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RESEARCH ARTICLE

NAIL CAPILLAROSCOPIC FINDINGS IN PATIENTS WITH HEART FAILURE

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ABSTRACT

Purpose: The nail fold microvasculature can be examined non-invasively with capillaroscopy. The endothelium plays a crucial role in atherosclerosis pathogenesis and, in certain instances, the occurrence of heart failure. This study was designed to explore microcirculatory alterations by employing nail fold capillaroscopy in individuals with heart failure.
Material and Methods: In this observational, prospective study involving individuals with heart failure and controls, nail fold capillaroscopic findings visualized by dermoscopy were evaluated comparatively between the two groups (SPSS version 29.0).
Results: A total of 54 participants, consisting of 24 individuals with heart failure and 30 controls without heart failure were included. Nail fold capillaroscopic characteristics significantly more prevalent in the heart failure group compared to the controls included microhemorrhage (70.8% vs. 36.7%), the irregular vessel distribution (20.4% vs. 11.1%), vascular dilatation (45.8% vs. 20%) and vascular tortuosity (58.3% vs. 3.3%) (all $p<0.05$). No significant relationship was found between any of the capillaroscopic features and gender, presence of diabetes mellitus, hypertension, thyroid disease, and use of beta-blockers or ACE inhibitors in the last month in heart failure patients ($p>0.05$).
Conclusion: Nail fold capillaroscopy may serve as a useful and easy method to examine systemic microvascular changes in heart failure patients.

Keywords: Capillaroscopy; heart failure; nail fold capillaroscopy; microcirculatory changes

INTRODUCTION

Coronary artery disease (CAD), also called ischemic heart disease, is one of the major cardiovascular diseases and cause of death affecting the population in Turkiye and worldwide (1). It is a chronic disease that develops gradually over time and remains asymptomatic for many years (2). Narrowing or occlusion of major blood vessels (coronary arteries) due to thickening and hardening of the arterial wall (atherosclerosis) is the main underlying pathological basis for the occurrence of CAD (2, 3).

Nail fold capillaroscopy (NFC) is a relatively simple method that can be used to examine microvasculature noninvasively (4). It has a major role in rheumatology, especially in distinguishing primary Raynaud's phenomenon in systemic sclerosis, which is characterized by calcification, vasculopathy, and endothelial wall damage (5).

Endothelial damage is the basic pathogenesis involved in the development of atherosclerosis and cardiovascular disease (6). As commonly understood, the endothelium has a pivotal role in the initiation of atherosclerosis, an earlier stage in the progression of cardiovascular diseases and, in some instances, subsequent heart failure (6). While the primary role of nail fold capillaroscopy is to differentiate between primary and secondary Raynaud's phenomenon (7), it has also proven as a valuable tool for identifying microvascular abnormalities in various non-rheumatic systemic diseases (8).

This study aims to explore microcirculatory changes and identify capillaroscopic abnormalities in individuals with heart failure using nail fold capillaroscopy, comparing these findings with a healthy population.

MATERIAL AND METHODS

This study was approved by Eylül University Noninvasive Clinical Studies Ethics Committee (Date: 22.02.2023, Decision No: 2023/05-04), and every participant provided written informed consent. This prospective observational study included individuals with heart failure as well as age- and sex-matched healthy controls who visited our Dermatology clinic consecutively. All participants were aged 18 years or older, and their medical history and current medication information were documented. Those whose hands have undergone any orthopedic intervention or an invasive procedure such as laser, cautery, cryotherapy; patients with neurological problems involving the hand or fingers, patients with rheumatological or connective tissue diseases; and patients with any systemic disease that could potentially impact microcirculation were excluded from the study.

Nail fold capillaries were evaluated using dermoscopy (DermliteTM DL3). The dermoscopic images were evaluated by two experienced dermatoscopists (F.G. and Ö.Ö.) and a comparison was made between the patient and control groups. Before the evaluation, all patients were provided with a rest period of at least 15 minutes in the examination room, which was maintained at an approximate temperature of 23°C. During this time, their hands and forearms were kept at heart level on a seat side support. Eight fingers were examined for each individual except the smallest finger. To enhance image resolution, we applied clear ultrasound gel between the probe and the nail fold of each finger. Capillary morphology was evaluated as normal, enlarged, showing tortuosity and microhemorrhage. "Enlarged capillaries" were

Table 1. Age and Sex Distribution in Patient and Control Groups

	Patient Group (n= 24)	Control Group (n= 30)	P value
Age, years, mean ± SD, min-max	68 ± 11 (40-85)	64±13 (40-91)	0.191[1]
Sex, female, n (%)	12 (50%)	19 (63.3%)	0.325[2]

SD: Standard deviation, [1]Independent samples t-test and [2]Pearson chi-square test was used.

