STUDY

Morphologic Features and Natural History of Scalp Nevi in Children

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Objective: To characterize the clinical changes in clinically distinctive scalp nevi over time in children to help guide management and avoid misdiagnosis as melanoma.

Design: Cohort study.

Setting: Washington University School of Medicine pediatric dermatology clinics.

Patients: Of 93 patients younger than 18 years with photographically documented, clinically distinctive scalp nevi, 28 (30%) consented to participate. Minimum follow-up from the initial visit was 1 year. Collectively, these patients had 44 scalp nevi at the initial visit. No patient had a personal diagnosis of melanoma or dysplastic nevus syndrome.

Main Outcome Measures: Clinical changes in scalp nevi as determined using the ABCDE scoring system (ie, asymmetry, border irregularity, color variegation, diameter >6 mm, and evolution/elevation from initial to follow-up images) on initial and follow-up photographs of scalp nevi.

Results: Overall, 77% of the clinically distinctive scalp nevi (34 of 44) showed clinical signs of change during mean follow-up of 2.8 years. Of those with changes, 18 (53%) became more atypical and 16 (47%) became less atypical since the initial examination. None of the changes were concerning for melanoma. The mean total scalp nevus count was 2.6. Scalp nevi represented approximately 6% of total-body nevi. The number of scalp nevi increased with age. Boys had 1.5 times the number of scalp nevi as girls ($P=.03$).

Conclusions: Scalp nevi are clinically dynamic in childhood. These changes include an increase or a decrease in atypical features and occur in all age groups. This preliminary study does not support excisional biopsies but does support physician evaluation of scalp nevi evolution and serial photography of clinically distinctive lesions.

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DURING RECENT DECADES, the incidences of adult and pediatric melanoma have markedly increased.[1,2] Scalp melanoma may have a poorer prognosis than melanoma at other sites.[3-6] Better understanding of the precursors of scalp melanoma and the natural history of scalp nevi in children may lead to more informed management of these lesions.

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Atypical melanocytic nevi may be precursors of melanoma and are important risk factors for melanoma at all ages.[7-11] Clinically, atypical melanocytic nevi share some clinical features with melanoma (eg, asymmetry, border irregularity, color variability, and diameter >6 mm), but usually to a lesser degree.[12,13] In children, the scalp has been found to have a high incidence of either clinically or histopathologically dysplastic nevi and is often the first site involved in dysplastic nevus syndrome.[14-17]

The scalp has recently been added to the list of anatomical locations for nevi with site-related atypia, a subset of melanocytic nevi that share histologic features with melanoma but that are benign.[18,19] However, unlike nevi with site-related atypia at acral, genital, mammary, ear, and conjunctival locations, scalp nevi also demonstrate clinically distinctive features, not just pathologic atypia. When evaluating these nevi, if clinical features are suggestive of melanoma, prompt excision is warranted.

Differing opinions exist on how to manage clinically distinctive scalp nevi in children.[20] Because scalp nevi are difficult for patients, families, and physicians to observe over time, some physicians advocate excising all clinically distinctive scalp nevi in children, especially if there is a family history of melanoma.[15] Other physicians do not routinely excise clinically dis-

