A short historical note on authors' progression along the way of precise hair growth measurement.

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Measurement of hair growth and quantification of the maintenance of a stable mass of scalp hair by continuous stochastic cycling and replacement is a fascinating field of dermatology. Before entering into the details of our project, it is important to start with some key dates that paved the authors' way in this field (a detailed list of publications is available on our website: www.skinterface.be).

1975-1987: getting acquainted with duly controlled experimental planning, statistical methods and hair measurement

1987-1990: Edition of "Trends in hair growth and alopecia research" (1987) and Foundation of the European Hair Research Society.

1992: invited speaker at the World Congress of Dermatology (WCD) to deliver the plenary lecture 'what's new in Hair Research'.

1994: First Intercontinental Hair Research Meeting (Brussels) and Foundation for world group of Hair Research Societies

It is of note that, in 1992 microscopy of scalp biopsies and micrometry were gold-standard-methods and remained so until the early 2000. Then computer-generated hair measurements and non-invasive imaging gradually took over. However, while the computation of a global index for hair growth had already been proposed at the WCD in 1992, it was repeatedly discussed at length in a small international group during the last ten years (2009-2019). This lead to the public release of first Compound Index for Hair Growth data in 2019-2020. CIHG is now evolving into HMI for clinical use. The influence of computer technologies is undeniable but apparent 'ease' must be taken with caution[1]. After a personal exchange of correspondence and discussion with the late Nobel Prize winner Ilya Prigogyne, a group of mathematicians and computer scientists developed a mathematical model based on hair cycle measurements[2]. Hair cycling appeared interesting because of its inherent complexity while anagen appeared as the most important phase in the hair system. Pursuing along these lines, we found out that not all anagen were equal contributors to the build-up and maintenance of a stable hair mass. The duration of telogen may be much more variable than the accepted 'rule of thumb' average 3-month duration[3] i.e. relatively insignificant as compared with the normal anagen duration on scalp sites.

Finally

- while Iphone- and other screens are very attractive but become more and more intrusive,
- while speedy and automated computer-generated analyses became popular and trendy,

we drew - in line with the opinion of expert users of such 'in'-technologies - the attention of dermatologists on accuracy and precision with user-friendly computerised methods in terms of hair measurement. It might be considered for the new methodology described in this manuscript as concepts, designs and practical ways for future applications have been submitted for intellectual property rights (Benelux I-DEPOT 130713).

To make a long story short, all our work was based on hand processed images in order to feed the computer for data generation. Today we might enter a new era with machine learning employing high definition source files with global and analytical data as detailed in Benelux I-DEPOT 130713.
The development of our hair imaging procedures and analytical methods started in the early 80^{ies}. The findings presented herein employed methods that were all finalised in the early 21st century. A little more work was necessary between January 2019 and September 2020 to finalize the source data (about 500 000 individual hair measurements associated with clinical parameters) in a 'frozen database'.
Then it was time for statistical analysis and reporting on results. Contrary to most global methods our observations started from the basic unit i.e. the scalp hair follicle :

- how to exhaustively quantify scalp hair growth on a follicular basis?
- how should the constitutive elementary units contribute to an apparently stable mass on the scalp?
- Reassembling (through rather complex computational sequences) all hair fibre measurements into one single parameter named 'hair productivity' (production of hair per unit area and per unit of time) we found a linear correlation ($R^2 = 0,95134$) with a clinical measurement i.e. scalp coverage scoring (SCS). SCS could be established rapidly, without sophisticated tools, in real time by the practitioner during the consultation and turned via an abacus into 'precisely measurable' hair productivity.

Improved technology might help clinicians and patients to asses hair growth. Validated and accurate methodology could prevent raising undue hopes on the patient's side and temper the trend of overselling through incomplete or biased reports. Assessing changes of hair growth with assays less than 1 year duration appears in a lot of drug trials and even more often in the field of intervention by physical means, cosmeceuticals, nutriceuticals and alike.
After the initial steps a world-wide upsurge of interest followed[4], the author wishes to refer to the future with younger researchers in the field. Please remind a saying attributed to Thomas Edison:
What you are will show in what you do !
To-day, we all can do better!

REFERENCES

1. Saraogi PP, Dhurat RS. Automated digital image analysis (TrichoScan®) for human hair growth analysis: ease versus errors. *Int J Trichology* 2010;2:5-13.
2. Halloy J, Bernard BA, Loussouarn G, Goldbeter A. Modeling the dynamics of human hair cycles by a follicular automaton. *Proc Natl Acad Sci USA* 2000;97:8328-33.
3. Van Neste D. Natural scalp hair regression in preclinical stages of male androgenetic alopecia and its reversal by finasteride. *Skin Pharmacol Physiol* 2006;19:168-76.
4. Westgate GE, Bergfeld WF, Ceh V, et al. Thirty years (and more) of hair research societies. *J Am Acad Dermatol* 2019;81:652-3.