Can a Correct Diagnosis Be Established Using the Teledermatology Method?

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ABSTRACT Teledermatology is a remote method of diagnosis, treatment, and follow-up of the patient with visual communication technologies. It has been a research subject for many years, but its reliability has not been fully explained. With the emergence of the coronavirus disease-19 (COVID-19) pandemic in 2019, the need for teledermatology increased. This study aimed to evaluate the reliability of teledermatology. Material and Method: A total of 595 lesions of 546 patients who visited the dermatology outpatient clinic were included in the study. Two physicians evaluated the patients, one face-to-face and the other via multimedia messaging, and the diagnoses were compared with each other. Diagnoses were in total agreement if the first diagnoses were the same, in partial agreement if the second and third diagnoses were the same, and in no agreement if all diagnoses differed. The first diagnoses of Physicians 1 and 2 matched in 468 (total agreement rate: 76.8%) patients, and the second and third diagnoses matched in 44 and 8 patients, respectively (partial agreement rate: 8.7%). There was no agreement in the diagnoses of 75 patients (12.7%). In total, an agreement was reached in 520 patients (87.3%). Common diseases in dermatology practice, such as papulopustular and urticarial lesions, nails and hair diseases, infectious diseases, erythematous squamous diseases, those with pruritus, and skin malignancies, were diagnosed teledermatologically at a high rate of accuracy. In contrast, eczematous diseases, premalignant lesions, and other groups of diseases were less accurately diagnosed. In the last year, the importance of teledermatology has greatly increased with the COVID-19 pandemic. Our study shows that the store and forward (asynchronous) method of teledermatology can diagnose dermatological diseases with a high rate of accuracy.

KEY WORDS: Teledermatology; COVID-19; Store-forward

INTRODUCTION

Telemedicine uses visual communication technologies for remote medical information exchange. Being able to establish a visual diagnosis in dermatology makes teledermatology (TD) more useful.

There are two methods in teledermatology: store-forward (asynchronous) and video conference (synchronous). These two methods are sometimes combined (hybrid method). In the store and forward method (S&F), the patient's photograph is taken and saved to the device, which is sent to the relevant physician within hours or days, and the patient is evaluated accordingly. In the video conference (VC) method, evaluation is performed by directly communicating with the patient. This method is more advantageous

in establishing an accurate diagnosis because there is direct communication between the patient and the physician. However, the S&F method is preferred due to its availability and lower cost.

Teledermatology has been a research subject for many years, but its reliability has not been fully examined. The potential disadvantages of the methods include not being able to perform a whole-body dermatological examination, evaluation of only the lesion or condition the patient is focused on, inability to perform palpation, and dependence of the diagnostic evaluation on the connection and image quality during the photo shoot or video conference. With the emergence of the COVID-19 pandemic in 2019, the need for TD increased. This study aimed to evaluate the reliability of TD.

PATIENTS AND METHODS

This prospective study included patients of all age groups who visited our hospital's dermatology outpatient clinic between September 1, 2020 and December 1, 2020. Patients with skin lesions and no prior diagnoses who voluntarily participated in our study were included. Nine patients who did not accept the photo shoot and 12 patients who encountered photo shooting errors were excluded from the study.

The participating dermatologists were named Physician 1 and Physician 2 for blinding purposes. The two physicians were in different exam rooms and could not see one another. Sixteen-megapixel smartphone cameras were used to photograph the lesions. A neutral background was preferred to standardize the photo shoot as much as possible. Photographs, including those of only the lesion area, were taken in a well-lit room, using automatic focusing and without flash. There were no signs in the photograph that could reveal the patient's identity. During the examination in the outpatient clinic, Physician 1 took the photograph as stated, sent the images and the anamnesis of the patient to Physician 2 via multimedia messaging services, then began to examine the patient. Physician 2 numbered the image received and filled out the prepared form. The date of arrival of the image and the first, second, and third preliminary diagnoses were noted.