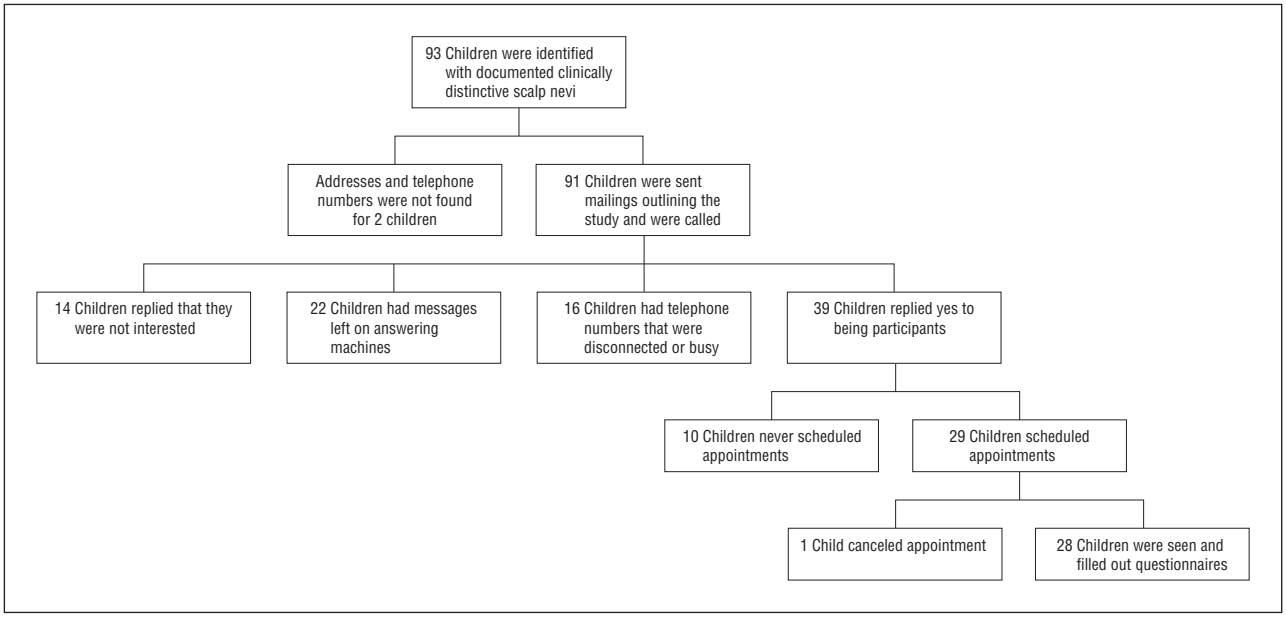

Figure 1. Flowchart of the participant selection process.

tinctive scalp nevi; instead, they follow these nevi with serial examinations and photography.

It is unclear whether clinically distinctive nevi on the scalp of children follow the same natural history as common melanocytic nevi because their clinical progression has rarely been documented.[21,22] A case study[23] examining the progression of an eclipse-type scalp nevus in a child showed fading of the defining peripheral brown rim and elevation of the tan center across 7 years. However, to our knowledge, no study has systematically evaluated the natural history of scalp nevi in children.

We performed a descriptive study of the morphologic features and natural history of a subset of pediatric scalp nevi, defined as those with sufficiently unusual or distinctive clinical features that they prompted photography and a recommendation for clinical observation but not excision to rule out melanoma. The objective was to describe the morphologic features of these scalp nevi using the ABCDE system (ie, asymmetry, border irregularity, color variegation, diameter >6 mm, and evolution/elevation from initial to follow-up images) and to catalog their evolution using digital photography and, in some follow-up cases, dermoscopy. We hope that this study will help physicians recognize scalp nevi in children that may be clinically distinctive or changing but benign.

METHODS

PATIENT RECRUITMENT

After receiving institutional review board approval from Washington University School of Medicine, a medical record review was conducted covering January 18, 1993, through March 27, 2008, at the Division of Pediatric Dermatology, Washington University School of Medicine, to identify children with high-resolution photographs of melanocytic scalp nevi. It has been our general practice to photograph scalp nevi with unusual clinical features. For this study, clinically distinctive scalp nevi included nevi that were larger than expected (>5 mm) or had color variations. Although these 2 features are also features of atypical nevi according to the 1992 World Health Organization consensus agreement, in the nevi included in this study, these 2 features were sufficiently notable to prompt digital photography and to recommend clinical observation only.

