaining hair stubble is of equal length. For less expert hair clippers, we recommend the use the anagen hair count tool instead. An anagen hair count requires less

hair clipping consistency and so it is much easier to obtain accurate results with this approach.

TrichoScan analysis

The recorded photographs are loaded into the TrichoScan software which automatically proceeds with the first analysis. There are the two modes, mode TrichoScan and mode Trichogram.

A – Mode TrichoScan



Show / hide navigation menu: In the menu e.g. the mode can be changed or a report can be printed. For the Trichogram mode, a score can be shown.

Left image: Here the area to be analysed has a blue border once the image has been loaded.

Right image: According to the stage of the analysis, various distinguishing features are marked which give an indication of the progress of the image analysis (red: telogen hair, yellow: hairs that touch the border, green: anagen hair).

Result: The results area shows values for the analysed area, the estimated image quality and hair parameters (see below).

Diagram: The diagram shows the frequency distribution of hair length. The red line marks the maximum length of telogen hairs defined in the software analysis.

Results – Hair parameters

The sequence of the hair parameters varies for the two different modes.

Total hair count : The number of detected hairs.

Hair density (1/cm²): With the TrichoScan-Automatic V 4.0 edition it is possible to calculate the number of hairs detected (hair count) and the hair density (hairs / cm^2). Please note, that due to the image resolution of digital cameras the TrichoScan software cannot detect very fine hairs (approx. less than 10µm diameter). In addition, TrichoScan cannot identify hairs which are too short for analysis (approx. less than 0.3 mm in length). As digital camera image resolution improves, these limitations may change in the future.

Hair mass (mm/cm²): The cumulated thickness (diameters) of hairs normalized for an area of 1 cm^2.

Hair thickness median (µm): The median of the distribution of the hair thicknesses (diameters).

Hair thickness mean (µm): The mean of the distribution of the hair thicknesses (diameters).

Density vellus hairs (1/cm²): By definition a vellus hair is thinner than 40µm. Trichoscan uses this value to identify vellus hairs in images. The number of vellus hairs relative to terminal hairs is also calculated and provided in the analysis results.

Density terminal hairs (1/cm²): By definition a terminal hair is thicker than 40µm. Trichoscan uses this value to identify terminal hairs in images. The number of terminal hairs relative to vellus hairs is also calculated and provided in the analysis results.

Ratio vellus hairs (%): Ratio of vellus hairs to total hairs in percent.

Ratio terminal hairs (%): Ratio of terminal hairs to total hairs in percent.

Anagen hairs (%) [1]: Ratio of anagen hairs to total hairs in percent. In the definition of the TrichoScan procedure, an anagen hair is a hair which is detectable three days after complete hair shaving. Within this time only anagen hairs should grow significantly.

Telogen hairs (%) [1]: Ratio of telogen hairs to total hairs in percent. By definition a telogen hair will not grow whereas anagen hairs do. When images are taken three days after hair clipping, growing hairs can be differentiated from non-growing hairs based on different hair length.

[1] only available in mode Trichogram

Trichoscan identifies non-growing hairs as telogen hairs and growing hairs as anagen hairs.

Hair length median (mm): Medain of the distribution of the estimated hair length.

Printing the results

Using the menu, the results can be printed. The image displayed on screen is the image that is printed (with adaptations taken into consideration, accordingly). Additionally, the parameters are displayed beneath the picture. Thus, the reproducibility of the results is ascertained according to the print.

Additionally, information about the name and location of the software license owner appears at the bottom edge of the picture.

B – Mode Trichogram

In the mode Trichogram, the anagen / telogen ratio can be measureed, additionally. Therefore, after preparing the scalp and measureng two days after clipping, the cut-off for anagen and telogen hairs can be set by a regulator which is located above the diagram: The slider enables the maximal hair length for defining telogen hairs to be manually adjusted by the user when the software is in the “Trichogram” mode. Color-coding of the hairs indicates the group they belong to.

- Red: Telogen hair.
- Yellow: Hair is touching the edge of the picture, grouping follows via a special statistical procedure (Product-Limit-Estimation).
- Green: Anagen hair.

