Dermatology Practical & Conceptual

Patients' Ability to Take Dermoscopic Follow-Up Images of Atypical Melanocytic Lesions With Smartphones: A Pilot Study

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Key words: Teledermatology, Dermoscopy, Atypical melanocytic lesion, Short-term monitoring, Smartphone

Citation: Berglund S, Paoli J, Svensson P, Terstappen K, Gillstedt M, Dahlén Gyllencreutz J. Patients Ability to Take Dermoscopic Follow-Up Images of Atypical Melanocytic Lesions With Smartphones: A Pilot Study. *Dermatol Pract Concept*. 2024;14(4):e2024268. DOI: https://doi.org/10.5826/dpc.1404a268

Accepted: June 27, 2024; **Published:** October 2024

Funding: None.

Competing Interests: None.

Authorship: All authors have contributed significantly to this publication.

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ABSTRACT

Introduction: Short-term teledermoscopic monitoring helps to distinguish early melanomas from nevi. As the incidence of melanoma is increasing, there are several benefits of patients' taking their own dermoscopic images, but only a few previous studies have investigated the feasibility of this approach.

Objectives: To examine patients' ability to take evaluable dermoscopic images of atypical melanocytic lesions in need of short-term monitoring.

Methods: Patients were asked to take follow-up images in their homes using a borrowed dermoscope and their own smartphone. It was investigated whether the management decision differed when assessing follow-up images taken by patients compared to follow-up images taken by hospital staff. Lesions were rated as either changed, unchanged, or in need of further monitoring. In addition, image quality and patients' attitudes towards taking dermoscopic follow-up images were studied.

Results: Ninety-five patients with 132 lesions completed the study. Images taken by hospital staff were of better quality than images taken by patients (P<0.001). A total of 24 dermoscopic images taken

by patients (18.2%) were of poor quality and considered unsuitable for assessment at follow-up. In the remaining 108 lesions, the management decision was concordant in 95 cases (88.0%). Most patients found the procedure to be easy to perform, and 76.0% of patients answered that they preferred self-photography.

Conclusions: Self-photography for teledermoscopic evaluation of atypical melanocytic lesions is feasible, but it results in worse image quality, which may lead to discordant evaluations. Dermoscopes used for this purpose need to be more user-friendly and maintain a higher technical standard.

Introduction

Melanomas diagnosed at an early stage (≤1 mm in Breslow thickness) without ulceration have an excellent prognosis, with almost 100% melanoma-specific survival [1]. Although melanomas are often visible to the naked eye, early cases (in situ and thin melanomas) can be difficult to distinguish from nevi. Since melanomas change over time, early melanomas can be identified by comparing sequential dermoscopic images (safety interval 2.5–4.5 months apart) of atypical melanocytic lesions (AMLs) [2-4]. During short-term teledermoscopic monitoring, sequential dermoscopic images are examined by an expert in dermoscopy side-by-side on a computer screen instead of face-to-face [3].

Teledermoscopy is safe and effective for referral triaging, skin self-examination, and lesion monitoring [3, 5-8]. There are a variety of different hand-held dermoscopes available today, and as technology evolves, so does the image quality [9]. Traditionally, dermoscopic images are taken by health care professionals. A previous study presented promising results when investigating patients' ability to take dermoscopic follow-up images of AMLs during short-term monitoring using borrowed smartphones and dermoscopes under supervision [10].

The purpose of this study was to determine whether patients were able to take evaluable dermoscopic follow-up images of AMLs for teledermoscopic short-term monitoring using a borrowed dermoscope and their own smartphone without supervision. The primary outcome was to compare the concordance between the assessment of lesion change made between follow-up images taken by patients and hospital staff. Secondary outcomes were to compare image quality and to assess patients' perceived difficulty when taking dermoscopic images with their own smartphone. The main hypothesis was that the assessment of lesion change would not differ between images taken by patients and hospital staff.