At the end of the day, Physician 2 met with Physician 1. The patient number was found in the image archive, and both physicians' diagnoses were noted on the form. The diagnoses were considered in total agreement if the first diagnoses were the same, in partial agreement if the second and third diagnoses were the same, and in no agreement if all diagnoses differed.

Statistical analysis

Frequency (N) and percentage (%) values were used to define categorical variables. Kappa test was used to evaluate consistency among evaluators. Comparison of two variables suitable for independent and normal distribution was performed using the Student's t test, and comparison of more than two variables was done using the Kruskal Wallis test.

Statistical significance level was determined as 0.05. The analyzes were performed using the MedCalc Statistical Software version 12.7.7 (MedCalc Software bvba, Ostend, Belgium; http://www.medcalc.org; 2013) program.

RESULTS

A total of 595 lesions in 546 patients, 338 (56.8%) women and 257 (43.2%) men, were included in the study. The mean age of the patients was 32.72±17.4 years. Ninety-four patients (15.8%) aged between 0-16 years, 473 patients (79.5%) aged between 17-64 years, and 28 patients (4.7%) over 65 years of age were included in the pediatric, adult, and geriatric populations, respectively.

The first diagnoses of Physicians 1 and 2 matched in 468 (total agreement rate: 76.8%) patients, and the second and third diagnoses matched in 44 and 8 patients, respectively (partial agreement rate: 8.7%). There was no agreement in the diagnoses of 75 patients (12.7%). In total, an agreement was reached in 520 patients (87.3%). Eczematous lesions were the most evaluated (n=99, 16.6%), among which total agreement was reached in 64 patients (64.6%) and partial agreement in 14 patients (14.1%). There was no agreement in 21 patients (21.2%). Papulopustular lesions were the second most evaluated (n=96, 16.1%), with 89 patients with acne and 7 with rosacea. An agreement was reached in all these patients, with total and partial agreement rates of 95.8% and 4.2%, respectively. Tinea infections were the third most diagnosed disease group, with 67 (11.3%) patients. The rates of total, partial, and no agreement among these patients were 83.5% (n=56), 4.4% (n=3), and 12.1% (n=8), respectively. There were 29 patients (4.9%) with erythematous squamous diseases. The physicians were in total, partial, and no agreement in 82.7% (n=24), 6.9% (n=2), and 10.4% (n=3) of these patients, respectively. Total and partial agreement was reached in 41 (80.4%) and 3 (5.9%) of 51 (8.6%) patients in the viral diseases group, respectively. Among bacterial diseases, total and partial agreement was reached in 14 (70%) and 2 (10%) of 20 (3.4%) patients, respectively. The physicians agreed entirely on the diagnoses of two patients with syphilis.

In 19 patients with psoriasis, total, partial, and no agreement was reached in 14 (73.7%), 2 (10.5%), and 3 (15.8%) patients, respectively. Agreement was reached in all 8 patients (100.0%) with pityriasis rosea. Among 10 patients with urticaria, the diagnoses of 9 (90.0%) patients were in total agreement, and that of 1 (10.0%) patient was in partial agreement. Among 21 patients with pruritus the rates of total, partial, and no agreement were 52.3% (n=11), 28.6% (n=6), and 19.1% (n=4), respectively. In 30 patients (5%) with scabies, a disease recently seen all over the world, there was total agreement in 29 patients (96.7%) and partial agreement in one (3.3%). Total agreement was reached in 6 (86%) of 7 patients with vitiligo, and no agreement could be reached in 1 patient (14.0%).

Total agreement was reached in 23 (85.1%) of 27 patients with nail diseases, partial agreement was reached in 1 (3.7%) patient, and no agreement was reached in 3 (11.2%) patients. The rates of total, partial, and no agreement among 22 patients with onychomycosis were 91.0% (n=20), 4.5% (n=1), and 4.5% (n=1), respectively. Total agreement was reached in all patients (100.0%) with hair diseases. In 9 patients with seborrheic keratosis, the physicians were in total agreement in 6 patients (66.7%), partial agreement in 1 patient (11.1%), and no agreement in 2 (22.2%). In two patients with actinic keratosis, which is one of the premalignant lesions of the skin, there was total agreement in one and no agreement in one patient. The physicians were in partial agreement on one patient with actinic cheilitis. There was total agreement in all patients with malign lesions, four basal cell carcinoma (BCC), and one squamous cell carcinoma (SCC).