Using the menu, a score can be given for the result.

Support

Up to date and additional information about TrichoScan can be found on the Internet at www.trichoscan.com .

In case of problems concerning the recording images and technical issues of the recording system, please contact the manufacturer.

Medical questions, such as enquiries about measurement results, can be addressed to Prof. Rolf Hoffmann, MD in Freiburg, Germany (Email: info@tricholog.de, Fax: ++49 761-6800113).

If you have any technical problems or TrichoScan software program faults, please contact the TrichoScan software engineers (Email: info@datinf.de, Fax: ++49 7071-2536962).

The program was tested using many images with numerous parameters. However, there is the possibility that not all of the hairs are correctly recognized in an image. In case recognizable hairs are not identified by the TrichoScan software, please send the picture in question via email to info@trichoscan.de for evaluation. These pictures will also be used to further improve and develop the TrichoScan software system.

A research edition of TrichoScan is available for research purposes, which is able to define additional hair growth parameters. This program version also has the capacity to analyse a greater number of image recordings. For further information please contact Prof. Rolf Hoffmann, MD (Email: info@tricholog.de), or visit the TrichoScan website at www.trichoscan.com.

Initialization data

Initialization data is an integral part of the TrichoScan software. This data should never be altered. Unauthorized changes of this file may result in incorrect data output.

Appendix

References

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TrichoScan target sites

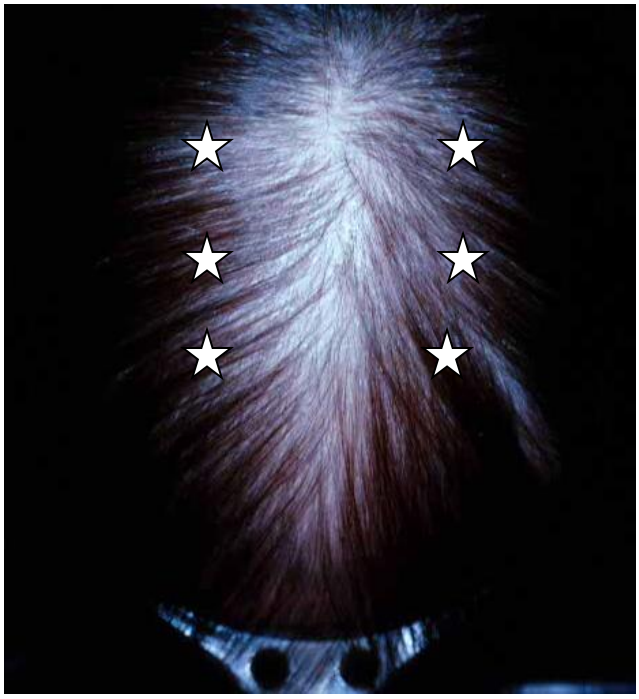


Fig ~~16~~16: Recommended TrichoScan target site (stars).

Fig. 17: Recommended TrichoScan target site (stars).

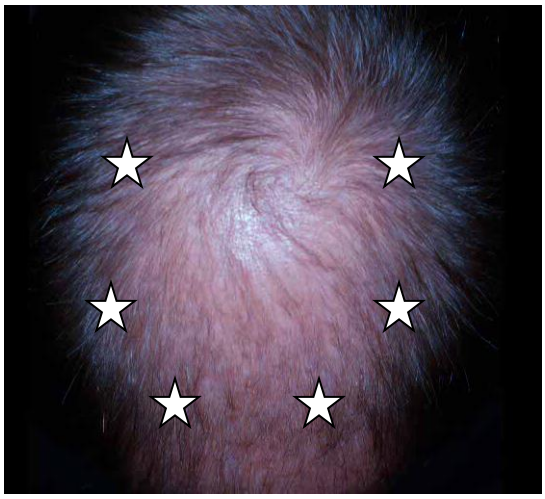


Fig. 18 Recommended TrichoScan target site (stars).

Fig 19: Recommended TrichoScan target site (stars).