Materials and Methods

Participants

Eligible patients (aged ≥18 years) with 1–3 AMLs suitable for short-term teledermoscopic monitoring were asked to participate in the study. They had to have access to a smartphone with a built-in camera, and if their lesion was situated on an inaccessible body part, they had to be able to ask a relative or friend for help. Exclusion criteria were patients with familial melanoma and lesions with any of the following criteria: high suspicion of melanoma, blue or gray color, nodular lesions, and lentiginous lesions in chronically sun-damaged skin. Recruitment was performed during 2021-2022 at Sahlgrenska University Hospital (Gothenburg, Sweden), Frölunda Specialist Hospital (Gothenburg, Sweden), and Skaraborg Hospital (Skövde, Sweden).

Study Design

Baseline clinical and dermoscopic images of AMLs planned for short-term teledermoscopic monitoring were taken by hospital staff during the first appointment. Hospital images were taken with either an iPhone SE, iPhone 8, or iPhone 11 smartphone (Apple Inc, USA) and a DermLite DL4 dermoscope (3Gen Inc, San Juan Capistrano, CA, USA). After 3–4.5 months, patients were asked to return to the hospital to take new sets of images in line with the current short-term monitoring procedure [3]. In addition, patients were instructed to take images at home with their own smartphone and a borrowed DermLite HÜD dermoscope (3Gen Inc, San Juan Capistrano, CA, USA) 1–7 days prior to their second hospital visit (Figure 1). The dermoscope and its universal connection device were sent to the patients by mail or handed to them at the first appointment. Simple oral instructions on how to take dermoscopic images were given to the patients at the time of study inclusion. More detailed written instructions and a video showing how to attach the dermoscope to a smartphone and how to take images were also made available to the patients. The importance of adding a large amount of immersion fluid to the lesion before it was photographed was emphasized in all instructions. Dermoscopes were returned during the second hospital visit and the images were transferred to the hospital server.

Management Decision

The teledermoscopic comparisons between the baseline and the follow-up images were performed by experts in

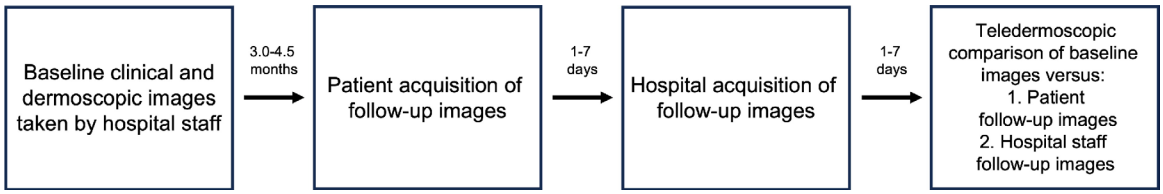

Figure 1. Timeline of the Study Procedures and Visits.

teledermoscopy (J.P. at Sahlgrenska University Hospital, J.D.G. at Frölunda Specialist Hospital, and K.T. at Skaraborg Hospital) 1–7 days after the follow-up visit. First, the baseline image and the patient's image were examined side-by-side on a computer screen. At this point, the examiner did not have access to the follow-up images taken by hospital staff. The lesion in the images was rated as either (1) changed - proceed with excision, (2) unchanged, or (3) need for further monitoring (i.e., the patient was asked to return to the hospital after another 4–6 months to take additional follow-up images). Subsequently, the same teledermoscopy experts compared the baseline images and the follow-up images taken by hospital staff. Once again, the images of the same lesion were examined side-by-side on a computer screen, and the lesion was rated as either changed, unchanged, or in need of further monitoring. The final management decision was based solely on the images taken by hospital staff compared to the baseline images.

Significant Change

If a lesion demonstrated a significant change, the teledermoscopist was asked to state what dermoscopic changes appeared. Examples of significant changes included morphological changes (shape, border, color, size, or elevation) or the appearance of known dermoscopic melanoma features (e.g., dots/globules, vascular structures, multiple colors, or regression) [11]. An example of non-significant changes was a uniform increase or decrease in pigmentation due to seasonal tanning, dermoscopic lighting, or camera exposure.

Image Quality

The teledermoscopists also assessed the quality of the follow-up images according to the following classification: (1) high quality, (2) acceptable quality, or (3) poor quality. High-quality images were considered to be perfect or close to perfect, and images of acceptable quality could have flaws but were considered good enough to allow for a confident management decision, whereas poor quality images were considered to be useless for this purpose. Lesions with images of poor quality were not included in the analyses of concordance.

