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Comparative study between conventional camera images and smartphone images for eyelid tumor telediagnosis.

Estudo comparativo entre imagens de câmera fotográfica convencional e smartphone para o telediagnóstico de tumores palpebrais.

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ABSTRACT

Objective: to compare the accuracy of eyelid tumor diagnosis obtained by evaluating conventional camera images with the ones obtained by evaluating smartphone images. **Methods:** from January 2016 to July 2017, 36 patients underwent face-to-face external assessments and biomicroscopic examinations to establish clinical diagnoses. The lesions were photographed using Canon PowerShot SX530 HS Digital Camera (16.8 Megapixels) and Samsung GALAXY S4 smartphone camera. All lesions were resected and submitted to anatomopathological examinations. Preoperative images were sent to two specialists in eyelid diseases and then remotely analyzed. Data from in-person diagnoses and telediagnoses were compared with the gold standard of histological diagnosis. **Results:** the most frequent lesions were basal cell carcinoma (33.3%), actinic keratosis (19.4%), and nevus (13.9%). Kappa coefficient for the diagnosis of malignant lesion showed agreement between the two tele-evaluators in the conventional digital camera images (0.68) and in the smartphone images (0.78). The face-to-face examiner's accuracy was of 94.4%; the tele-evaluators' accuracy in the conventional digital camera images was of 83.3% and in the smartphone images varied from 80.6% to 86.1%. Comparing the in-person diagnoses with the telediagnoses (obtained by evaluating conventional digital camera images or smartphone images), there was no significant difference in the hit rates. **Conclusion:** for eyelid tumor telediagnosis, images obtained using smartphone camera were equivalent to those obtained using conventional digital camera.

Keywords: Telemedicine. Eyelid Neoplasms. Smartphone. Diagnosis. Comparative Study.

INTRODUCTION

Photodocumentation is essential in the medical field, not only for the doctor but also for the patient. It is used in medical records to register the evolution of the diseases along the treatments, as well as a tool and reference for preoperative planning/period, for surgeons' self-evaluation, and for sharing information with colleagues in presentations and publications. It is also widely considered for medical insurance and medical-legal purposes[1]. In countries such as Australia, clinical pictures are considered part of medical records and physicians are required to keep them for seven years[1,2].

Several authors consider cameras with large image sensors (≥22.3mm x 14.9mm), which produce better quality images, as fundamental requirements for obtaining medical photography[1,3]. Cameras that do not allow changing lenses, such as compact ones, are not recommended. The best cameras for oculoplastic photography are the digital single-lens reflex cameras (DSLR), heavier and more expensive, or digital cameras without mirrors. The ideal lens is the macro one, which allows the 1:1 reproduction of the object with a 60-90mm lens body diameter.

On the other hand, it is undeniable that multifunction cell phones (smartphones), all with photo cameras, have changed the landscape of conventional medical photography. Currently indispensable work tools for doctors all around the world, cell phones have shown their versatility in the photographic record and information storage, along with the capacity of sharing them. However, there are doubts whether images obtained using smartphones are comparable to the ones obtained using conventional digital cameras.

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There are few studies on eyelid tumors, both in telediagnosis and in comparison of photodocumentation methods. The objective of the present study is to compare the accuracy of eyelid tumor diagnosis obtained by evaluating conventional digital camera images with the ones obtained by evaluating smartphone images.

METHODS

We selected 36 patients who were consecutively enrolled in the Ocular Plastic Surgery Center at Hospital das Clínicas (University of Sao Paulo School of Medicine/HCFMUSP), from January 2016 to July 2017, for evaluating eyelid tumors. All patients were informed about this research and signed a free and informed consent form. The study was conducted following the precepts of the Declaration of Helsinki.

All patients had their lesions photographed in two ways: with conventional Canon PowerShot SX530 HS Digital Camera (16.8 Megapixels) and Samsung GALAXY S4 smartphone camera (13 Megapixels), which takes photos with a maximum resolution of 4128x3096 pixels. All pictures were taken with LED flash on, at a distance of approximately 30cm, and with 12mm circular adhesive glued on each patient's forehead. In order to establish clinical diagnosis, patients' lesions were assessed by one of the authors of this study, through macroscopic external examinations and biomicroscopic examinations. All lesions were resected and submitted to anatomopathological examination.

The preoperative images, without any identification if they were taken with conventional digital camera or smartphone camera, were sent to two specialists in eyelid diseases and then remotely analyzed. These images were displayed on MacBook Pro Notebook Computer, with 13.3-inch screen and resolution of 2560x1600 pixels. In order to verify accuracy, data of the in-person diagnoses and telediagnoses were compared with the gold standard of histological diagnosis.