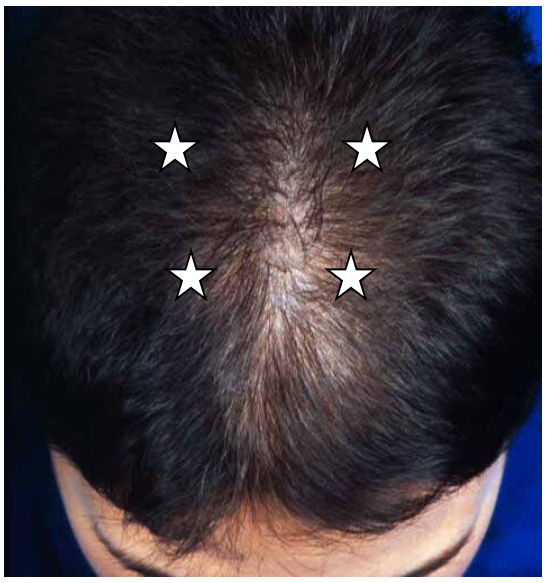


Fig 20: Recommended TrichoScan target site (stars).

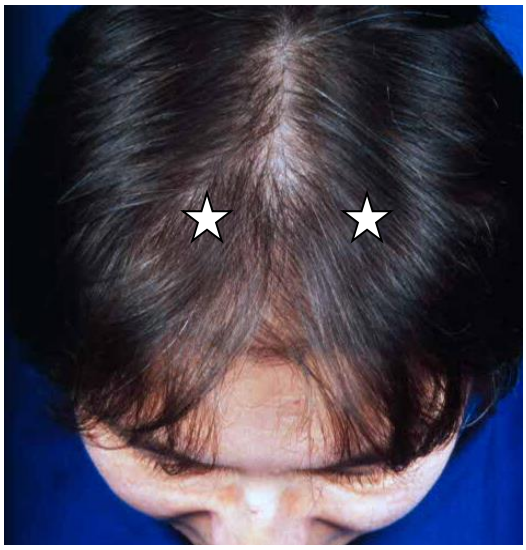
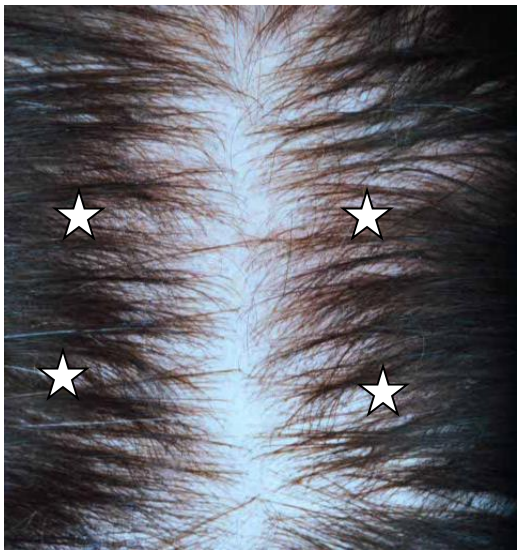


Fig. 21: Recommended TrichoScan target site (stars).

Fig. 1: Recommended TrichoScan target site (stars).



Images not suitable for TrichoScan analysis

Fig. 23: No hair dye and the black dot in the middle of the image make this photograph unsuitable for TrichoScan analysis.