Patient Attitudes

The patients' attitudes towards taking images at home were also registered. Patients were asked to estimate on a visual analog scale of 0 (very easy) to 10 (very difficult) how easy/difficult they perceived the technique to be. Furthermore, patients were asked if they would prefer to return to the hospital to take follow-up images or take follow-up images at home in the event that they were to develop another lesion in need of short-term teledermoscopic monitoring.

Statistical Analysis

Since this was a pilot study, a power calculation was not performed prior to study initiation. Besides descriptive statistics, Fisher's exact tests were used to compare proportions, Kruskal-Wallis tests were used to compare three or more groups, and Wilcoxon rank-sum tests were used for two-sample comparisons. P-values <0.05 were considered to be statistically significant. All statistical analyses were carried out with R version 3.5.3 (The R Foundation for Statistical Computing, Vienna, Austria).

Results

Patient and Lesion Characteristics

A total of 106 patients with 157 lesions in need of short-term teledermoscopic monitoring were included in this study. Another 51 patients were asked to participate but declined. Eleven patients with 23 lesions were excluded during the course of the study (Figure 2). Another two lesions from two different patients who had several AMLs were excluded due to (1) images being taken of the wrong lesion (this patient had a total of three lesions monitored), and (2) one out of two included AMLs not being photographed. Thus, data from a total of 95 patients with 132 lesions were analyzed. The age of the patients ranged from 19.9 to 79.7 years, and 63.2% were women (Table 1). The median size of the lesions was 5 mm, and the most common anatomical location of the AMLs was the back (Table 2). The time interval between the baseline and follow-up images taken by hospital staff ranged from 3.2 to 4.9 months (mean, 3.9 months).

Lesion Change and Excisions

Table 3 presents how many lesions were assessed as changed, unchanged, or in need of further monitoring when examining follow-up images taken by patients and by hospital staff. A total of 24 lesions had dermoscopic follow-up images of