Kappa coefficient, with pontual estimates and confidence intervals of 95% (95% CI), was considered to evaluate the agreement between the two tele-evaluators in each of the photo types. The following parameters were taken into account: $k<0.40$- light agreement; k between 0.41 and 0.60- moderate agreement; and k between 0.61 and 0.80- optimal agreement. Sensitivity, specificity, positive predictive value, and negative predictive value were calculated. McNemar's test, Fischer's exact test, and the estimate equation model for logistic regression were used to evaluate the difference concerning assessment and diagnostic accuracy. The significance level assumed was 5%, that is, tests with p-values less than 0.05 were considered statistically significant. Data analysis was performed using IBM SPSS Statistics for Windows, Version 20.0, software (IBM Corp., Armonk, NY, USA) and R software (R Core Team, 2017).

This work was approved by the Institutional Ethics Committee with the following reference number 12487.

RESULTS

Table 1 shows the general characteristics of the lesions. As to location, 61.1% were in the lower eyelids and 38.9%, in the upper ones. The mean size was 7.9mm, being the percentage of malignant lesions greater than of benign ones (58.3% x 41.7%). The most frequent lesions were basal cell carcinoma (33.3%), actinic keratosis (19.4%), and nevus (13.9%).

Regarding the comparison with the gold standard of histological diagnosis, the in-person evaluator scored more than the two tele-evaluators but without significant difference ($p>0.05$) (Table 2).

Table 1. *General characteristics of patients.*

Location	N	%
Upper eyelids	14	38.9
Lower eyelids	22	61.1
Size (mm)	7.9 (mean)	
	5.50 (median)	
	1 (minimum)	
	38 (maximum)	
Benign lesion	15	41.7
Malignant lesion	21	58.3
Histology		
BCC*	12	33.3
SCC**	2	5.6
Hidrocystoma	2	5.6
Nevus	5	13.9
Papilloma	3	8.3
Actinic keratosis	7	19.4
Seborrheic keratosis	2	5.6
Xanthelasma	1	2.8
Others	2	5.6

BCC: basal cell carcinoma; SCC**: squamous cell carcinoma.*

Table 2. *Comparison of the in-person evaluator's hits with the two tele-evaluators' hits in relation to the histopathological diagnosis.*

Evaluator	Hits	Percentage of hits
In-person	22	61.1
Tele-evaluator 1		
Conventional digital camera	21	58.3
Smartphone camera	19	52.8
Tele-evaluator 2		
Conventional digital camera	20	55.6
Smartphone camera	17	47.2

Kappa coefficient showed optimal agreement between the two tele-evaluators, both in the conventional camera images and in the smartphone images, regarding the diagnosis of malignancy (Table 3).

Figure 1 illustrates one of the cases in which there was agreement in diagnosis of malignancy between in-person evaluation and tele-assessment.

Table 4 shows high sensitivity and specificity of the in-person evaluator, with very good accuracy (94.4%) in the diagnosis of malignancy. Considering conventional digital camera images, tele-evaluators' accuracy in the diagnosis of malignancy was of 83.3% (for both evaluators). In relation to smartphone images, accuracy was of 80.6% (tele-evaluator 1) and of 86.1% (tele-evaluator 2),

Table 3. *Agreement in diagnosis of malignancy between tele-evaluators.*

Diagnostic agreement	Kappa coefficient Tele-evaluator 1 x Tele-evaluator 2
Conventional camera images	0.68 (95% CI: 0.45-0.90)
Smartphone images	0.78 (95% CI: 0.58-0.97)

Table 4. *Comparison of the evaluators in the diagnosis of malignancy.*

	In-person	Tele-evaluator 1- Conventional digital camera	Tele-evaluator 2- Conventional digital câmera	Tele-evaluator 1- Smartphone camera	Tele-evaluator 2- Smartphone camera
Sensitivity	90.4%	71.4%	85.7%	71.4%	85.7%
Specificity	100%	100%	80.0%	93.3%	86.7%
PPV*	100%	100%	85.7%	93.7%	90.0%
NPV**	88.2%	71.4%	80.0%	70.0%	81.2%
Accuracy	94.4%	83.3%	83.3%	80.6%	86.1%

