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Nailfold capillary patterns in healthy subjects: A real issue in capillaroscopy

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ABSTRACT

Nailfold capillaroscopy has been extensively applied in a broad spectrum of pathologic conditions, but very few data have been published in healthy individuals. The aim of this study was to describe the nailfold capillary findings on a large series of healthy subjects using the video-capillaroscopy technique. Nailfold capillaries were studied based on their morphology, dimensions and density. Then, to evaluate jointly the association between different capillary findings in groups of subjects which were homogeneous for their characteristics, cluster analysis was performed. The results (median) of capillary measurements were as follows: loop length 207 μm, external diameter 39 μm, internal diameter 17 μm, apical diameter 17 μm, and intercapillary distance 143 μm. Based on the cluster analysis three major "normal" morphologic capillaroscopic patterns were depicted: 1) the "normal" pattern mainly with 2 to 5 U-shaped loops/mm and ≤2 tortuous loops/mm; 2) the "perfect normal" pattern with ≥5 U-shaped loops/mm and 3) the "unusual normal" with at least 1 meandering or bushy loop, or at least 1 microhemorrhage, or with >4 crossed loops/mm. Regarding the loop measurements, the majority of subjects had a median of 7 capillaries/mm with a median length of 198 μm.

Introduction

Nailfold capillaroscopy is a non-invasive imaging technique used for the "in vivo" assessment of microcirculation. As a matter of fact that different device (e.g. videocapillaroscope, microscope, ophthalmoscope, or dermatoscope) is used to perform the exam (Baron et al., 2007; Minkin and Rabhan, 1982; Moore et al., 2010; Murray et al., 2011; Ranft et al., 1987; Sontheimer, 2004; Wildt et al., 1999, 2007, 2012). Next to the already existing tools, video-capillaroscopy represents an upgrade of this technique that has obtained increasing interest by physicians over the past years for its usefulness in clinical practice and in research (Anderson et al., 2005; De Angelis et al., 2009a; Grassi and De Angelis, 2007; Herrick and Cutolo, 2010). Nailfold video-capillaroscopy has some advantages such as the real-time control of the image obtained, the fidelity of image storage and reproduction, the advanced image analysis and the measuring features (Hofstee et al., 2012; Ingegnoli et al., 2009). A further advantage is the presence of a contact probe with polarized light microscopy which allows an easier observation of the skin surface. Moreover, the training period for the use of the video-capillaroscopy is brief because of the simplicity of the equipment (De Angelis et al., 2009b).

For all these reasons nailfold video-capillaroscopy has now become an established method to assess microcirculation in patients with Raynaud's phenomenon (RP) and connective tissue diseases (CTDs), as well as in the early diagnosis and monitoring of systemic sclerosis (SSc) (Cutolo et al., 2010; Herrick et al., 2010; Ingegnoli et al., 2008, 2010; Sebastiani et al., 2012). Although successfully and extensively applied in a broad spectrum of pathologic conditions (Bhushan et al., 2000; Bongard et al., 1995; Lambova and Muller-Ladner, 2012; Pazos-Moura et al., 1990), very few data have been published in healthy individuals (Hoerth et al., 2012). In fact, most of the information available on this topic is obtained using different and less accurate optical tools (Andrade et al., 1990; Bergman et al., 2003; Bosley et al., 1956; Fahrig et al., 1995; Kabasakal et al., 1996; Monticone et al., 2000; Rouen et al., 1972).

It has been reported that the capillaroscopic pattern in healthy subjects is characterized by a great variety of findings (Andrade et al., 1990; Fahrig et al., 1995) often leading to confusion with regard the overall evaluation between a normal or a pathological pattern (Gutierrez et al., 2012). Although a relevant inter-individual and intra-individual variability can be observed in healthy individuals (Cutolo, 2010; Grassi and Del Medico, 2004) some features may occur very frequently,

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while other findings may be considered rare, but not necessarily pathologic. A more accurate characterization of capillary patterns in healthy subjects is fundamental in order to early recognize the potential pathologic patterns.

The routinary evaluation of the capillaroscopic pattern is not based on a single parameter, but on the judgment of an overall pattern resulting from the combination of numerical and morphologic characteristics of the image. We expect the majority of healthy subjects to share a similar pattern; although, because of demographic and biological heterogeneity, groups of patients with different capillaroscopic characteristics can be found and the identification of less frequent but still normal profiles is also relevant. Against this background, the aim of our study was to describe the nailfold capillary findings on a large series of healthy subjects using the video-capillaroscopy technique. Moreover, to allow a standardization of the capillaroscopic judgment, a statistical technique (cluster analysis) that allows to identify the presence of different capillaroscopic profiles as a combination of measurements and morphological characteristics accounting for their association was used.

Firstly, we evaluated the profiles of morphologic aspects (based on the number of different capillary shapes) and profiles of measurements (total number of capillaries, length and loop diameters). Then we studied jointly the association between different capillary profiles describing different "normal" capillaroscopy patterns.