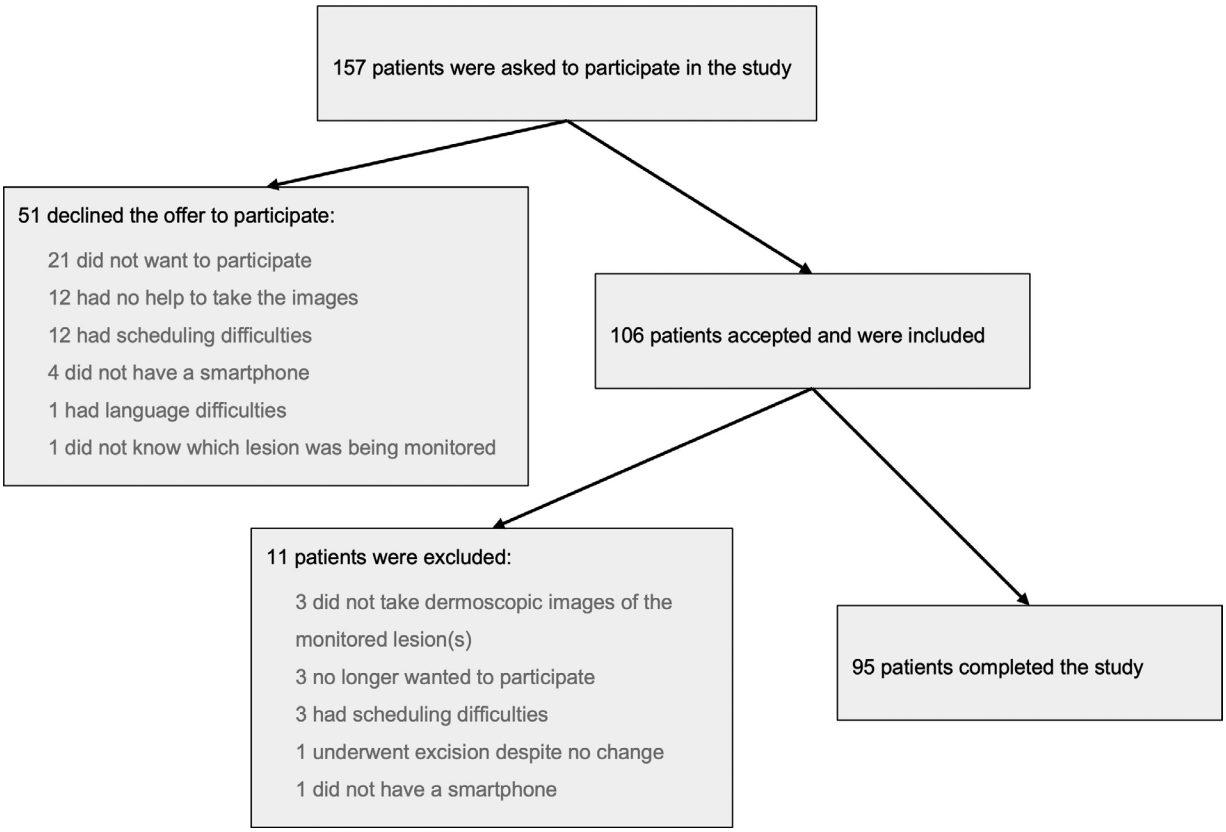

Figure 2. Flowchart of the Inclusion Process.

too poor a quality for assessment and were therefore not taken into account when looking at concordance. Among the remaining 108 lesions, the management decision was concordant for 95 of them (88.0%). Figure 3 displays an example of a discordant assessment. Of the five lesions assessed as changed when examining follow-up images taken by patients, two were assessed as changed, one as in need of further monitoring, and two as unchanged when examining the hospital images. Of the six lesions assessed as changed when examining the hospital images, two were assessed as changed, one as in need of further monitoring, and two as unchanged when examining the follow-up images taken by patients (n.b., the sixth lesion did not have follow-up images of good enough quality to make a management decision) (Table 4). Another six lesions were considered to have changed after further monitoring for another 4–6 months and were excised then.

Histopathological Diagnoses

None of the excised lesions were melanomas. Out of the six lesions excised after the initial short-term monitoring time interval, four were low-grade dysplastic nevi, and two were non-dysplastic nevi. Out of the six lesions excised after further monitoring of 4–6 months, four were low-grade dysplastic nevi, one was a high-grade dysplastic nevus, and one was a non-dysplastic nevus.

Image Quality

A total of 18.2% of the patients' images were of poor quality and could not be used for the evaluation of concordance. Images taken by hospital staff were of better quality than images taken by patients ($P<0.001$). Images taken by hospital staff were predominantly of high quality, while images taken by patients were primarily of acceptable quality (Table 5). When analyzing images taken by patients, neither their age ($P=0.062$) nor the lesion location ($P=0.17$) affected image quality. Examples of images with different quality are presented in Fig. 4.

Patients' Attitudes

Most patients (76.6%) would prefer to take their own follow-up images instead of returning to the hospital if required in the future. There was no age difference between patients who wished to return to the hospital to take images and patients who preferred to take their own dermoscopic images ($P=0.98$). Patient sex was also equally distributed between the groups ($P=1.0$). The degree of perceived difficulty varied, but 61.1% answered less than two on the visual analog scale (Figure 5).

Table 1. Patient Characteristics.

Characteristics	
Patients, *n*	95
Age, years	
Mean	48.7
Median	48.4
Range	19.9–79.7
Sex, *n* (%)	
Female	60 (63.2)
Male	35 (36.8)
Heredity for melanoma, *n* (%)	
None or unknown	73 (76.9)
First-degree relative	13 (13.7)
Second-degree relative	9 (9.5)
Prior melanoma diagnosis, *n* (%)	
None	72 (75.8)
One melanoma	21 (22.1)
Two melanomas	1 (1.1)
Three melanomas	1 (1.1)
Skin type, *n* (%)	
I	8 (8.4)
II	45 (47.4)
III	41 (43.2)
IV	1 (1.1)
Nevus count, *n* (%)	
0–25	37 (38.9)
26–50	26 (27.4)
51–100	15 (15.8)
>100	17 (17.9)
Number of nevi >5 mm, *n* (%)	
0	25 (26.3)
1–5	50 (52.6)
6–10	8 (8.4)
>10	11 (11.6)
NA	1 (1.1)

Abbreviation: n: number of patients; NA: data not available.

Table 2. Atypical Melanocytic Lesion Characteristics.