Table 2. Evaluation of Comorbidities, Medication Usage, and Heart Failure Symptomatology in the Heart Failure Patient Group

	Patient Group (n= 24)
Presence of DM, n (%)	7 (29.2%)
Presence of HT, n (%)	12 (50%)
Beta-blocker usage in the last month, n (%)	15 (62.5%)
ACE inhibitor usage in the last month, n (%)	12 (50%)
Presence of dyspnea, n (%)	12 (50%)
Presence of fatigue, n (%)	16 (66.7%)
Presence of ankle swelling/edema, n (%)	9 (37.5%)
Presence of exercise intolerance, n (%)	19 (79.2%)
Frequency of patients with EF≤40%, n (%)	13 (54.2%)

DM: Diabetes Mellitus, HT: Hypertension, ACE: Angiotensin converting enzyme, EF: Ejection Fraction

Table 3. Evaluation of Dermoscopic Findings of Nail fold Capillaries in the Patient and Control Groups

Dermoscopic Findings	Patient Group (n= 24)	Control Group (n= 30)	P value
Microhemorrhages	17 (70.8%)	11 (36.7%)	**0.013****
Presence of branching	2 (8.3%)	1 (3.3%)	0.425
Irregular arrangement	11 (45.8%)	6 (20.0%)	**0.042****
Tortuous dilatation	14 (58.3%)	1 (3.3%)	**<0.001****
Presence of avascular areas	4 (16.7%)	1 (3.3%)	0.093
Decreased capillary density	1 (4.2%)	1 (3.3%)	0.872
Dilated capillaries	11 (45.8%)	4 (13.3%)	**0.008****
Giant capillaries	3 (13.5%)	0 (0%)	**0.046****

The Pearson chi-square test was employed, and statistically significant p-values were indicated in bold with a double star superscript (**) sign.

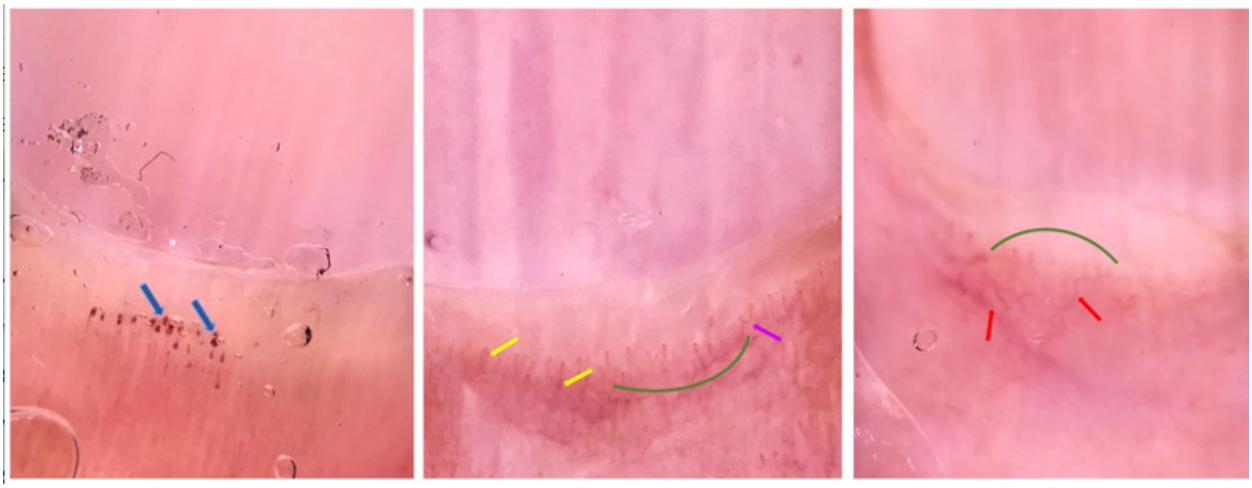

Figure 1. Nail fold capillaroscopy of heart failure patients**.** Microhemorrhage (blue arrows), the irregular distribution of the capillaries (green curved lines), dilation (yellow arrows) and tortuosity (red arrows) of capillaries can be seen in the nail capillaroscopic images of heart failure patients.

designated as a uniform or localized expansion along the capillary's path. Tortuosity was characterized by the distortion of nail fold capillaries and their formation into irregular loops. Microhemorrhage was identified by the presence of at least two pinpoint hemorrhages surrounding a single capillary.