Methods

A prospective selection of healthy adult volunteers (Berg et al., 1981) in two Italian Rheumatology centers was studied over a six month period. The selection was made using established exclusion criteria, obtained from the existing literature (Andrade et al., 1990; Fahrig et al., 1995; Ingegnoli et al., 2008).

Exclusion criteria were: 1) the presence of signs and/or symptoms suggestive of a CTD or a history of RP, 2) the use of drugs that may modify microcirculation (i.e. chemotherapeutic agents, interferon, estrogens, nicotine, narcotics, sympathomimetic agents, cocaine, polyvinyl chloride, ergotamines, clonidine), 3) other conditions that potentially cause microcirculatory abnormalities (i.e. frostbite, repetitive occupational stress such as hand–arm vibration syndrome, hypothenar hammer syndrome, neuropathy, carpal tunnel syndrome, arterial hypertension), and 4) subjects with repetitive periungueal traumatic lesions that may create artifacts (i.e. recent manicure, onychophagia, and gardening) (Bongard et al., 2000; De Angelis et al., 2003; Marie et al., 2007; Martina et al., 1998; Maurel et al., 1997). Sampling was carried out by age groups to account for the possible age-related morphological characteristics and equally distributed in age classes from 18 to 80 years old (Piette et al., 1990). 18 subjects were between the ages of 18 and 29 years, 24 between 30 and 39, 20 between 40 and 49, 19 between 50 and 59, and 19 between 60 and 80. Informed consent was obtained from each volunteer.

All of the recordings were made with the subjects sitting in a comfortable ambient temperature of 22 to 25 °C and with their hands at heart level. The equipment was explained and a drop of immersion oil was applied to the nailfold to maximize the translucency of the keratin layer. In each subjects the fourth and the fifth finger of both hands were examined.

In both centers, nailfold capillaroscopy was performed using a video-capillaroscope equipped with a 200× optical probe with the images (a mean of 4 images/subjects) being captured, coded, and stored using Videocap software (DS-Medica, Milan, Italy).

Capillaroscopy images were evaluated by an experienced observer (C.B. at the Marche Polytechnic University and R.G. at the University of Milan). The agreement between observers was assessed by testing a sample of 20 images.

For each image, the following parameters were studied: the total number of capillaries in 1 mm, the intercapillary distance (μm), the loop length (μm), and the loop diameter (external, internal and apical diameters) (Fig. 1). Moreover, the number of capillaries with different morphological aspects (i.e. hairpin shaped loops, tortuous capillaries, loops with one cross or with two or more intersections, bizarre, meandering and bushy loops) (Fig. 2) (Andrade et al., 1990), the presence of microhemorrhages, and the sub-papillary venous plexus visibility were analyzed. Particularly, capillaries with limbs crossed upon themselves or with another several times were defined as "meandering"; loops with limbs that originate from small and multiple buds were called "bushy"; aneurismal capillaries with the width of limbs 10 times the normal one were defined as "giant"; and, capillaries with striking atypical morphology, not conforming to the previously defined categories were called "bizarre" (Andrade et al., 1990).

Statistical analysis

The inter-observer agreement was estimated by the weighted Cohen's kappa (WCK) for the total number of capillaries and the number of capillaries of each morphological type (Cohen, 1968) and by the Intraclass Correlation Index (ICC) for the various capillary length measurements (Bartko, 1966).

Distributions of quantitative variables were summarized by the values of the minimum, first quartile, median, mean, third quartile and maximum. The profiles were separately studied for the number of capillaries with specific morphological characteristics and for the capillary dimensions by means of two hierarchical cluster procedures (Husson et al., 2011). For the morphological characteristics, including the visibility of sub-papillary plexus, cluster was performed on the coordinates of Multiple Correspondence Analysis (MCA). As MCA requires categorical variables, the original number of capillaries of each morphological type was singularly categorized by cluster analysis (Husson et al., 2011). For the capillary dimensions and the total number of capillaries, the coordinates needed for cluster analysis were obtained by Principal Component Analysis (PCA). Numbers of clusters were robustly selected by bootstrap. Finally, the association between the profiles on morphologic aspects and on capillary dimensions was assessed by Fisher's exact test.