There was one patient each with the diagnoses of photo contact dermatitis, lichen sclerosis, knuckle pad, pseudolymphoma, and lichen spinulosus in the "others" group, and there were no agreements on these diagnoses. Partial agreement was achieved in one patient each with traumatic bullae, pyogenic granuloma, and nevoid keratosis. Other findings are presented in Table 1.

DISCUSSION

TD has gained importance in the last year due to the COVID-19 pandemic. Studies from various countries report a 10-15 fold increase in teleconsultation rates during the pandemic. In a survey conducted among dermatologists in India, 85% of the participating doctors stated they used the teledermatology method during the pandemic (1). In one study, a survey was conducted with 434 dermatologists from 49 countries in which most dermatologists (88.2%) stated that the demand for TD increased during the pandemic. In addition, it was reported that 72.9% (145/199) of 199 doctors (199/434; 45.9%) who did not use TD before the COVID-19 pandemic began using this method during the pandemic (2). In some publications, it has been stated that TD was crucial during the COVID-19 pandemic and its use provided comfort to both the patient and the physician (3,4).

Our study has shown that diseases can be diagnosed correctly at a high rate using the S&F method. The total, partial, and no agreement rates in all diseases were 78.6%, 8.7%, and 12.7%, respectively. In a study evaluating 100 patients, when dermatologists and teledermatologists were compared in terms of diagnosis, total and partial diagnostic agreement rates were 52.8% and 84.9%, respectively (5). Similarly, the diagnostic agreement rates in other studies were 81-89%, 91%, and 83% (6-8). According to a recent article, the diagnostic reliability of teledermatology was between 60% and 100% in all conducted studies (9). In our study, 87.3% of patients were diagnosed correctly with TD, in accordance with the literature.

In acne, one of the most common diseases encountered in dermatology outpatient clinics, all patients diagnoses were correct, as 87 (97.8%) of 89 patients were diagnosed with a total agreement, and 2 (2.2%) were diagnosed with a partial agreement. Thus, prominent compliance was achieved in our study in the diagnosis of acne. In the study conducted by Klaz et al., 51 (93%) of 55 patients with acne were diagnosed correctly with the S&F method (10). Mc Gee et al. stated that acne is one of the most suitable dermatological diseases for which the TD method can be used (11). In another study, total agreement was reached in 113 of 122 patients with acne diagnosis (93%), partial agreement was reached in 1 (1%), and no agreement was reached in 8 patients (6%) teledermatologically (12).

In a study by Armstrong et al. that included 296 patients diagnosed with psoriasis, the treatment responses of the patients who were followed up and treated using the face-to-face and teledermatology methods were similar (13). In our study, 84.2% of patients with psoriasis were diagnosed correctly. Teledermatology can be used safely in both diagnosis and follow-up of patients with psoriasis when needed. In a study conducted by Klaz et al., 16 of 17 patients with pityriasis rosea were diagnosed correctly by teledermatology, and 1 patient was diagnosed by face-to-face examination (10). In a study conducted on pediatric patients, none of three patients with pityriasis rosea could be diagnosed correctly (14). In our study, all patients with pityriasis rosea were accurately diagnosed.

In our study, diagnostic agreement was reached in 13 patients diagnosed with atopic dermatitis (AD), with a total agreement in 10 (76.9%) and partial agreement in 3 (23.1%). In one study, there was total agreement in 75 (93%) of 81 patients with atopic dermatitis and no agreement in 6 patients (12). A study was conducted in which 156 adult and pediatric patients diagnosed with AD were followed face-to-face or through TD for one year, and the recovery rate was similar in both groups (15).