Statistical analyses

We conducted statistical analysis using SPSS software version 29.0. Data normality was assessed with the Kolmogorov-Smirnov test. For comparing normally distributed data between two groups, we employed the independent samples t-test. Pearson's chi-square test was used for comparisons involving categorical data between two groups. All statistical tests were two-tailed with a significance threshold of 0.05 for the p-value.

RESULTS

A total of 54 participants, consisting of 24 patients with heart failure (HF) and 30 controls without heart failure, were included in this observational study. Among the participants in the patient group, half were female, while this ratio was 63.3% in the control group, indicating a similar sex distribution between the two groups (p= 0.32). The mean age of the HF group and the control group was also similar (p= 0.19) (Table 1).

The comorbidities and medication status of patients in the HF group were evaluated (Table 2). In patients with HF, ejection fraction (EF), an indicator of cardiac function, was found to be 30% in 14.8% of the patients (n= 8). The EF was ≤40% in more than half

Table 4. Regression Analysis of Factors for Nail fold Capillary Abnormalities

	Univariate Regression Analysis				***Multivariate Regression Analysis***			
	Sig.	***Exp (B)***	***95% C.I.***		***Sig.***	***Exp (B)***	***95% C.I.***	
			Lower	***Upper***			***Lower***	***Upper***
Age, years	*0.207*	*0.971*	*0.927*	*1.016*	–	–	–	–
Sex	*0.326*	*0.579*	*0.194*	*1.725*	–	–	–	–
Microhemorrhages	***0.015****	*0.238*	*0.075*	*0.754*	*0.496*	*1.631*	*0.399*	*6.670*
Irregular arrangement	***0.047****	*0.295*	*0.089*	*0.983*	*0.483*	*0.449*	*0.048*	*4.195*
Tortuous dilatation	***<0.001****	*0.025*	*0.003*	*0.212*	***0.009****	*48.255*	*2.628*	*886.157*
Dilated capillaries	***0.012****	*0.182*	*0.048*	*0.683*	*0.716*	*1.413*	*0.220*	*9.085*
Giant capillaries	*0.999*	*0.000*	*0.000*	*0.000*	–	–	–	–

Multivariate Logistic Regression model Nagelkerke R Square: 0.475.
Statistically significant p-values were indicated in bold with a double star superscript (**) sign.

of the HF patients (54.2%, n= 13) and was 60% in 7.4% of the patients.

The nail fold capillaroscopic features which were significantly more prevalent in the HF group compared to controls were microhemorrhage (70.8% vs. 36.7%), the irregular distribution of vessels (20.4% vs. 11.1%), dilatation of vessels (45.8% vs. 20%) and tortuosity (58.3% vs. 3.3%) (all p<0.05) (Figure 1). While the prevalence of giant capillaries was 13.5% in the HF group, they were not seen in the control group (p<0.005) (Table 3).

In the nail fold dermoscopic examination, heart failure patients exhibited higher rates of branching of vessels, the presence of avascular areas, and decreased capillary density compared to the control group. Nevertheless, these disparities did not reach statistical significance (p>0.05) (Table 3).

The association of the nail fold capillaroscopic features of HF patients with the sociodemographic characteristics and comorbidities was also evaluated using logistic regression analysis. In HF patients, no significant relationship was found between any of the capillaroscopic features and sex, presence of diabetes mellitus (DM), hypertension (HT) or thyroid disease, use of beta-blockers or ACE inhibitors in the last month (p>0.05). Heart failure symptoms such as dyspnea, fatigue, ankle swelling/edema, and exercise intolerance, and EF also did not show a significant relationship with the development of the mentioned capillary characteristics (p>0.05).

In the univariate regression analysis, no significant associations were found between HF and giant capillary development. However, significant relationships were observed between HF and observing of microhemorrhage (p= 0.015), irregular arrangement of vessels (p= 0.047), tortuous dilatation (p< 0.001), and dilated capillaries (p= 0.012).

In the multivariate regression analysis, aimed at identifying parameters with a significant association with HF from those showing significance in the univariate analysis and establishing their independent relationship with HF, only tortuous dilatation of vessels was observed to have a significant association with HF (p= 0.009). The results of the regression analysis are presented in Table 4.

DISCUSSION

In this study, we observed that some capillaroscopic features were significantly more common in HF patients than in healthy controls. NFC can assist the diagnostic process as a quick and easy method and can help to understand HF-related microvessel involvement in these patients. Capillary changes that were significantly more common in patients with HF included microhemorrhages, irregular arrangement, tortuosity, and enlarged (dilated) capillaries. Tortuous dilatation of vessels in nail capillaroscopy was also determined to be an independent risk factor for HF, independent of other NFC features. Inflammation and endothelial damage play an important role in the pathogenesis of CAD (9). Atherosclerosis is a long-term progressive disease that develops as a result of endothelial dysfunction, resulting in rupture of the atherosclerotic plaque and thrombosis. This process causes the microvessels to narrow and eventually become completely occluded (9). Atherosclerosis is a

systemic problem (9). These NFC findings, which were detected more frequently in HF patients in our study compared to the healthy population, may have resulted from this systemic microvascular damage. Systemic microvascular damage is important in terms of its involvement in the early pathogenesis of heart failure.