PPV: positive predictive value; NPV**: negative predictive value.*

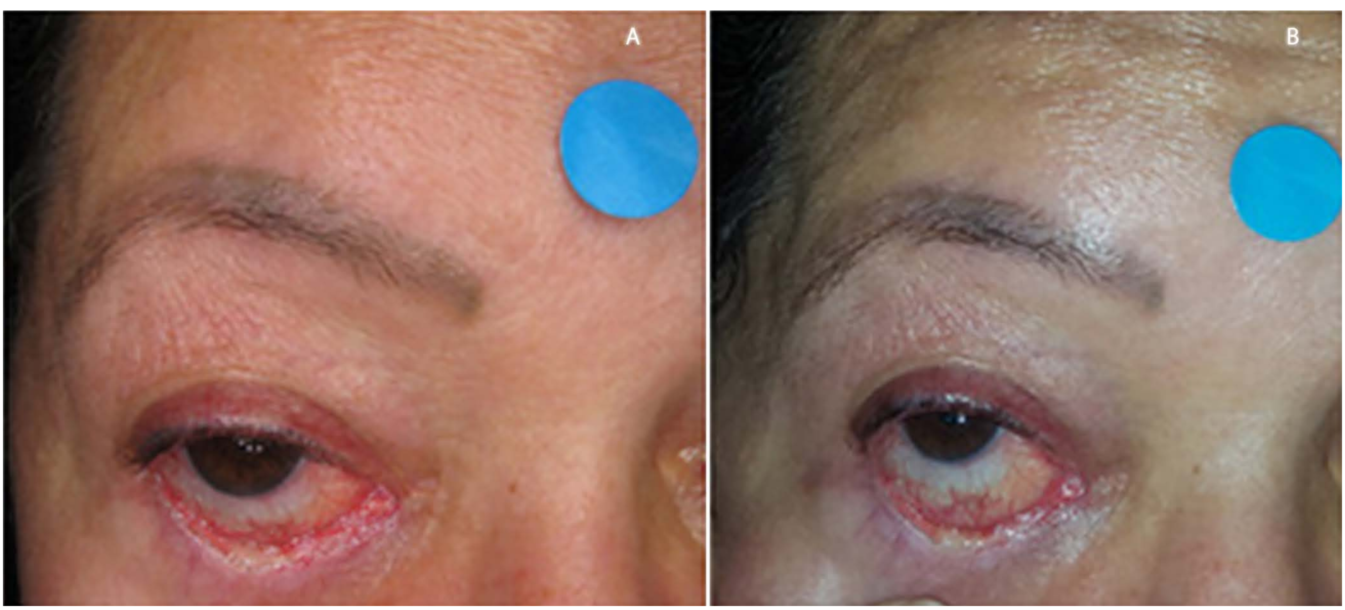

Figure 1. *Right lower eyelid with altered margin, whitish lesion, absence of eyelashes, and conjunctival hyperemia. The in-person diagnosis and the anatomopathological one were of basal cell carcinoma (BCC). The conventional digital camera photo (on the left), called A, and the smartphone photo (on the right), called B, were remotely evaluated. The diagnosis by tele-evaluator 1 was of BCC and the one by tele-evaluator 2 was of squamous cell carcinoma (SCC).*

which were also very good indexes. McNemar's test (p>0.05) showed that there was no difference in error/hit rates due to conventional digital camera or smartphone use when compared to in-person evaluation. Tumor size or location did not interfere with diagnosis in both conventional digital camera and smartphone imaging.

Image quality did not practically interfere in the tele-evaluators' performance. An exception happened with tele-evaluator 1 who performed better analyzing good quality smartphone images than regular quality ones (p=0.025).

Table 5 shows, by logistic regression model, that no variable was significant at a significance level of 5%, that is, no evidence was found to indicate that there is difference in the accuracy of the diagnoses made in person, by conventional digital camera image, or by smartphone image.

Table 5. *Multiple logistic regression model for diagnostic accuracy.*

Variable	Coefficient	Standard error	p-value
Intercept	0.402	1.287	0.755
Size mm	-0.049	0.078	0.526
Location=UL*	-0.125	1.741	0.943
Location=UR**	0.511	1.759	0.772
Location=LL***	-0.318	1.537	0.836
Good quality photo	0.372	0.345	0.282
Tele-evaluator 1 Smartphone	-0.255	0.298	0.393
Tele-evaluator 1 Camera	-0.056	0.434	0.897
Tele-evaluator 2 Smartphone	-0.511	0.338	0.130
Tele-evaluator 2 Camera	-0.115	0.296	0.697

UL: upper left; UR**: upper right; LL***: lower left.*

There were also no indications associating tumor size, location, and photo quality with the proportion of correct answers.

DISCUSSION

Several requirements are necessary for the good practice of clinical photography, from the use of a camera with appropriate lens and a computer to process and store images (computers are increasingly powerful to accumulate data) to programs to manipulate images and share files. All this demands time and financial expenditure. On the other hand, the mobile (smartphone), which is currently an indispensable work tool for physicians all over the world, has shown its versatility in the photographic record, information storage, and capacity of image and data sharing. The evolution of smartphones has been continuous, and much of its focus has been on improving the quality of cameras in order to produce more perfect images. There has been a growing replacement of conventional digital cameras with smartphones in the medical environment.