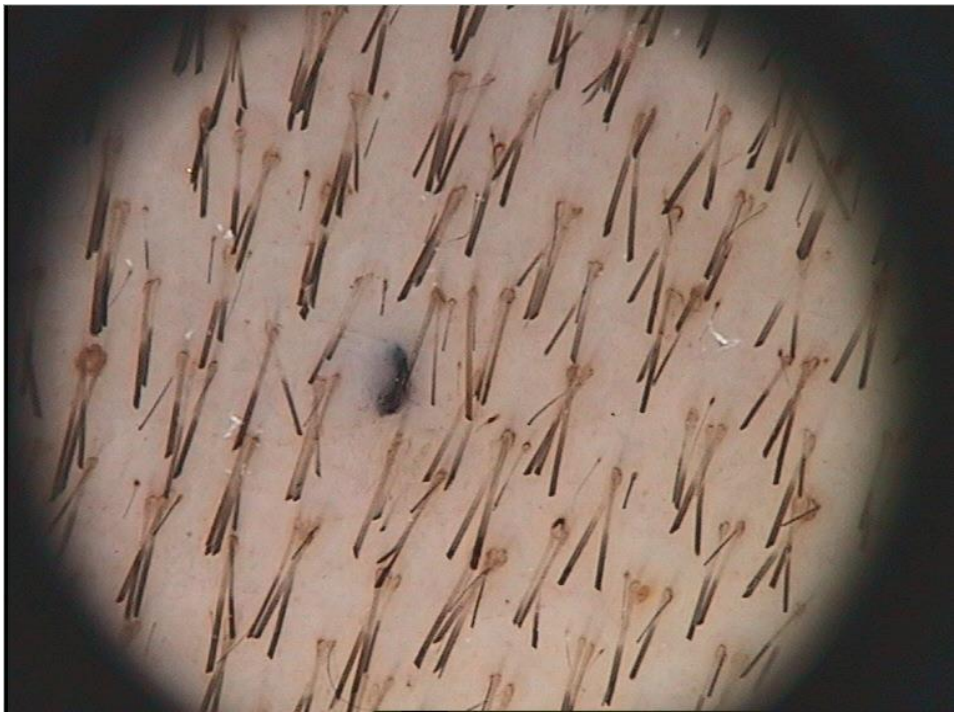


Fig 24: Hairs from the outside cross the TrichoScan target area making it unsuitable for analysis.

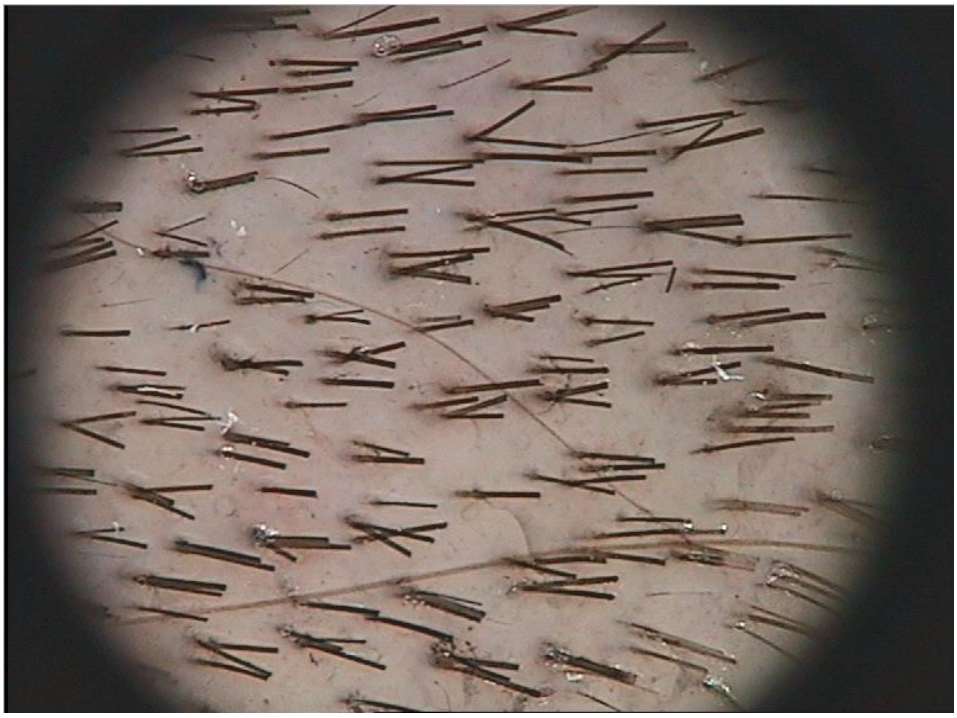


Fig. 25: Too many air bubbles make this image unsuitable for analysis.