

The Effect of Online Cytology Education on Knowledge Levels: A Pretest and Posttest Study

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Abstract

Background: Dermatologic cytology is a rapid, inexpensive, and minimally invasive diagnostic method that can provide valuable information in the evaluation of various skin diseases. However, effective use of cytology requires appropriate training and repeated exposure to cytologic images. Online learning may provide a practical approach to dermatologic cytology education by facilitating continuous access to visual educational materials. **Objective:** This study aimed to evaluate the effect of a structured online dermatologic cytology training program on the knowledge levels of dermatology residents, specialists, and faculty members. **Methods:** This single-arm prospective educational intervention study included 46 participants who completed both pretest and posttest assessments. Participants underwent a three-month online dermatologic cytology training program consisting of three live sessions and the regular sharing of cytologic images, case examples, and written and visual educational materials. Knowledge was assessed before and after the intervention using the same 25-item multiple-choice test covering different dermatologic disease groups. Changes in performance were also evaluated according to sex, professional title, hospital type, age, and duration of dermatology experience. **Results:** Significant improvements were observed after training in the proportion of correct responses for erosive disorders (0.58 ± 0.20 vs. 0.71 ± 0.18 ; $p < 0.001$), tumoral disorders (0.68 ± 0.28 vs. 0.83 ± 0.20 ; $p = 0.001$), and granulomatous disorders (0.58 ± 0.22 vs. 0.67 ± 0.14 ; $p = 0.010$). Although performance for pustular disorders increased from 0.59 ± 0.24 to 0.62 ± 0.27 , the difference was not statistically significant ($p = 0.624$). Changes in performance did not differ significantly according to sex, professional title, or hospital type. Age and duration of dermatology experience were not significantly associated with learning outcomes. **Conclusion:** A three-month structured online dermatologic cytology education program was associated with significant improvements in participants' knowledge, particularly in erosive, tumoral, and granulomatous disease groups. These findings suggest that structured online education incorporating repeated exposure to cytologic images and case-based materials may represent an accessible and useful educational approach for dermatologic cytology. Further controlled studies with larger samples and long-term follow-up are needed to confirm these findings.

Keywords: dermatologic cytology; online education; e-learning; Tzanck smear; medical education; dermatology

1. Introduction

Dermatologic cytology, commonly known in clinical practice as the Tzanck smear, is a rapid, inexpensive, easy to perform, and minimally invasive diagnostic method used in the evaluation of inflammatory, infectious, and neoplastic diseases of the skin and its appendages. This method is based on the microscopic examination of appropriately stained cellular material obtained from a lesion and can provide clinicians with diagnostic information within a short period of time, thereby supporting clinical assessment in daily dermatology practice^{1,2}.

The use of the Tzanck smear is not limited to vesiculobullous diseases but also includes infectious, inflammatory, granulomatous, and neoplastic skin disorders. Durdu et al. demonstrated the diagnostic value of the Tzanck smear in the evaluation of erosive, vesicular, bullous, and pustular skin lesions and reported that it may be particularly useful in the differential diagnosis of diseases with similar clinical presentations^{3,4}.

In addition, the potential diagnostic role of the Tzanck smear in the evaluation of pigmented skin lesions has been investigated in comparison with dermoscopy.¹ Studies evaluating its diagnostic reliability in dermatologic diseases have also supported the value of cytologic examination as an adjunctive diagnostic method when used under appropriate clinical conditions⁵.

Effective use of cytology in dermatology requires accurate recognition of cellular features and disease specific patterns in cytologic images. Repeated visual exposure and structured visual training have been shown to improve diagnostic accuracy and confidence in dermatology education^{6,7}. Therefore, visually oriented educational approaches may be useful in improving dermatologic cytology training.

Online education is a learning method that enables the sharing of visual materials and repeated access to educational content. E learning and web based educational approaches in dermatology have been shown to support knowledge acquisition⁸⁻¹⁰. Particularly in visually oriented fields such as dermatology and dermatopathology, the use of digital images and case based materials can support visual learning^{7, 11}. Given these characteristics, online education may represent an appropriate approach for dermatologic cytology training by allowing repeated evaluation of cytologic images and comparison of different cases.