The impression is that camera makers have been teaming up with mobile phone manufacturers and developing such devices to gradually replace the digital cameras as we know them today. On the other hand, it is important to emphasize that smartphones have also been associated with the easiness of information sharing. The unscrupulous use of smartphones can not only affect the doctor-patient relationship, with ethical risks and medical-legal problems, but also lead to judicial penalties for breach of confidentiality[4].

As a small all-in-one computer, called ectopic brain, the smartphone has the power to benefit from softwares (applications/apps) that facilitate and customize physicians' needs for assistance, learning, and teaching. An interesting study by Patel *et al*. on smartphones used in conjunction with applications, in addition to photographs, has showed that mobiles have improved postoperative care in the area of breast reconstruction surgery[5].

Literature focusing on the telediagnosis of eyelid lesions is scarce[6]. Our study involved 36 patients with female predominance. The higher frequency in the lower eyelids (61.1%) corroborated with data from literature, which indicate that lesions are more frequent in lower eyelids and in individuals over 60 years of age[7]. Regarding size, although there was a variation, the mean size was 7,9mm, which, in terms of dimensions, can be considered clearly visible in photographs that show the eyelids.

Considering our study, malignant lesions (58.3%) were more frequent than benign ones (41.7%), what does not reflect the distribution in the community outside tertiary hospitals. Hospital das Clínicas has the bias of receiving more complex cases, so there was no surprise in the frequency of tumors. Studying 5504 eyelid tumors, Deprez and Uffer have found that 86% of the lesions have been benign[8]. In our research, the most frequent lesions were BCC (33.3%). In fact, BCC is the most frequently described malignant eyelid tumor and the most common malignant tumor in humans[7].

The equipments used in this study were the following: Canon PowerShot SX530 HS Digital Camera (16.8 Megapixels) and Samsung GALAXY S4 smartphone, equipped with full HD screen, Android operating system, and other good settings. Samsung GALAXY S4 may be a cheaper option, although newer models have come up. Its 13-megapixel camera has an excellent image resolution and therefore it was chosen for the photographic record of the present study.

The two tele-evaluators answered approximately 53.5% of the anatomopathological diagnosis in a correct manner while the in-person evaluator answered 61.1%, corroborating previous data that have revealed a greater difficulty in making a histological diagnosis via telemedicine[6]. Kappa coefficient showed a substantial agreement between the two tele-evaluators in the diagnosis of malignancy. In choosing the tele-evaluators, care was taken to indicate two professionals with similar experience and training time in the area in order to avoid bias. The in-person diagnostic evaluation of malignancy showed high sensitivity and specificity with very good accuracy (94.4%), comparable to the best results in literature[9]. In tele-evaluation, accuracy was a little lower than in the in-person one, but similar when comparing photos taken by conventional digital camera and by smartphone camera. In the present study, tumor size and location or photo quality did not interfere with the tele-evaluators' accuracy.

Thus, for all the presented considerations, it can be seen that images obtained by smartphone were comparable to ones obtained by conventional digital camera for eyelid tumor telediagnosis. Therefore, the growing role of the smartphone in medical documentation is undeniable.

R E S U M O

Objetivo: *comparar a acurácia do diagnóstico de tumor palpebral por avaliação de fotos obtidas por câmera convencional versus câmera acoplada em smartphone.* **Métodos:** *trinta e seis pacientes foram submetidos a exame externo e exame biomicroscópico para estabelecimento de diagnóstico clínico. As lesões foram fotografadas com câmera convencional Canon SX530 HS, digital de 16,8 megapixels e com câmera do smartphone modelo GALAXY S4. Todas as lesões foram ressecadas e submetidas a exame anatomopatológico. As imagens pré-operatórias foram analisadas à distância por dois especialistas em doenças palpebrais. Os dados dos diagnósticos presencial e dos teleavaliadores foram confrontados com o padrão ouro do diagnóstico histológico.* **Resultados:** *as lesões mais frequentes foram constituídas por carcinoma basocelular (33,3%), queratose actínica (19,4%) e nevo (13,9%). O coeficiente de Kappa para diagnóstico de lesão maligna mostrou concordância entre os teleavaliadores nas imagens por câmera (0,68) e com smartphone (0,78). A acurácia do examinador presencial foi de 94,4%, a dos teleavaliadores nas imagens por câmera foi de 83,3% e as do smartphone variou entre 80,6% e 86,1%. Não houve diferença nos índices de acerto por uso de câmera ou smartphone quando comparado com o exame presencial.* **Conclusão:** *imagens obtidas por smartphone foram equiparáveis em relação à câmera convencional para uso em telemedicina para diagnóstico de lesão maligna palpebral.*

Descritores: *Telemedicina. Neoplasias Palpebrais. Smartphone. Diagnóstico. Estudo Comparativo.*

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