Ninety-three children (<18 years old) met the following inclusion criteria: clinical diagnosis of acquired scalp nevi, minimum of 1 year of follow-up, and availability of high-resolution photographs taken at initial evaluation. Scalp nevi were determined to be acquired based on history. No children were excluded because of a previous diagnosis of dysplastic nevus syndrome, melanoma, or subsequent biopsy findings. A letter was mailed to their parents or guardians outlining the study's purpose and design and requesting permission for the child's participation (**Figure 1**). Follow-up telephone calls were made to answer questions about the study and to schedule appointments. Written informed consent was obtained from the parents or guardians of all the participants. The study was conducted between June 1 and August 31, 2008.

FOLLOW-UP SKIN EXAMINATION

Before the follow-up examination, scalp nevus photographs from the initial examination were printed to determine site. For children with more than 1 qualifying nevus, scalp nevi were numbered randomly. During the follow-up examination, new photographs were taken of the identified scalp nevi. Any previously undocumented scalp nevi were also counted and photographed. Study participants (n=15) who had appointments in August 2008 also had dermoscopic photographs taken (a total of 26 lesions) using the DermLite II multispectral attachment to the Nikon CoolPix 4500 (Nikon Inc, Melville, New York). Because baseline documentation of the scalp nevi did not include dermoscopy, we did not use dermoscopy in this study for comparison.

All the participants also had a total-body survey. Similar to previous studies,[24] all pigmented macules or papules 2 mm or larger considered to be melanocytic nevi were counted on the body. The scalp was defined as the hair-bearing region on top of the head with 1-cm margins and corresponded to 6.5% of the body surface area. Freckles, defined as lightly pigmented, irregular macules appearing in clusters in sun-exposed sites, were distinguished from melanocytic nevi.

PHOTOGRAPH ANALYSIS

Images from the initial and follow-up examinations were reviewed by two of us (M.G. and S.J.B.). Each scalp nevus photographed was assessed using the ABCDE criteria.[25-27] A lesion was classified as asymmetrical if the pigment was not equally distributed throughout the entire lesion or if there were discrepancies in the lesion's border or shape along its vertical or horizontal axis. Borders were classified as irregular if the border was indistinct and faded into the surrounding skin (smudged) or if the border was jagged or undulated. A lesion was classified as having color variegation if multiple shades existed within 1 lesion or if there was a patterned distribution of pigment (see the next paragraph). Nevi diameters were measured from the computer monitor calibrated to a scale included in the image. Any change in these ABCD characteristics or elevation between initial and follow-up images was classified as evolution.

Scalp nevi that had characteristic patterns of color were categorized as eclipse, reverse eclipse, or cockade. Eclipse nevi have a tan center and an irregular brown peripheral rim.[23] Reverse eclipse nevi have a brown center and a tan peripheral rim. Cockade nevi have targetlike morphologic features, typically with a centrally pigmented portion, an intervening nonpigmented area, and a peripheral pigmented portion.[28]

Nevi that demonstrated objective evidence of change were categorized as either more or less atypical than in the initial photograph. To be categorized as more atypical, nevi had to demonstrate more asymmetry, more irregular borders, more color variegation, or increased diameter. In contrast, a nevus was categorized as less atypical if the shift in clinical morphologic features was toward the appearance of a banal or disappearing nevus.

FOLLOW-UP QUESTIONNAIRE

All the participants completed a questionnaire at their follow-up appointment with the help of their guardians or parents. They were asked to answer the following questions regarding their scalp nevi (moles): (1) Have you noticed a change in the symmetry of your mole since your last visit? (If you drew a line down the middle of the mole, has one side changed more than the other?) (2) Have you noticed a change in the borders of your mole since your last visit? (3) Have you noticed a change in the color of your mole since your last visit? (4) Have you noticed a change in the size of your mole since your last visit? If yes, has it gotten bigger or smaller? (5) Does your mole ever itch? (6) Does your mole ever bleed? (7) Does your mole ever hurt? (8) Does the appearance of the mole bother you?[29] The questionnaire also included questions about demographics and personal or family history of melanoma.