Characteristics, n	
Total number of lesions	132
Lesions per hospital, n (%)	
Sahlgrenska University Hospital	64 (48.5)
Skaraborg Hospital	41 (31.1)
Frölunda Specialist Hospital	27 (20.5)
Maximum diameter, mm	
Mean	5.9
Median	5.0
Range	2.0–12.0
Location, n (%)	
Back	62 (47.0)
Chest/abdomen	36 (27.3)
Lower extremities	22 (16.7)
Upper extremities	9 (6.8)
Acral areas	3 (2.3)
Head and neck	0 (0)
Lesions per patient	
Mean	1.4
Median	1.0
Range	1.0–3.0

Abbreviation: n: number of lesions.

Discussion

In the present study, we demonstrate that patients with AMLs in need of short-term monitoring are often able to acquire evaluable dermoscopic images with a borrowed dermoscope and their own smartphones. In addition, patients' attitudes towards taking their own images were predominantly positive, and the majority preferred this approach to returning to the hospital to take follow-up images. Nevertheless, almost one-fifth of the images did not allow for management decisions due to poor quality, and significant dermoscopic changes were sometimes only observed in the hospital staff images and not in the patient images.

The few discordant assessments of change may partially be explained by differences in technology between the dermoscopes used by the patients and the hospital staff. The borrowed dermoscope was less expensive than other dermoscopes and was chosen since it could be purchased in larger quantities and distributed to patients. Although no dermoscopes were damaged or lost during this study, there is a possible risk of this occurring when lending dermoscopes to patients. There were also technological differences between the dermoscopes. The hospital staff's dermoscope allows contact dermoscopy, unlike the borrowed dermoscope. When taking images with a non-contact dermoscope, the distance to the camera's focal point within a lesion might differ slightly and cause parts of a lesion to be unfocused [12]. Further, just a slight movement of the patient could lead to an image turning out blurry, especially when using non-contact dermoscopy [12]. However, by using non-contact dermoscopy, alteration in blood perfusion due to pressure is avoided [13]. Another example of technical differences was that although both dermoscopes used polarized light, shiny white

Table 3. Assessment of Lesion Change during Short-Term Monitoring.

	Patient image	Hospital image
Changed – proceed with excision, ***n***	5	6
Unchanged, ***n***	90	111
Need of further monitoring, ***n*** *(thereafter excised)*	13	14 *(6)*
Uncertain due to poor image quality, ***n***	24	1

n, number of lesions.