However, although studies have investigated online and visually based educational methods in dermatology and dermatopathology, studies specifically focusing on dermatologic cytology education remain limited⁶⁻¹¹. Therefore, this study aimed to evaluate the effect of a three month online dermatologic cytology training program on the dermatologic cytology knowledge levels of dermatology residents, specialists, and faculty members using a pretest and posttest design.

2. Materials and Methods

2.1. Study Design and Participants

This study was conducted as a single arm, prospective educational intervention study to evaluate the effect of a three month online dermatologic cytology training program on participants' knowledge levels. The study was approved by the Scientific Research Ethics Committee of Adana City Training and Research Hospital, Meeting No. 21, Decision No. 997, dated January 15, 2026. Online informed consent was obtained from all participants.

Dermatology residents, dermatology specialists, and faculty members working in the field of dermatology were included on a voluntary basis. A total of 46 participants who completed both the baseline and final assessments were included in the final analysis.

2.2. Training Program

The training program was conducted online over a three month period. A total of three live training sessions were held at different time points during the program. The live sessions were conducted via the Zoom platform.

In addition to the live training sessions, case examples, cytologic images, and written and visual educational materials related to the topic were regularly shared through a WhatsApp group created by the participants. These materials were shared throughout the training period during the day, with the aim of exposing participants to cytologic findings from different dermatologic diseases and improving their knowledge and interpretative skills through these findings.

2.3. Knowledge Assessment Test

To assess participants' knowledge of dermatologic cytology, a 25 item multiple choice test prepared by a faculty member experienced in dermatologic cytology was used. The test was designed to cover dermatologic cytologic findings from different disease groups. Questions addressing various clinical categories, particularly tumoral, erosive, pustular, and granulomatous diseases, were included.

The questions were based on cytologic images from relevant diseases. Participants were asked to identify the most likely diagnosis from the images, select the appropriate diagnostic test, determine the next diagnostic approach, or recognize specific cell types and cytologic findings. Each question included five response options and one correct answer.

Each correct answer was scored as 1 point, whereas an incorrect answer was scored as 0 points. Accordingly, the total test score ranged from 0 to 25.

2.4. Pretest and Posttest Administration

Before the training program began, all participants completed the 25 item knowledge test online as the pretest. After completion of the pretest, the three month training program was initiated.

At the end of the three month training period, the same 25 item knowledge test used in the pretest was administered again online as the posttest. Pretest and posttest responses were matched using individual participant codes. A total of 46 participants who completed both assessments were included in the final analysis.

Using the same set of questions in both assessments was intended to evaluate changes in participants' knowledge levels following the training program.

2.5. Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics for Windows, Version 26.0, IBM Corp., Armonk, NY, USA. Continuous variables were expressed as mean $\pm$ standard deviation, minimum, and maximum values, whereas categorical variables were presented as number and percentage.

A paired samples t test was used to compare the proportions of correct responses before and after the training. A two way mixed repeated measures analysis of variance was used to assess whether changes in performance before and after training differed according to sex, professional title, and type of hospital. The potential effects of age and duration of dermatology experience on training outcomes were evaluated by including these variables as covariates in the model. All statistical tests were two sided, and a p value below 0.05 was considered statistically significant.

3. Results

3.1. Participant Characteristics

A total of 46 participants who completed both the pretest and posttest assessments were included in the study. The mean age of the participants was 32.35 ± 8.37 years, with a range of 24 to 55 years, and the mean duration of experience in dermatology was 6.53 ± 8.13 years, with a range of 0.1 to 28 years. Of the participants, 31, corresponding to 67.4%, were women and 15, corresponding to 32.6%, were men. Regarding professional title, 28 participants, corresponding to 60.9%, were dermatology residents, 8, corresponding to 17.4%, were specialists, 2, corresponding to 4.3%, were assistant professors, 4, corresponding to 8.7%, were associate professors, and 4, corresponding to 8.7%, were professors. Table 1.

Table 1. Demographic and professional characteristics of the participants, n = 46

Variable	N	%
Sex		
Female	31	67.4
Male	15	32.6
Professional title		
Dermatology resident	28	60.9
Specialist	8	17.4
Assistant professor	2	4.3
Associate professor	4	8.7
Professor	4	8.7

3.2. Performance Before and After Training

When the proportions of correct responses before and after training were compared according to disease group, the mean proportion of correct responses for erosive disorders increased from 0.58 ± 0.20 before training to 0.71 ± 0.18 after training, with a statistically significant difference, $p < 0.001$.