STATISTICAL METHODS

Descriptive statistics were calculated to characterize the study cohort, to describe the percentage of scalp nevi that experienced change, and to compare questionnaire responses with investigator findings. All the demographic data are reported at the time of each patient's follow-up examination. The prevalence of scalp nevi was determined in relation to sex, age group, and total-body nevus count.

Univariate analysis using clustered logistic regression models was conducted to evaluate factors that affect nevus change, including sex, age group (<8, 8 to 12, and >12 years old, similar to previous studies[18]), patterned distribution of color (eclipse, reverse eclipse, and cockade), and family history of melanoma. Follow-up time was included as an adjustment variable in all the models because patients with longer follow-up are more likely to have changes in their nevi than are patients with shorter follow-up. A clustered model was used to account for the correlation between nevi on the same patient.

The Fisher exact test was used to identify differences in the number of scalp nevi by sex. A $P \leq .05$ was considered significant. Statistical analyses were performed using SAS statistical software (version 9.1.3; SAS Institute Inc, Cary, North Carolina).

RESULTS

RESPONSE AND DEMOGRAPHIC CHARACTERISTICS

Of the 93 invited children, 28 (30%) participated, including 13 boys and 15 girls. Participants ranged from 5 to 17 years old (mean age, 11 years). Eleven participants were older than 12 years but no older than 18 years, 12 were aged 8 to 12 years, and 5 were younger than 8 years. The 28 participants had a total of 44 clinically distinctive scalp nevi documented at initial examination. Follow-up ranged from 1 to 12 years (mean, 2.8 years). All the participants were white. No participant developed melanoma during follow-up. A family history of melanoma was present in 36% of the patients (n=10).

On follow-up examination, 69 scalp nevi (clinically distinctive or otherwise) were observed on the 28 participants, of which 44 (64%) had been documented on the initial examination as clinically distinctive and were, therefore, compared. The remaining 25 scalp nevi were first photographed at the follow-up examination only and were, therefore, not compared. These newly documented nevi do not necessarily represent new nevi and may reflect more thorough counting of the overall number of scalp nevi (whether clinically distinctive or not) at follow-up. The 25 newly documented scalp nevi were much smaller than the 44 clinically distinctive scalp nevi originally documented (mean diameter, 3.5 vs 6.1 mm). None of these newly documented scalp nevi (36% of total scalp nevi) demonstrated clinically unusual or distinctive features.

Of the 44 scalp nevi originally documented and followed up, 28 (64%) had characteristic color distributions, with 8 being classified as eclipse, 16 as reverse eclipse, and 4 as cockade (**Figure 2**). None of the 25 newly documented scalp nevi had a characteristic color distribution. Twenty-three of the 28 participants had at least 1 scalp nevus with one of these patterns of color distribution. Three participants had more than 1 of the 3 varieties of nevi on their scalp, supporting claims that eclipse nevi and cockade nevi may be on a continuum.[30] Participants with any of these 3 scalp nevi with characteristic color distributions had a mean scalp nevus count of 2.7 and a mean total-body nevus count of 47. All other participants had a mean scalp nevus count of 2.6 and a mean total-body nevus count of 19.4. None of the nevi resembled typical Spitz nevi.[31]

CHANGES IN SCALP NEVI AND QUESTIONNAIRE RESULTS

Of the 44 clinically distinctive scalp nevi originally documented, 34 (77%) demonstrated observable clinical changes on follow-up (symmetry, 24% [n=8]; border, 15% [n=5]; color, 44% [n=15]; diameter, 26% [n=9]; papu-

