

Polarized Microscopy as a Helpful Tool to Distinguish Chronic Nonscarring Alopecia From Scarring Alopecia

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Background: Nonscarring alopecia differs from scarring alopecia on pathologic examination by the preservation of follicular units and lack of follicular dropout. However, long-standing cases of active nonscarring hair loss can show follicular dropout on pathologic examination and can be difficult to interpret.

Observations: We describe a patient with nonscarring alopecia that was misdiagnosed as scarring alopecia due to difficulty in distinguishing between scarred tracts (follicular dropout) and long-persisting fibrovascular streamers. Polarized light microscopy permits us to distinguish follicular scars from fibrous streamers be-

cause the fibrous streamers are birefringent negative for collagen. The main advantages of polarized microscopy are that it is fast and cost free and can screen all sections within minutes; it is also easy to interpret for beginners because there is a built-in control of birefringent-positive dermal collagen.

Conclusion: Polarized light can be used in the pathological evaluation of hair loss to distinguish between the follicular scars in scarring alopecia and the fibrovascular streamers in long-standing nonscarring alopecia.

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MOST TYPES OF ALOPECIA demonstrate at least some overlapping histologic features.¹ However, it is usually not difficult to distinguish nonscarring from scarring alopecia. This is especially true when using horizontal sections of scalp biopsy specimens because they allow for visualization and counting of all hair follicles present in a 4-mm punch biopsy specimen.²

The main pathologic criteria that distinguish nonscarring alopecias are (1) the number of preserved follicular units with their sebaceous glands at the isthmus level and (2) the absence of follicular scars (replacement of follicular epithelium by connective tissue).³ However, according to some researchers,² follicular dropout may occur in long-standing nonscarring alopecia. This phenomenon has been referred to as a biphasic pattern on pathology and has been reported for alopecia areata, androgenetic alopecia, and traction alopecia.¹

In our experience, polarized microscopy can be helpful in distinguishing cases of long-standing nonscarring alopecia from scarring alopecia. The following clinical case is a good example of how the use of

this technique in dermatopathology may go beyond screening biopsy specimens for foreign bodies.

REPORT OF A CASE

A 58-year-old woman presented with a 10-year history of progressive diffuse hair loss and scalp itching. Scarring alopecia without specific features was previously diagnosed on a scalp biopsy specimen by 2 independent dermatopathologists. A physical examination revealed diffuse hair thinning. Dermoscopy of the scalp showed hair diameter variability without loss of follicular openings (**Figure 1**). Two 4-mm punch biopsy specimens were obtained from the upper parietal scalp for horizontal and vertical sections. At the isthmus and infundibular levels, they showed a reduced number of follicular units ($n=6$) and terminal hair follicles ($n=14$). The ratios of anagen to telogen (79% to 21%; reference range, 93.5% to 6.5%⁴) and terminal to vellus (2.8 to 1; reference range, 7 to 1⁴) were decreased as a sign of increased hair shedding, shortened hair cycle, and follicular miniaturization. There were 10 fibrovascular streamers in the lower dermis and the subcutis. Differen-

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Figure 1. A dermoscopic view of the scalp reveals preserved follicular openings with hair shaft variability (FotoFinder Systems, Inc, original magnification $\times 40$).

tial diagnosis between scarring and nonscarring alopecia was difficult because of (1) the presence of 5 focal areas where follicular units were absent and replaced by compact pink-gray connective tissue (**Figure 2A**) and (2) the presence of 2 compound follicular structures representing the fused outer root sheaths of 2 adjacent follicles. These structures were present only at the level above the isthmus, closer to the infundibulum, and were surrounded by mild inflammatory infiltrate and loose thin fibroplasia (**Figure 2B**).

To establish whether the focal areas of follicular dropout were follicular scars or avascular fibrous streamers, we used polarized light microscopy because human collagen is known to be birefringent on polarization.⁵ The results showed that all 5 areas of follicular dropout were not birefringent, in contrast to the normal collagen in the dermis (built-in control) (**Figure 3**). This allowed us to diagnose these structures as long-standing fibrous streamers.