A study reported that a face-to-face examination is superior to TD in the diagnosis of non-pigmented neoplasms (16). In another study, BCC and SCC were correctly diagnosed at rates of 65% and 59%, respectively (17). In a retrospective study on 393 patients with previously recorded lesions, 14 BCC, 5 SCC, and 2 melanomas were diagnosed, and patients reported 100% satisfaction (18). In a study on the geriatric population, most patients had skin and lip cancer (24.61%), while 13.84% had seborrheic keratosis and 10.76% had actinic keratosis. The correct diagnosis rates of these diseases with TD were 84.4%, 94.4%, and 92.9%, respectively (19). Although the number of patients in this group was low, all patients were diagnosed correctly. In our study, there was total agreement in all patients with malign lesions. However, the number of patients in our group was also low.

Teleconsultation among dermatologists is called tertiary TD. A study was conducted in which dermatologists working in the periphery consulted university hospitals in difficult cases. In this study, 12 of the 17 patients (71%) did not need to be transferred. The dermatologists involved in the study had a high satisfaction rate of TD use (an average of 7.6 points on a 10-point scale). All dermatologists had a high rate of satisfaction and acceptance of TD. It has also been said that it prevents unnecessary patient burden (20). In another tertiary TD study, 85 teleconsultations were evaluated and there was no need for patient referral in 81% (21). Diagnostic agreement among physicians is higher than that between family physicians and teledermatologists. However, the fact that the examiner was a dermatologist played primary role in this high rate of agreement, as knowing which lesion is diagnostic and photographing the correct areas is of great significance. Even though the gold standard for diagnosis is still a face-to-face examination, TD physicians can increase the rate of correct diagnosis by inviting patients with suspicious lesions.

The results obtained so far have demonstrated that TD is a diagnostically accurate, low-cost method. Additionally, it has positive effects on facilitating and accelerating dermatological examination. The use of TD has become mandatory in pandemic conditions. Unfortunately, it is difficult for individuals residing in distant areas or crowded metropolises and immobile patients to reach a dermatologist. Teledermatology is a wonderful opportunity, especially for these groups of patients.

Despite all these advantages, palpation, one of the main principles of dermatological examination, is not possible in TD. Adding palpation findings to the patient anamnesis by the physician who performs the examination may increase the rate of correct diagnosis. In addition, although a whole-body examination is one of the main elements of dermatological examination, TD evaluation remains localized to the lesion area. Teledermatology has various problems with patient privacy and security, legal issues, and reimbursement, all of which need to be solved.

In our study, common diseases in dermatology practice, such as papulopustular lesions (100%), hair diseases (100%) and malignant skin tumors (100%), urticarial lesions (91.6%), erythematous squamous diseases (89.6%), nail diseases (88.8%) infectious diseases (bacterial, viral, tinea, and parasitic diseases) (88.2%), and benign (85%) skin tumors and diseases with pruritus (81%) were correctly diagnosed teledermatologically at a high rate. In contrast, eczematous lesions (78.7%), premalignant lesions (66.6%), and diseases in the "others" group (75%) were diagnosed less accurately. Early detection and timely treatment of serious skin diseases reduce patient morbidity and mortality. When teledermatology is used appropriately, highly accurate diagnoses can be established. More effective use of dermatology atlases based on visual findings in dermatology education will increase the accuracy of teledermatological diagnosis.

The COVID-19 pandemic has led to a breakthrough in the healthcare sector, as in many other fields. Although the gold standard method in healthcare service is a face-to-face examination, one of the best weapons to keep patients and healthcare workers safe under pandemic conditions is telemedicine, ensuring that general healthcare services are run smoothly. This is especially true today, when we cannot predict exactly how long the pandemic will last and whether there will be second or third waves. It may be useful to complete the infrastructural studies on telemedicine applications in our country and worldwide, make official regulations, and determine the authorities, responsibilities, and rights of physicians with regard to this topic.