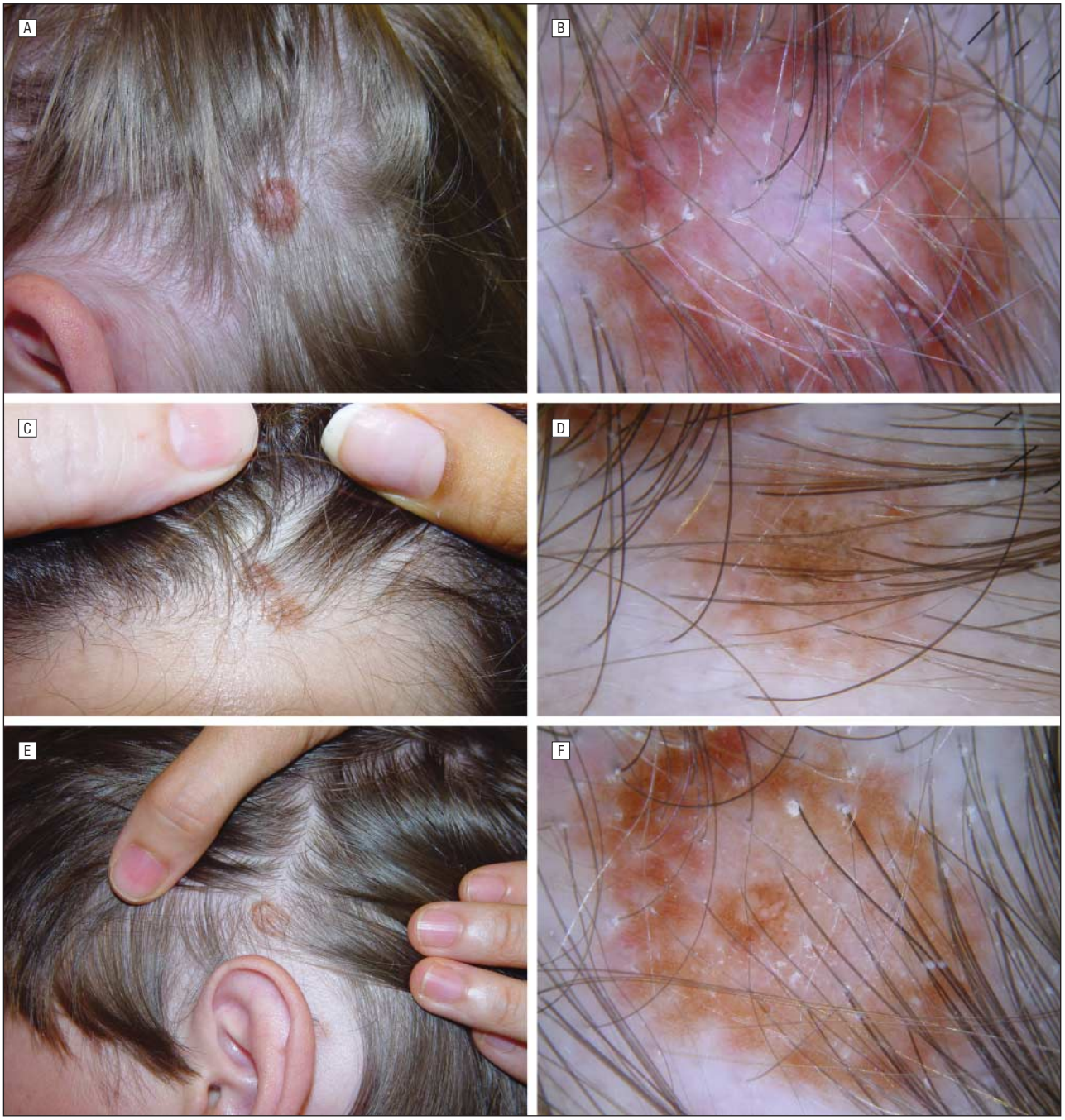

Figure 2. Examples of pattern morphologic features of scalp nevi. Shown are overview pictures (A, C, and E) from a digital camera and close-up photographs (B, D, and F) from a dermoscopic camera (original magnification ×10). The images demonstrate eclipse (A and B), reverse eclipse (C and D), and cockade (E and F) morphologic features.