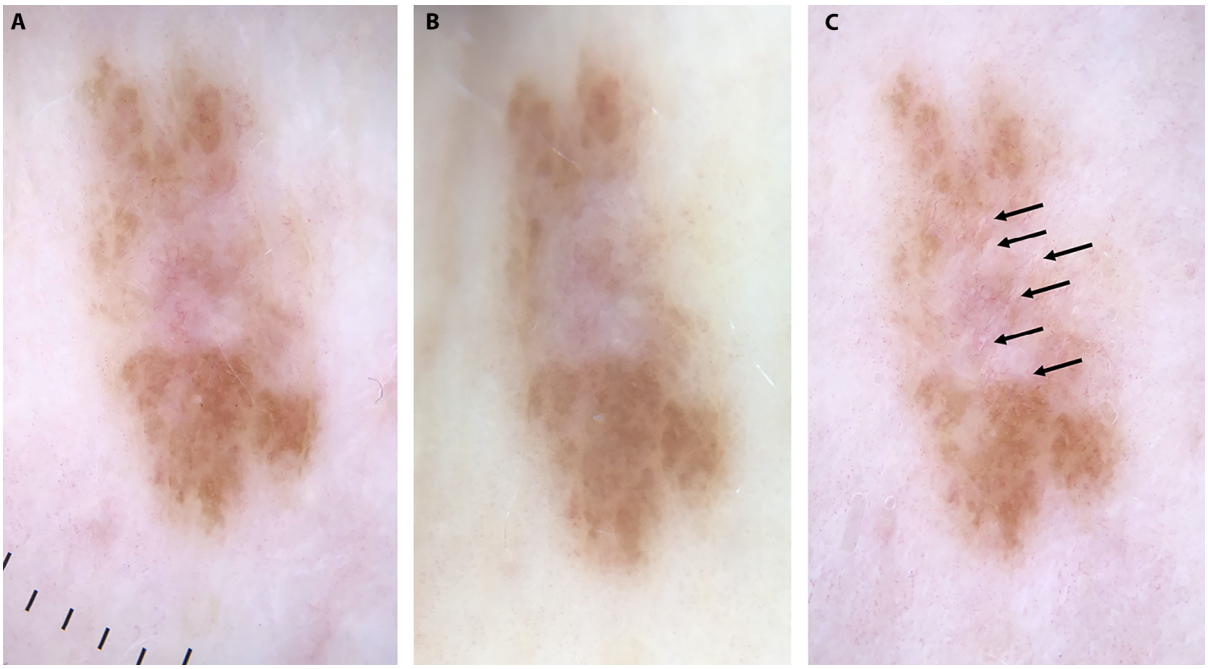

Figure 3. Example of a lesion with discordant assessments based on the patient's and the hospital staff's images. (a) Baseline image taken by hospital staff. (b) Follow-up image taken by the patient four months after the baseline image. (c) Follow-up image taken by hospital staff four months after the baseline image. A tendency towards shiny white structures was noted in the follow-up image taken by hospital staff (arrows).

structures were more apparent with the hospital staff's dermoscope. The optimal type of dermoscopic instrumentation and technique used by patients themselves still needs to be determined. To ensure the safety of the short-term monitoring process, technical aspects between different dermoscopes must be studied further [14]. Moreover, legal and ethical issues such as safe data transfer and guaranteed secrecy needs to be addressed before implementation [15].

Short-term teledermoscopic monitoring of AMLs has previously been shown to be safe and accurate. An excision rate of 9.1% in the present study (six lesions after short-term monitoring and an additional six lesions after further monitoring) was similar to the excision rate observed in a previous study by Berglund et al. (8.6%) but slightly lower than the excision rates observed by Altamura et al. and Menzies et al. (18.7–22.3%) [2-4]. This discrepancy might be explained by the option of continued monitoring after another 4–6 months, which was offered to selected patients in which possible dermoscopic changes were difficult to assess at the first follow-up visit. The optional mid-to-long-term monitoring adds slightly more complexity and subjectivity to the short-term monitoring procedure but subsequently spares even more patients from unnecessary excisions. No melanomas were diagnosed in our study, which may be explained by the small number of monitored lesions.

The hypothesis that dermoscopic images for short-term monitoring can be taken by patients themselves was first introduced by Wu et al. in 2015 [10]. In line with the findings of Wu et al., our results show a relatively high, but not perfect, diagnostic concordance between examinations of dermoscopic images taken by patients and those taken by hospital staff. In contrast, Boyce et al. presented a slightly lower concordance (69%) when comparing the diagnostic assessment of clinical images of melanocytic lesions taken by patients with smartphones with face-to-face assessments [16].

Table 4. Characteristics of Excised Atypical Melanocytic Lesions. Lesions 1-6 were Excised after Short-Term Monitoring, and Lesions 7-12 were Excised after Further Monitoring.

N	Sex	Location	Max diameter, mm	New dermoscopic feature(s)	Management decision based on patient image	Histopathological diagnosis
1	Female	Back	5	Gray/blue color	Changed – proceed with excision	Low-grade dysplastic nevus
2	Female	Lower extremities	3	Dots & globules	Changed – proceed with excision	Low-grade dysplastic nevus
3	Male	Back	3	Gray/blue color and dots and globules	Further monitoring	Low-grade dysplastic nevus
4	Female	Back	6	Atypical network	Poor image quality	Non-dysplastic nevus
5	Male	Back	7	Gray/blue color	Unchanged	Non-dysplastic nevus
6	Female	Chest/abdomen	12	Tendency towards shiny white structures	Unchanged	Low-grade dysplastic nevus
7	Female	Back	6	Dots & globules	Further monitoring	Low-grade dysplastic nevus
8	Male	Back	5	Gray/blue color and dots and globules	Further monitoring	High-grade dysplastic nevus
9	Female	Back	6	Dots & globules and atypical network	Further monitoring	Low-grade dysplastic nevus
10	Male	Chest/abdomen	10	Atypical network	Further monitoring	Low-grade dysplastic nevus
11	Female	Chest/abdomen	4	Atypical network	Unchanged	Non-dysplastic nevus
12	Male	Chest/abdomen	6	Dots & globules	Unchanged	Low-grade dysplastic nevus

Abbreviations: N: number; mm: millimeter; NA: data not available.