Table 1. Disease Groups and Agreement Numbers

	Physician 1 diagnosis	n	Physician 2/ diagnosis 1 Total Agreement		Physician 2/ diagnosis 2 Partial Agreement		Physician 2/ diagnosis 3	
			n	κ P	n	κ P	n	κ P
PAPULOPUSTULAR RASH	Acne	89	87	**0.733**	1	**0.020**	1	0.001
	Rosacea	7	5	**<0.001**	2	**<0.001**	0	0.778
TINEA INFECTIONS	*T. pedis*	21	21		0		0	
	T. versicolor	17	14		0		0	
	T. cruris	14	14	**0.794**	0	**0.041**	0	0.000
	Candidiasis	5	2	**<0.001**	2	**<0.001**	0	1.000
	T. corporis	8	4		1		0	
	T. capitis	2	1		0		0	
NAIL DISEASE	Onicomycosis	22	20		1		0	
	Habitual nail disease	1	0	**0.617**	0	0.007	0	0.000
	Onycomadesis	1	1	**<0.001**	0	0.627	0	1.000
	Unguis incarinatus	3	2		0		0	
URTICARIAL LESION	Urticarial vasculitis	1	1	**0.769**	0	0.015	0	0.000
	PUPPP	1	1	**<0.001**	0	0.640	0	1.000
	Urticaria	10	9		1		0	
PRURITUS	Pruritus	21	11	-	6	-	0	-
BACTERIAL INFECTION	Folliculitis	15	11		0		0	
	Erytrasma	2	0	**0.316**	2	**0.091**	0	0.000
	Syphilis	2	2	**<0.001**	0	**<0.001**	0	1.000
	Cellulitis	1	1		0		0	
HAIR DISEASE	Alopecia areata	12	12	**1.000**	0	0.044	0	0.000
	AGA	4	4	**<0.001**	0	0.054	0	1.000
	Cicatricial alopecia	2	2		0		0	
VIRAL INFECTION	Verruca	32	28		0		1	
	Herpes	2	1	**0.685**	0	**0.017**	1	**0.026**
	Zona zoster	8	5	**<0.001**	0	**0.011**	0	**0.010**
	Molluscum	2	1		0		0	
	Anogenital verruca	7	6		1		0	
PARASITIC INFECTION	Scabies	30	29	**0.377**	0	**0.030**	1	0.002
	Larva migrans	1	0	**<0.001**	1	**<0.001**	0	0.793
	Demodicosis	1	0		0		0	
PAPULOSQUAMOUS DISORDERS	Psoriasis	19	14		2		0	
	Pityriasis rosea	8	8	**0.715**	0	0.025	0	0.000
	Pustular psoriasis	1	1	**<0.001**	0	0.288	0	1.000
	PLC	1	1		0		0	
DISEASE WITH ULCER	Piyoderma gangrenosum	1	1	**0.571**	0	0.000	0	0.000
	Decubitus ulcer	1	0	**0.028**	0	1.000	0	1.000
	Venous ulcer	1	1		0		0	
ECZEMA	PPD	2	1		0		0	
	Seborrheic dermatitis	19	16		1		0	
	Stasis dermatitis	2	2		0		0	
	Contact dermatitis	49	29	**0.560**	10	**0.081**	0	**0.009**
	Atopic dermatitis	13	10	**<0.001**	2	**<0.001**	1	**0.010**
	LSC	13	5		0		0	
	Photocontact dermatitis	1	0		0		0	
	Nummuler dermatitis	1	1		0		0	
PRE-MALIGN DISEASE	Actinic keratosis	2	1	0.143	0	0.250	0	0.000
	Actinic cheilitis	1	0	0.386	1	0.083	0	1.000