The compound follicular structures shown in **Figure 2B** were assessed as normal infundibular ostia that fused into compound follicles at the upper follicular level. Although they resembled the fusion of the outer root sheaths wrapped up by fibrosis seen in scarring alopecia, they were present only above the isthmus and at no lower level. The diagnosis of long-standing chronic androgenetic alopecia was established.

COMMENT

The difficulty of classifying cases of long-standing active chronic alopecia areata or long-standing androgenetic alopecia as either nonscarring or scarring on pathology is known. It comes from the difficulty of distinguishing between scarred tracts (follicular dropout) and long-persisting fibrovascular streamers, which, after time, lose their vascularity and acquire a more compact sclerotic appearance. The first description of fibrous streamers was made by Headington⁶ in his original article on horizontal sectioning. The streamer is an angiofibrotic whorl that can be seen at different levels (from the subcutis to the upper dermis) and, depending on its "longevity," may show many small blood vessels

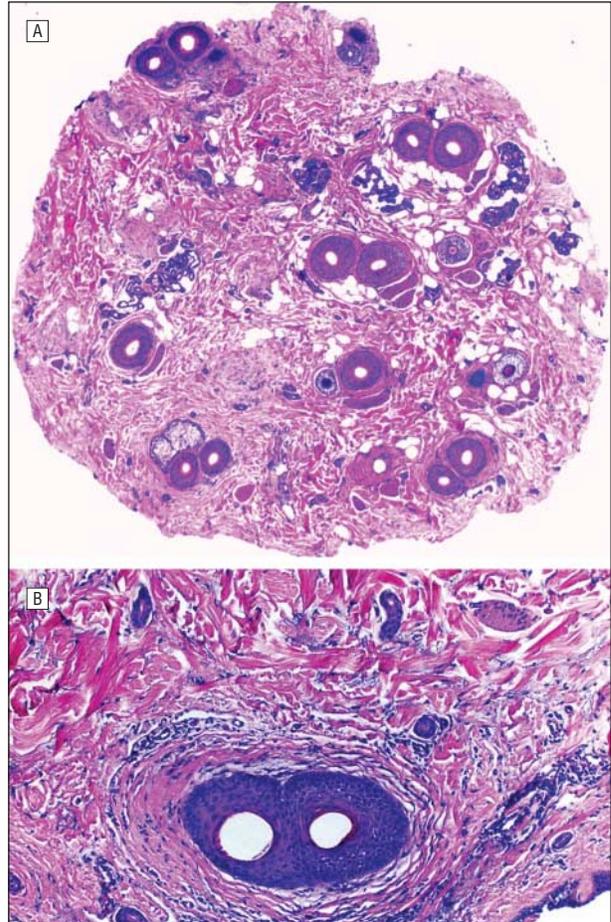


Figure 2. Pathological presentation of the case of long-standing androgenetic alopecia. A, A horizontal section at the level of the lower follicle (sweat glands level) shows decreased follicular density with the presence of 12 terminal anagen follicles, 4 vellus follicles, and 2 telogen follicles. Note the obliteration of 5 follicles by pink-gray connective tissue (hematoxylin-eosin, original magnification $\times 2$). B, A compound follicle made of the fusion of the outer root sheaths of 2 adjacent follicles at the level of the upper follicle with mild loose perifollicular fibroplasia (connective tissue sheath) and inflammatory cells (hematoxylin-eosin, original magnification $\times 10$).