For tumoral disorders, the mean proportion of correct responses increased from 0.68 ± 0.28 to 0.83 ± 0.20 , $p = 0.001$. For granulomatous disorders, the mean proportion increased from 0.58 ± 0.22 to 0.67 ± 0.14 , and this change was also statistically significant, $p = 0.010$.

For pustular disorders, the mean proportion of correct responses increased from 0.59 ± 0.24 to 0.62 ± 0.27 ; however, this difference was not statistically significant, $p = 0.624$. Table 2.

Table 2. Proportions of correct responses before and after training according to disease group

Disease group	Pretest, mean $\pm$ SD	Posttest, mean $\pm$ SD	Change	P
Erosive	0.58 ± 0.20	0.71 ± 0.18	+0.13	<0.001
Tumoral	0.68 ± 0.28	0.83 ± 0.20	+0.15	0.001
Granulomatous	0.58 ± 0.22	0.67 ± 0.14	+0.09	0.010
Pustular	0.59 ± 0.24	0.62 ± 0.27	+0.03	0.624

Note: Values are presented as mean $\pm$ standard deviation. Proportions are expressed on a scale from 0 to 1 and correspond to 58%, 71%, 68%, 83%, 58%, 67%, 59%, and 62%, respectively. The p values were obtained from paired samples comparisons.

3.3. Subgroup Analyses

Changes in performance before and after training were evaluated according to sex, professional title, and type of hospital. No statistically significant differences were observed according to sex, professional title, or hospital type in any of the erosive, tumoral, granulomatous, or pustular disease groups, with all p values greater than 0.05. Table 3.

3.4. Effects of Age and Experience

The possible effects of age and duration of experience in dermatology on learning outcomes after training were also evaluated as covariates. No statistically significant associations were identified for age or experience in any of the disease groups, with all p values greater than 0.05.

Table 3. Evaluation of changes in performance before and after training according to sex, professional title, and hospital type

Disease group	Variable	Subgroup	Pretest Mean $\pm$ SD	Posttest Mean $\pm$ SD	P
Erosive	Sex	Men	0.59 $\pm$ 0.22	0.71 $\pm$ 0.22	0.261
		Women	0.57 $\pm$ 0.19	0.71 $\pm$ 0.16	
Erosive	Professional title	Resident	0.56	0.70	0.609
		Specialist	0.59	0.73	
		Assistant professor	0.65	0.60	
		Associate professor	0.58	0.63	
		Professor	0.67	0.83	
Erosive	Hospital type	State hospital	0.83	0.83	0.196
		Training and Research Hospital	0.51	0.68	
		University hospital	0.60	0.71	
Tumoral	Sex	Men	0.80	0.84	0.495
		Women	0.63	0.83	
Tumoral	Professional title	Resident	0.62	0.84	0.468
		Specialist	0.78	0.88	
		Assistant professor	0.60	0.70	
		Associate professor	0.75	0.80	
		Professor	0.90	0.85	
Tumoral	Hospital type	State hospital	0.87	0.93	0.585
		Training and Research Hospital	0.64	0.87	
		University hospital	0.70	0.79	
Granulomatous	Sex	Men	0.55	0.63	0.105
		Women	0.59	0.69	
Granulomatous	Professional title	Resident	0.55	0.65	0.824
		Specialist	0.56	0.72	
		Assistant professor	0.75	0.63	
		Associate professor	0.56	0.63	
		Professor	0.69	0.75	

Disease group	Variable	Subgroup	Pretest Mean $\pm$ SD	Posttest Mean $\pm$ SD	P
Granulomatous	Hospital type	State hospital	0.75	0.75	0.114
		Training and Research Hospital	0.53	0.67	
		University hospital	0.60	0.65	
Pustular	Sex	Men	0.65	0.62	0.419
		Women	0.56	0.62	
Pustular	Professional title	Resident	0.57	0.60	0.471
		Specialist	0.59	0.75	
		Assistant professor	0.75	0.38	
		Associate professor	0.56	0.69	
		Professor	0.69	0.56	
Pustular	Hospital type	State hospital	0.75	0.83	0.953
		Training and Research Hospital	0.55	0.60	
		University hospital	0.61	0.61	

4. Discussion

This study evaluated the effect of online cytology education on participants' knowledge levels using a pretest and posttest design. Our findings demonstrated a significant increase in participants' knowledge levels following the educational intervention and support the potential effectiveness of online learning environments as a tool for cytology education. This result is consistent with previous studies in medical education showing that web based learning interventions can improve knowledge acquisition¹². Similarly, web and mobile based platforms such as CytoAcademy, developed by the Korean Society for Cytopathology in the post pandemic period, have emerged as successful examples of maintaining continuity in cytopathology education through whole slide images, on demand lectures, and self assessment tests¹³.