Group	Diagnosis							
DERI BENIGN NEOPLASM	Seborrheic keratosis	9	6		1		0	
	Millium	1	1		0		0	
	Fordyce spots	2	2	**0.754**	0	0.028	0	0.000
	Skin tag	3	3	**<0.001**	0	0.257	0	1.000
	Dermatofibroma	2	1		0		0	
	Xantelasma	1	1		0		0	
	Syringoma	2	2		0		0	
DERI MALIGN NEOPLASM	BCC	4	4	**1.000**	0	0.000	0	0.000
	SCC	1	1	**0.025**	0	1.000	0	1.000
HYPERPIGMENTATION	Postinflammatory hyperpigmentation	2	0	**0.367**	1	**0.082**	0	0.000
	Efelides	1	1	**0.001**	0	**0.035**	0	1.000
	Melasma	5	4		0		0	
	LPP	1	0		0		0	
HYPO-DEPIGMENTATION	Vitiligo	7	6	**0.619**	0	0.000	0	0.000
	Postinflammatory hypopigmentation	1	1	**0.013**	0	1.000	0	1.000
CONNECTIVE TISSUE DISEASE	Striae	3	3		0		0	
	Keloid scar	4	2	**0.571**	0	0.000	0	0.000
	Morphea	1	1	**<0.001**	0	1.000	0	1.000
	Lichen sclerosus	1	0		0		0	
NEVUS	Nevus sebaceous	1	1	1.000	0	0.000	0	0.000
	Nevus	1	1	0.157	0	1.000	0	1.000
DRUG REACTIONS	Pityrosporum folliculitis	2	1	0.250	1	0.130	0	0.091
	Drug reactions	3	1	0.149	0	0.171	1	0.361
VASCULAR DISEASE	Angioma	2	2		0		0	
	Pyogenic granuloma	1	0	**0.636**	1	**0.385**	0	0.000
	Vascular malformation	1	1	**0.015**	0	**0.046**	0	1.000
DISEASE WITH ERYTHEMA	Palmar erythema	2	1		1		0	
	Figurate erythema	3	2	**0.475**	0	0.106	1	0.087
	Facial erythema	1	0		0	0.088	0	0.212
	Intertrigo	1	1		0		0	
DISEASE WITH KERATOSIS	Callus	11	10		0		0	
	Knuckle pads	1	0	**0.595**	1	**0.126**	0	0.000
	Plantar keratosis	2	2	**<0.001**	0	**<0.001**	0	1.000
	Nevoid hyperkeratosis	1	0		1		0	
OTHER	Epidermal cyst	3	2		1		0	
	Keratosis pilaris	5	3		0		0	
	Insect bite	15	9		1		1	
	Traumatic bullae	1	0		1		0	
	Ecchymosis	3	3	**0.551**	0	**0.077**	0	0.017
	Pseudolymphoma	1	0	**<0.001**	0	**<0.001**	0	0.279
	Id reaction	1	1		0		0	
	Oral aphthae	1	1		0		0	
	Lichen spinulosus	1	0		0		0	
	Terra firma-forme	1	1		0		0	

T: Tinea; PUPP: Pruritic urticarial papules and plaques of pregnancy; AGA: Androgenic alopecia; PLC: Pityriasis lichenoides chronica; PPD: Pigmented purpuric dermatosis; LSC: Lichen simplex cronicus; BCC: Basal cell ca; SCC: Squamous cell ca; LPP: Lichen planus pigmentosus

Compliance analysis with a *P* value below 5% was found to be statistically significant. The reference values of kappa (κ) that should be taken into consideration while interpreting the value of are as follows:

<0.00 Poor

0.00-0.20 Not Significant

0.21-0.40 Low

0.41-0.60 Moderate

0.61-0.80 Significant

0.81-1.00 Very High (22).

Agreement between Physician 1 and doctor 2 in 1 diagnosis: 6, 9, 16. Low level in terms of disease groups, 23. Moderate in terms of disease group, 1, 2, 3, 8, 10, 14, 17, 22. Significantly in terms of disease groups, 7, 15. There was a very high level of statistically significant agreement in terms of disease groups.

Agreement between Physician 1 and Physician 2 in 2 diagnoses: 1, 2, 6, 8, 9, 12, 16, 24, 25. There was an insignificant level of agreement in terms of the disease groups and a low level of statistically significant agreement for the 22nd disease group.

Agreement between Physician 1 and Physician 2 in 3 diagnoses: 8, 12. There was insignificant statistically significant agreement in terms of disease groups.

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