Table 5. Assessment of Image Quality.

	Patient image	Hospital image	*P* value
High quality, ***n***	50	116	<0.001
Acceptable quality, ***n***	58	15	
Poor quality, ***n***	24	1	

n=number of lesions.

Images taken by patients were primarily of acceptable or high quality. Nevertheless, approximately one in five images taken by patients were of poor quality compared to only one percent of images taken by hospital staff. Previous studies on image quality of images taken by patients show varying but more promising results. Manahan et al. found that less than 1% of dermoscopic images taken by patients were of poor quality [17], and Janda et al. found that 12% of dermoscopic images taken by patients were of poor quality [18]. Participants in these two studies used technically advanced and expensive dermoscopes. In addition, they investigated the diagnostic feasibility of skin self-examination and not short-term monitoring with sequential dermoscopic images, which may require a higher quality standard to be able to assess. In the study by Wu et al., only one out of 29 dermoscopic images were of too poor a quality to use for short-term monitoring assessment [10]. Poor image quality might be due to lack of training and experience among patients. Perhaps an instructive checklist could aid patients in acquiring images of better quality [19].

Most patients had a positive attitude towards taking dermoscopic follow-up images themselves and found the procedure to be easy to perform. However, since only 62.5% of the patients asked to participate actually completed the study, there might have been a selection bias with regards to which patients were included. Perhaps patients with lesions

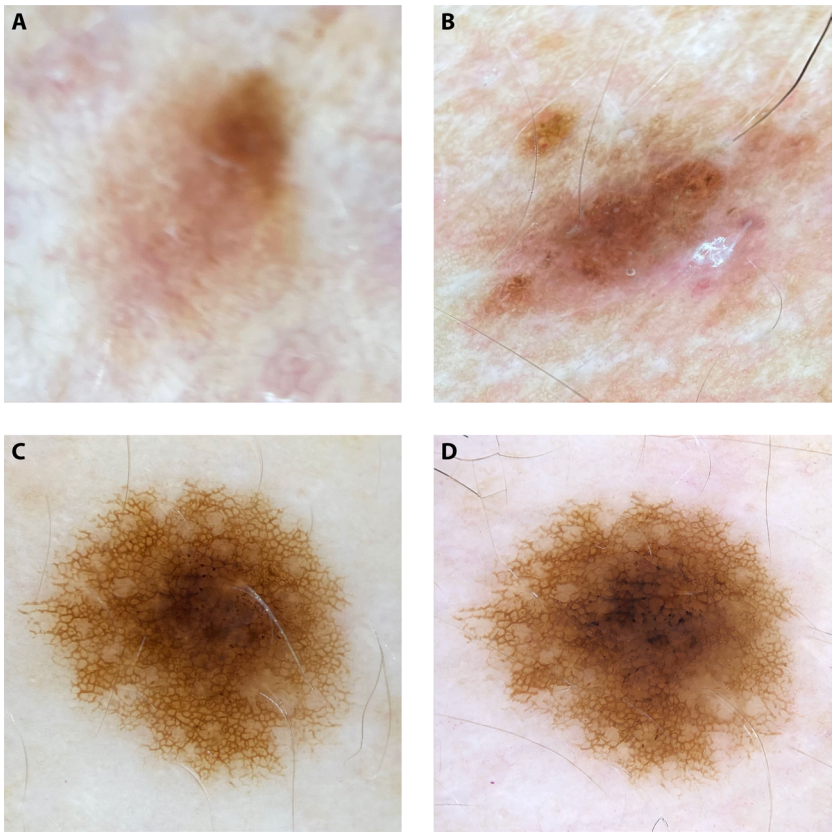

Figure 4. Examples of images of different quality. (A-C) Images taken by patients and (D) image taken by hospital staff. (A) Image rated as having poor quality, (B) image with acceptable quality, and (C-D) high-quality images.