lar center, 32% [n=11]; and multiple factors, 32% [n=11]). Of those with noticeable changes, 18 (53%) became more atypical and 16 (47%) became less atypical. Most scalp nevi that became more atypical were because of increased diameter (7 of 18 [39%]) and more color variegation (6 of 18 [33%]). Six percent of the scalp nevi (1 of 18) had more than 1 feature that became more atypical. Although clinical features in 53% of the nevi became more atypical, none of the changes were considered to be concerning for melanoma or to require excision. The most common features to change in those nevi to become less atypical were color variegation, asymmetry, and elevation. The effects of sex ($P=.56$), age ($P=.16$), and patterned color distribution ($P=.51$) on the probability of scalp nevus change were not significant. Nevi on participants with a family history of melanoma were not more likely to change compared with those on participants without such a history ($P=.02$).

When participants and their parents or guardians were asked to assess scalp nevi, 43% (12 of 28) noted a change in the ABCD criteria (symmetry, 0%; border, 0%; color, 14% [4 of 28]; and diameter, 39% [11 of 28]). Fifteen of the 28 respondents (54%) agreed with the investigator regarding overall change in ABCD criteria. Of those, only

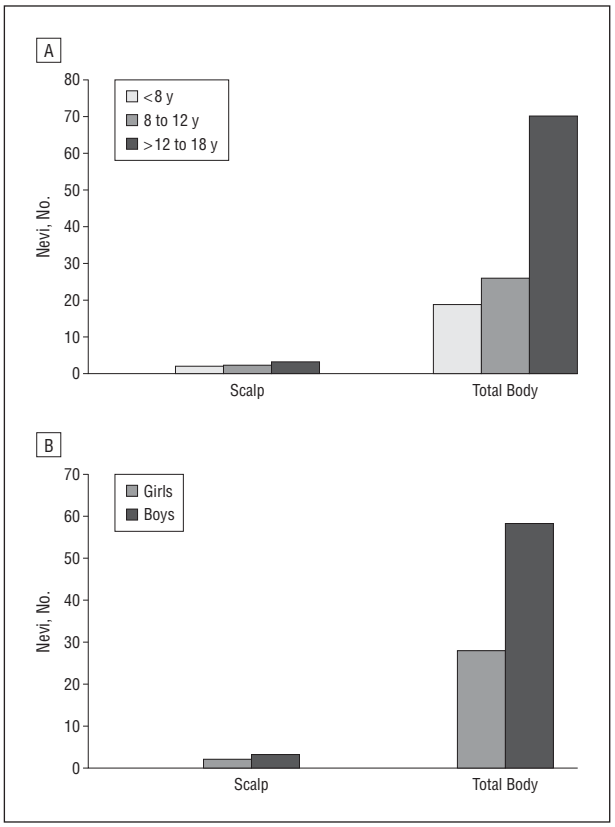

Figure 3. Trends in mean nevus counts by age group (A) and sex (B). Scalp and total-body mean nevus counts increased by age group, and boys had more nevi than did girls on the scalp and the total body.

6 (40%) of the respondents agreed with investigators regarding the specific criterion that had changed. No participant reported that their scalp nevus itched or bled, although 1 participant described mild pain. The appearance of the scalp nevus bothered 5 of the 28 participants (18%).

TOTAL-BODY NEVUS COUNTS

All nonscalp nevi on the 28 patients were clinically banal in appearance. The mean total-body nevus count was 42, and the mean total scalp nevus count was 2.6. Anatomic site breakdown for total-body nevi on the 28 participants was as follows: scalp, 6% (2.6 of 42); upper extremities, 29% (12 of 42); back, 22% (9.4 of 42); lower extremities, chest, and face; 11% each (4.5 of 42); neck; 8% (3.2 of 42); and ears and buttocks, 1% each (0.5 of 42). All calculations were based on means for site. Mean total-body nevus count and mean scalp nevus count increased with age (**Figure 3**A). Boys had higher total-body nevus counts (2.1 times higher; $P=.04$) and scalp nevus counts (1.5 times higher; $P=.03$) than did girls (Figure 3B).