This study found no significant relationship between any of the capillaroscopic features and sex, presence of DM, HT or thyroid disease, use of beta-blockers or ACE inhibitors in the last month, in HF patients. Likewise, in a study examining the capillaroscopic characteristics of nail fold capillary circulation regarding the extent of coronary disease, there were no notable differences between patients with and without DM (P>0.05 for all), or between those with and without HT (p>0.05 for all), regarding NVC findings, including capillary density, the presence of giant capillaries, microhemorrhage, branching, disorganization, tortuosity, and avascular area (9). DM and HT are also conditions with systemic microvascular damage, and abnormal findings have been reported in NFC in both conditions (9). However, in patients with already existing heart disease and possibly associated underlying vascular and endothelial disorders, NFC findings were observed more frequently than in the normal healthy population, therefore the presence of DM or HT may not have caused a significant difference in NFC characteristics.

In our study, it was observed that HF symptoms such as shortness of breath, fatigue, ankle swelling/edema, exercise intolerance, and EF did not show a significant relationship with the development of nail fold capillary characteristics (p>0.05). The study investigating whether CAD-related nail videocapillaroscopic (NVC) findings differ according to the severity of the disease included 100 patients with lesions in the coronary arteries on coronary angiography, and no significant difference was found between the severity of coronary atherosclerosis and NVC findings (p> 0.05 for all) (9).

The reason why endothelial dysfunction is not observed more frequently in patients with severe heart disease than in early-stage patients may be that it is a problem observed at a very early stage in the development of coronary disease. In this respect, NFC findings can be evaluated as helpful tool in early diagnosis rather than of prognostic importance. A study investigating the capillaroscopic abnormalities of asymptomatic chronic smokers with dermoscopy, compared to healthy non-smokers, found that nail fold capillaroscopic abnormalities including enlargement of vessels, tortuosity, and microhemorrhages were more common even among asymptomatic chronic smokers (16, 53.3%) compared to healthy nonsmokers (7, 23.3%) (p < 0.05) (4).

There are limited studies that investigate nail fold capillaroscopy in individuals with HF. In a study conducted in Turkey, capillaroscopic observations of HF patients with decreased and maintained EF were compared to those of healthy controls (10). Capillaroscopic enlargement of vessels and/or hemorrhages was detected in 24% (7) in HF patients with decreased EF, 66% (19) in patients with preserved HF, and 37% (11) in the control group (10). Significantly higher rates of abnormal capillaroscopic characteristics were observed in HF patients with maintained EF when compared to both HF patients with decreased EF (p < 0.05) and healthy controls (p < 0.05) (10). In our study group, EF was decreased in more than half of HF patients (54.2%, n= 13), and microhemorrhage and dilatation of vessels were observed more frequently in capillaroscopy of all HF patients (70.8% and 45.8% n= 13, respectively), independent of HF symptoms or EF (p>0.05). In our study, vascular changes were also observed more frequently in the capillaroscopic examination of healthy controls compared to the aforementioned study; enlargement of vessels and/or bleeding was 43.3%. While examining the vascular structures in this study, we used a technique that we have experienced its ability to observe the vascular structures more prominent in tumoral and inflammatory lesions. In this technique, after the clear ultrasound gel application, the dermoscope glass was lightly contacted with the gel, and then, we pulled back the dermoscope with a slight back force and therefore the negative pressure let the vascular structures to be filled with blood. In this way, it was prevented that any dermoscope would deflate the vessels with pressure. This may be the reason why capillaroscopic features were observed more frequently in both patients and controls in our study.

The primary limitation of this study is that nail fold capillaroscopy findings were exclusively examined in patients with a HF diagnosis, without distinguishing between those with and without microvascular damage using an imaging method like angiography. Future studies could provide more insightful results by investigating the relationship between angiographic findings and the nail fold capillaroscopic

features identified in our study among patients with HF.

CONCLUSION

In summary, patients with HF have significantly more microhemorrhages, irregular distribution, tortuousity and dilatation of capilleries in their nail folds compared to healthy individuals. Therefore, nail fold capillaroscopy may serve as a useful and easy method to examine systemic microvascular changes in HF patients and to take necessary precautions for these individuals.

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