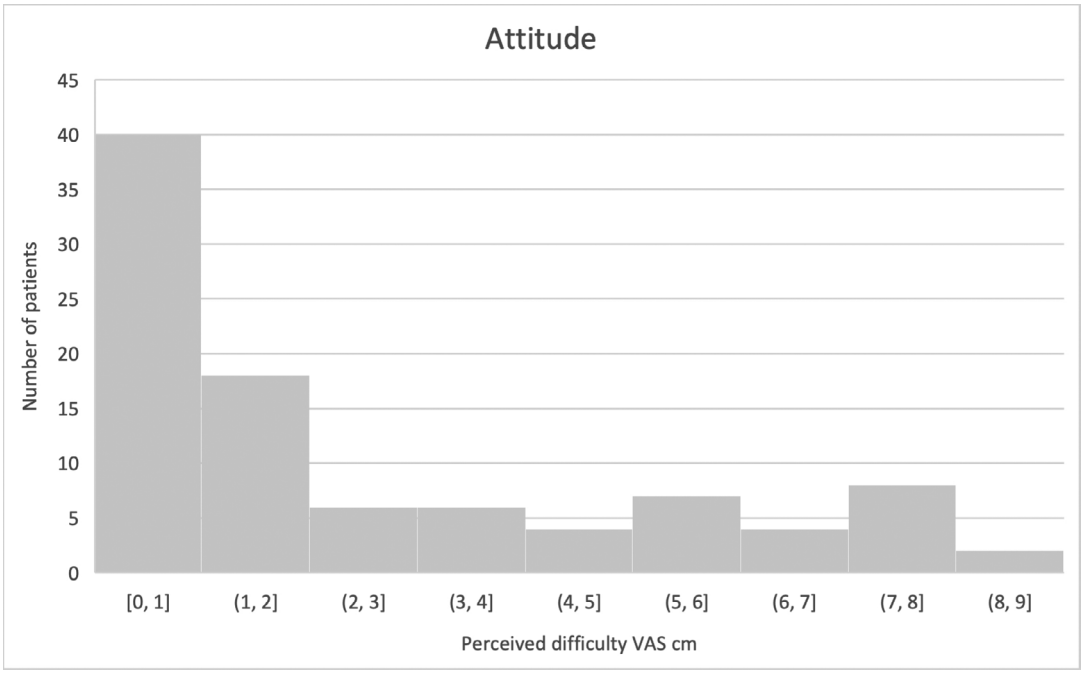

Figure 5. Patients' perceived difficulty with taking dermoscopic images with a borrowed dermoscope (0 meaning 'very easy' and 10 meaning 'very difficult'). VAS, visual analog scale.

in inconvenient or intimate areas and patients with poor technical skills chose not to participate. A prior survey study by Diethei et al. highlighted the emotional aspects of taking images of one's own body. Two-thirds of the patients preferred to send images to their doctor, but if the image was of an intimate body part, or the potential diagnosis had a poor prognosis, they preferred to see a doctor in person [20]. The option to return to the hospital to take follow-up images must always be available for these patients as well as for patients without smartphones and patients with lesions on hard-to-reach body sites without a partner to help out with the photography. In line with our results, several other studies demonstrate that patients' attitudes are overall positive when it comes to sending images to their physician for assessment, especially for detecting changes within a lesion over time [21-23]. If patients were to take their own follow-up images, it could enhance patient involvement in their own care, improve convenience by not having to travel to the hospital, and ease health care professionals' scheduling.

There are a few limitations to this study. Firstly, it was not possible to blind the teledermoscopists to which image they were assessing since the patient images had a slightly different tone of color. Therefore, the teledermoscopists had to evaluate the patient images first without access to the hospital images to minimize bias. Secondly, the evaluation of significant change within a lesion and the rating of image quality are subjective assessments [8]. However, subjectivity is inevitable when it comes to visual assessments and does therefore mimic real-world clinical practice. Furthermore, all assessments were made by single observers at single points in time. Lastly, this was a pilot study in which no melanomas were found. However, this study may help to prepare power calculations in future studies with larger study populations.

In conclusion, we show that self-photography for teledermoscopic evaluation of atypical melanocytic lesions is feasible, but it often results in worse image quality. Patients have a positive attitude towards taking dermoscopic follow-up images with smartphones. Due to the risk of discordant assessments, a lower threshold for change may need to be applied when examining images taken by patients. In addition, dermoscopes borrowed by patients probably need to be more user-friendly and maintain a higher technical standard.

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