The effectiveness of online learning in knowledge acquisition is not limited to studies specifically addressing cytology. A meta analysis involving medical students reported that online learning resulted in significantly higher posttest scores compared with offline learning, with an SMD of 0.81 and a 95% confidence interval of 0.43 to 1.20. However, no significant difference was observed between the two methods in terms of changes between pretest and posttest scores, with an SMD of 3.03, a 95% confidence interval ranging from negative 0.13 to 4.13, and a p value of 0.07¹⁴. This finding suggests that the quality of educational content and instructional design may be more important than the medium through which the content is delivered.

Similarly, a Cochrane systematic review reported that online learning did not provide a significant advantage over traditional learning in terms of knowledge, behavior, or patient outcomes among health professionals, but emphasized its value as a complementary educational approach because of its accessibility, flexibility, and cost advantages¹⁵. Another systematic review involving students in health professions demonstrated that the effect of online educational interventions on knowledge acquisition varied according to the content and design characteristics of the intervention¹⁶.

Evidence specifically related to cytology education also supports these findings. A randomized crossover study conducted among medical students with no previous experience in cytology demonstrated that whole slide images and virtual microscopy based

tutorials were effective digital resources for learning cytopathology¹⁷. Similarly, online cytology workspaces were reported to improve the knowledge levels of residents, and 86% of participants stated that these applications improved their cytology knowledge¹⁸. Consistent with this literature, our findings suggest that structured online educational modules may be effective in facilitating the acquisition of fundamental knowledge related to cytology. In addition, recent findings showing that online learning experiences can provide significant knowledge gains regardless of learners' baseline knowledge levels further support the interpretation that online education may be effective even among participants with differing levels of prior knowledge¹⁹.

Among the main strengths of our study are the use of educational content structured within a current and standardized curriculum, the incorporation of a self assessment component designed to reinforce learning, and the evaluation of participants before and after training using the same assessment tool. Self assessment tests are known to help learners identify their knowledge gaps and guide their learning processes, and this feature represents one of the core components of online cytopathology platforms¹³. Online education also offers important advantages by removing time and location constraints, allowing educational content to be updated, and reducing costs, particularly in the context of continuing medical education and during the pandemic period^{13,17}.

However, this study has several limitations. First, because the pretest and posttest self controlled design did not include a control group, it was not possible to determine whether the observed knowledge gain was attributable specifically to the online learning environment or to the educational content itself. Previous literature on web based learning has similarly emphasized that studies without a control group cannot distinguish gains attributable to the web based format from those attributable to the educational content¹². Second, repeated administration of the same assessment tool within a relatively short interval may have introduced a test retest effect and increased participants' familiarity with the assessment instrument. This may have contributed to some of the improvement observed in posttest scores. Third, the single center nature of the study and the voluntary participation of the participants may limit the generalizability of the findings. In addition, the absence of a delayed assessment to evaluate the retention of acquired knowledge limits conclusions regarding the long term effects of the educational intervention. Although the only comparison in the literature evaluating knowledge retention reported a significant advantage of online learning, this outcome could not be assessed in the present study¹⁴.

5. Conclusion

In conclusion, this study demonstrated that a three month structured online dermatologic cytology education program was associated with a significant increase in participants' knowledge levels, particularly in the erosive, tumoral, and granulomatous disease groups. The ability of online education to facilitate regular sharing of cytologic images and case examples, repeated access to educational materials, and continuity of visual learning may make it a valuable educational approach in dermatologic cytology, a field in which visual pattern recognition plays an important role.

The applicability of this model to dermatologists with different levels of professional experience may contribute to making dermatologic cytology education more accessible and sustainable. However, these findings should be confirmed in studies with larger sample sizes, controlled designs, and longer follow up periods.

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Informed Consent: Online informed consent was obtained from all participants prior to participation in the study.

Data Availability Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

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