and remnants of trichilemmal gray vitreous membrane (grayish hue). In horizontal sections at the level of the reticular dermis, the perifollicular vascular plexus of the streamer disappears so that it looks like delicate collagen.⁷ It has been proposed to use elastic tissue stains to demonstrate the elastic fibers in a streamer vs the absence of elastic tissue in a follicular scar.^{6,7} Elastic stains have been shown to outline the fibrous tracts in scarring alopecia while remaining negative in the tract.⁸ We show that polarized microscopy is a fast and simple method for identifying follicular scars from fibrous streamers. Polarized microscopy is mostly used in hair practice to assess abnormalities of the hair shafts.⁹ Similar to hair shafts, human collagen has the ability to pass light in a particular plane (birefringence). The present approach has several advantages over the elastic stains: (1) it is fast and cost free for most laboratories because the microscopes of dermatopathologists are usually equipped with a special attachment for screening specimens for foreign bodies under polarized light (the usual price of such an attachment is \$200-\$500), (2) it can

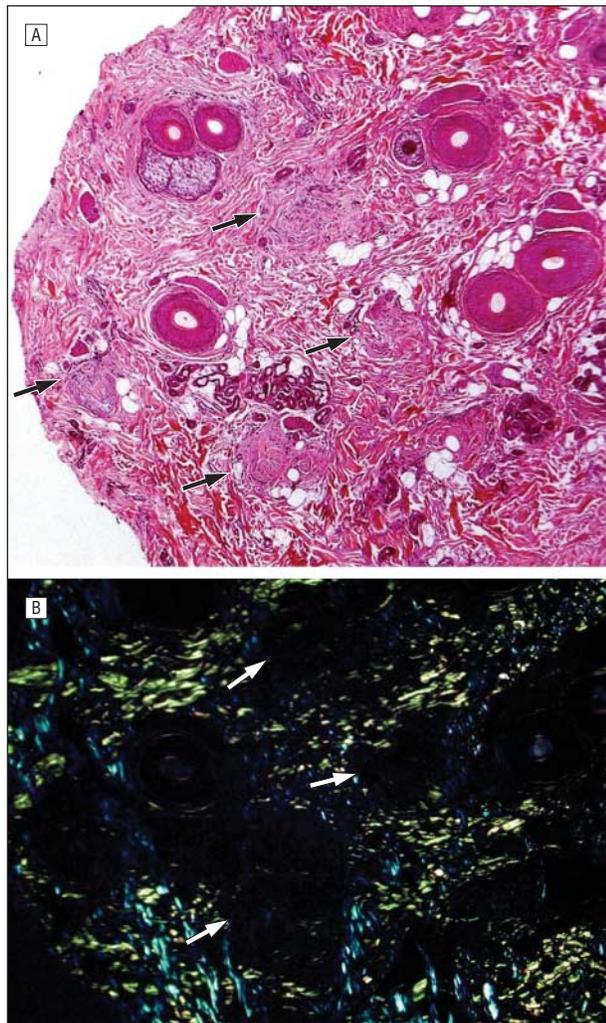


Figure 3. The same case of long-standing androgenetic alopecia assessed by polarized microscopy. A, A horizontal section at the level of the lower follicle shows a reduced number of follicles, with 5 areas of possible follicular dropout (arrows) (hematoxylin-eosin, original magnification $\times 4$). B, The same section shows negative birefringence in the areas of possible follicular dropout (arrows), whereas the interfollicular dermal collagen is birefringent (in-built control) (polarized light, original magnification $\times 4$).

screen all levels of the horizontal and vertical sections (>20 sections can be screened within minutes), (3) it does not require recuts that may no longer show the specific features, and (4) it is easy to interpret for beginners unfamiliar with special staining techniques because there is a built-in control of birefringent-positive dermal collagen. In the case of true follicular scars, the tract appears highly birefringent. The birefringence is better appreciated at higher magnifications ($\times 20$ and $\times 40$) because the fibrous tract is composed of finer collagen fibers compared with the thick collagen bundles of the surrounding reticular dermis (**Figure 4**). The recognition of follicular dropout as fibrous streamers in the present patient and in other cases of chronic active nonscarring alopecias that persist for years confirms the fact that these alopecias (excluding chronic traction) may be reversible. It has been suggested that follicular cycling may continue for as long as the follicular streamer is viable.¹⁰