COMMENT

Scalp nevi in children may be distinctive in appearance, change over time, and represent a common reason for referral to dermatologists.[32] Because of their relationship with melanoma, it is important to understand the evolution of nevi. Scalp nevi are particularly poorly understood and challenging to manage. Many scalp nevi often have a unique pattern of pigmentation, for example, eclipse. These benign morphologic features have appeared infrequently in the literature and may be worrisome to parents and inexperienced physicians.[23,28,30,33]

In this study, we observed several trends in nevus counts regarding age, sex, and the presence of scalp nevi with characteristic color distributions. Mean scalp and total-body nevus counts increased with age. Participants with scalp nevi with characteristic color distributions had a trend toward higher mean total-body nevus counts, supporting claims that these lesions are markers for children who are destined to become "moley."[34] We also found that boys had higher mean scalp and total-body nevus counts, agreeing with previous studies.[35-38]

The development of scalp nevi in childhood may be a marker for higher-than-average total-body nevus counts.[32,35] In a study[35] looking at the frequency and distribution pattern of melanocytic nevi in 524 Swedish children, those with 1 or more nevi on the scalp had twice as many nevi compared with those without scalp nevi. A recent study[32] of 180 children in Spain confirmed that scalp nevi are a marker for higher total-body nevus counts. The present study concurs.

We also found that a high percentage of children evaluated for scalp nevi had a family history of melanoma. Scalp nevi may be a genetic marker for those with increased risk of melanoma, on the scalp or elsewhere, or it may be that these patients were more concerned about nevi than were others without a family history of melanoma.

Based on responses to the questionnaire, patients and their families observed their own scalp nevi, and more than 50% had noted change. However, their observations agreed with the physician's assessment only 40% of the time. These discrepancies could be attributable to parents not having clinical photographs to accurately compare changes over time. These data reinforce the importance of serial physician evaluations and photography for scalp nevi.

This study has limitations. First, the sample size was small. Also, selection bias existed in terms of the original referral and families' subsequent decisions to participate. Children may have been brought in because of a family history of melanoma. Because of these biases, this population may have more scalp nevi and a greater rate of clinical change in nevi compared with the general population. In addition, we limited this study to acquired rather than congenital melanocytic nevi. This determination was based on parental recall. It is possible that some small congenital nevi were mistakenly included because of errors in parental recall.

The ABCDE evaluation system is a widely used, well-validated scale for clinical appraisal of pigmented lesions. However, application of the ABCDE criteria can be physician dependent, and, as shown in other studies,[23,28,39] many clinically distinctive yet benign nevi can share several of the ABCDE properties of melanoma. We used the ABCDE system as a descriptive method to serve as a starting point to decide whether a nevus may need further evaluation.

This preliminary study does not support excisional biopsies but does support physician evaluation of scalp nevi evolution and serial photography of clinically distinctive lesions. We plan to prospectively observe these patients via

clinical images and dermoscopy images. These results confirm and begin to characterize the evolution of scalp nevi.

This study demonstrated that clinically distinctive scalp nevi in children frequently undergo benign changes, with 77% of all evaluated nevi changing during the observation period. These clinical changes included either an increase or a decrease in atypical features; however, none of the changes were worrisome for melanoma. Long-term follow-up is needed to further delineate the significance of the changes.

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Author Contributions: Drs Gupta and Bayliss had full access to all the data in this study and take responsibility for the integrity of the data and the accuracy of the data analysis. *Study concept and design:* Gupta, Gray, and Bayliss. *Acquisition of data:* Gupta and Bayliss. *Analysis and interpretation of data:* Gupta, Berk, and Cornelius. *Drafting of the manuscript:* Gupta. *Critical revision of the manuscript for important intellectual content:* Gupta, Berk, Gray, Cornelius, and Bayliss. *Statistical analysis:* Gupta. *Obtained funding:* Bayliss. *Administrative, technical, and material support:* Cornelius and Bayliss. *Study supervision:* Bayliss.
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