In our experience, a common mistake in hair pathology is the interpretation of compound follicular infundibu-

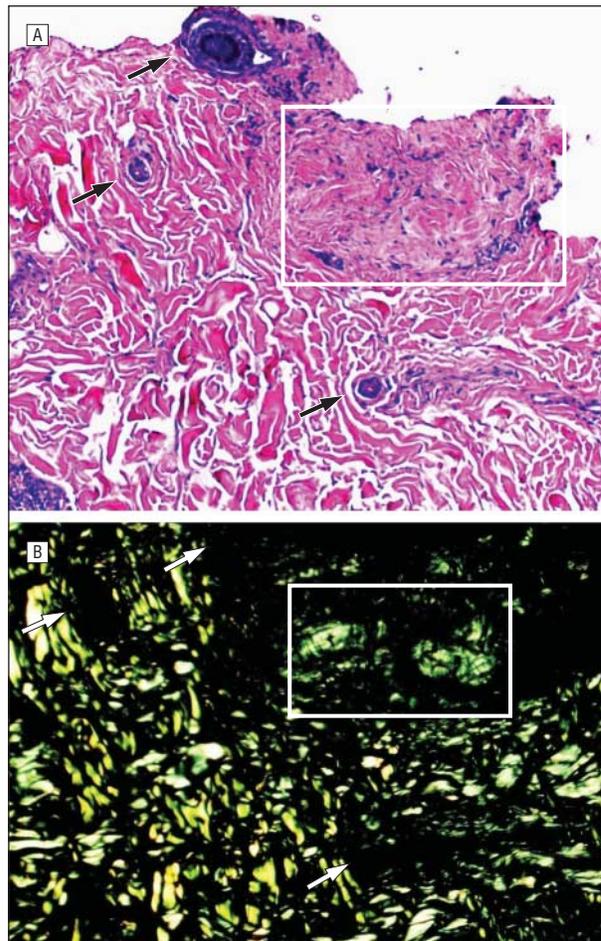


Figure 4. A case of scarring alopecia (lichen planopilaris) assessed by polarized microscopy. A, A horizontal section of a case of lichen planopilaris shows a follicular scar at the margin of the section at the site of a previously existing folliculosebaceous unit (rectangle) (hematoxylin-eosin, original magnification $\times 10$). The arrows highlight a vellus follicle and 2 dermal ducts in the dermis. B, The same section shows positive birefringence in the area of the follicular scar (rectangle). The 3 birefringent negative areas are from a vellus follicle (upper arrow) and small dermal ducts (lower arrows) (polarized light, original magnification $\times 20$). The collagen of the reticular dermis is highly birefringent positive.

lum surrounded by mild fibroplasia and sparse inflammation as a feature of scarring alopecia. The pitfall comes from the evaluation of the compound follicular structures only at the level of the upper follicle and not at all levels. At this level, the outer root sheaths of 2 or 3 follicles normally often fuse so that 2 or 3 hair shafts emerge from the same follicular ostium.⁷ Scalp biopsies of androgenetic alopecia often show mild perifollicular infiltrate and mild perifollicular fibroplasia at the upper follicular level.¹¹ When this is seen around compound follicles at the upper follicular level, this finding can be wrongly taken as a feature of scarring alopecia. A good example of androgenetic alopecia showing this feature can be found in the article by Whiting¹² on horizontal sections of male pattern androgenetic alopecia. Helpful clues that distinguish compound follicles in nonscarring alopecia from those in scarring alopecia are summarized in the **Table**.

Polarized microscopy is a helpful technique for distinguishing cases of long-standing active nonscarring alopecia from scarring alopecia. It is particularly useful in

Table. Compound Follicles in Nonscarring Alopecia vs Scarring Alopecia

Assessment Plan	Nonscarring Alopecia	Scarring Alopecia
Follicular level	Only close to or at the infundibulum level	At the lower and upper follicular levels
Fusion of the outer root sheaths	Symmetrical	Symmetrical/asymmetrical
Pattern of perifollicular fibrosis	Loose thin fibroplasia of the connective tissue sheaths	Thick concentric onionlike fibrosis or mucinous fibrosis
Inflammatory infiltrate		
Pattern	Mild perifollicular	Perifollicular (possible interfollicular) lichenoid or interface
Level	At the upper level only (androgenetic alopecia) At the lower level only (alopecia areata)	At the lower and upper levels
Apoptosis in the outer root sheaths	Absent	Possible

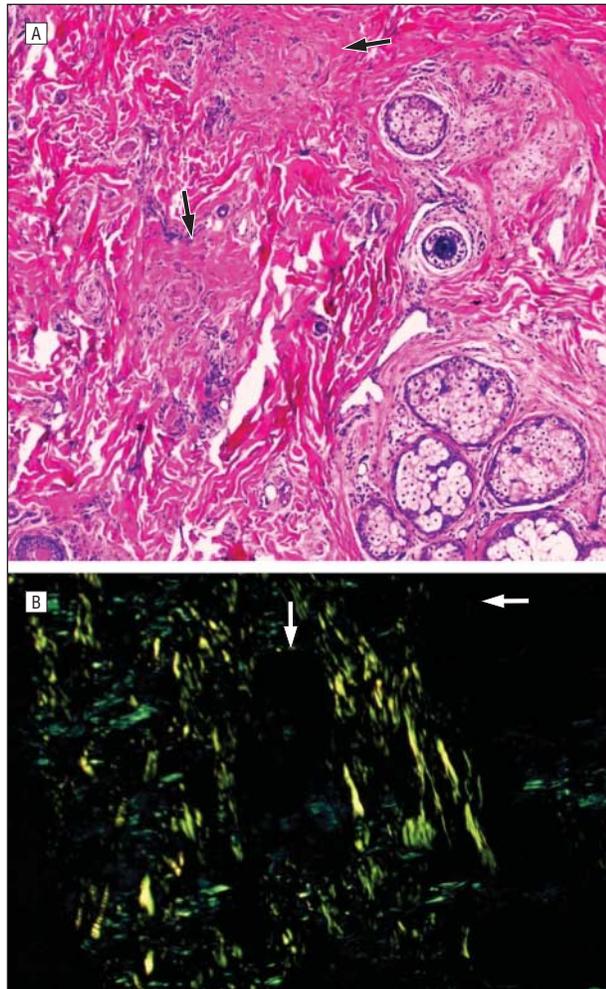


Figure 5. Useful application of the polarized microscopy in a case of long-standing alopecia areata. A, A horizontal section of long-standing alopecia areata totalis shows a few vellus/miniaturized follicles and 2 areas of absent hair follicles (possible follicular dropout) (arrows) (hematoxylin-eosin, original magnification $\times 2$). B, The same section under polarized light shows negative birefringence in the same zones of possible follicular dropout (arrows), whereas the interfollicular dermal collagen is birefringent (polarized light, original magnification $\times 2$).

horizontal sections of long-standing alopecia areata with the presence of only vellus/miniaturized follicles and many follicular dropout areas (**Figure 5**). Another implication is when the pathologist has only vertical sections to establish the diagnosis and they contain fibrous streamers but not hair follicles.

Being aware of these pathologic findings can spare our patients the major distress from the diagnosis of irreversible hair loss and can improve the outcomes with the correct treatment.

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Authorship Contributions: Drs Miteva and Tosti had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. *Study concept and design:* Miteva. *Acquisition of data:* Miteva and Tosti. *Analysis and interpretation of data:* Miteva and Tosti. *Drafting of the manuscript:* Miteva. *Critical revision of the manuscript for important intellectual content:* Miteva and Tosti. *Administrative, technical, and material support:* Miteva and Tosti. *Study supervision:* Tosti. **Financial Disclosure:** None reported.

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