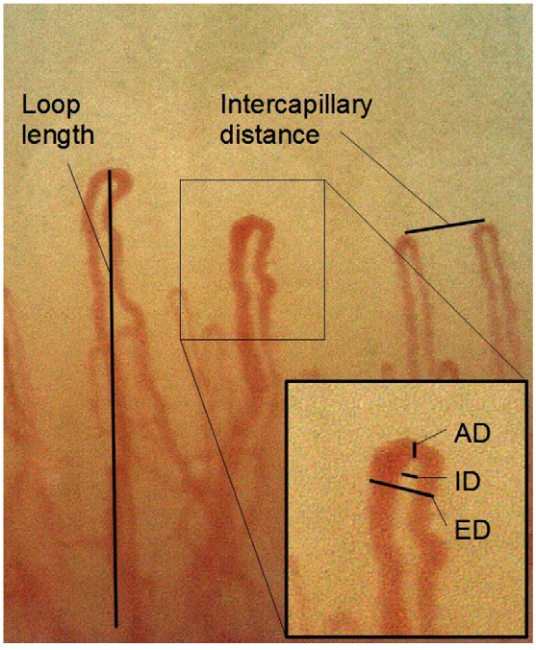

Fig. 1. The capillary dimensional parameters: loop length, intercapillary distance, apical diameter (AD), internal diameter (ID) and external diameter (ED).

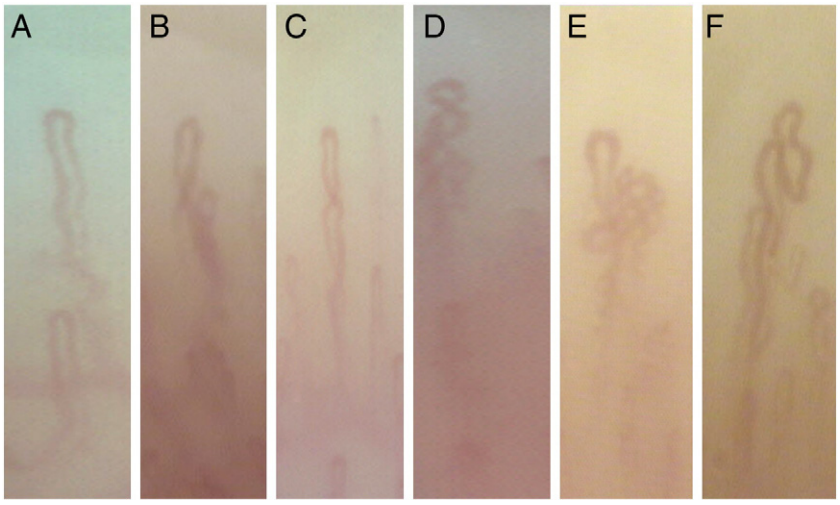

Fig. 2. Nailfold capillaries of healthy subjects with different morphological aspects: hairpin shaped loop (A), loops with one cross (B, C) or with more than two intersections (D), bushy loop (E) and meandering loop (F).

Results

100 healthy subjects (44 males and 56 females) were included in the study. A total of 400 nailfold images were analyzed. One subject was excluded because of the poor quality of capillaroscopy images.

Firstly, a good inter-observer agreement about both the categorical and continuous variables was noted, with the exception of apex diameter (Table 1).

Then, summary statistics of nailfold capillary morphologies and of capillary dimensions in the fourth and fifth fingers of both hands in healthy subjects were reported (Tables 2–3). Microhemorrhages were present only in 2 patients in the fourth finger of the right hand, 2 patients in the fourth finger of the left hand, 1 patient in the fifth finger of the right hand and 3 patients in the fifth finger of the left hand. Sub-papillary venous plexus was visible in 26 patients in the fourth finger of the right hand, 29 patients in the fourth finger of the left hand, 22 patients in the fifth finger of the right hand and 31 patients in the fifth finger of the left hand. Since such distributions appeared quite similar among the fingers, the subsequent analysis used the data of the fourth finger of the right hand.

Based on cluster analysis, the following classes for the number of capillaries were obtained: for U-shaped loops 0–1, 2–3, 4–5 or >5; for tortuous loops 0–2, 3–4 or >4; for loops with one cross and loops with two or more intersections 0–2, 3–4 or >4; and for bizarre, meandering and bushy loops 0 or >0.

Table 1
Weighted Cohen's kappa's for the total number of capillaries and the number of capillaries of each morphological types and Intraclass Correlation Indexes for the capillary measurements.

	WCK (95% confidence interval)
Overall loops	0.80 (0.65–0.94)
U-shaped loops	0.97 (0.95–1.00)
Tortuous loops	0.96 (0.90–1.00)
Loops with one cross	0.99 (0.98–1.00)
Loops with ≥2 crosses	1.00[a]
Bizarre loops	1.00[a]
Meandering loops	1.00[a]
Bushy loops	1.00[a]
Microhemorrhages	1.00[a]
	ICC (95% confidence interval)
Capillary length	1.00 (0.99–1.00)
External diameter	0.98 (0.98–0.99)
Internal diameter	0.87 (0.82–0.90)
Apex diameter	0.67 (0.58–0.75)
Intercapillary distance	0.99 (0.98–0.99)

[a] Confidence intervals were not available as the agreement was perfect.

According to the capillary morphologic aspects, six clusters of different aspects of normality were obtained (Table 4). The clusters are mainly described by means of the following patterns: cluster 1, composed of 71 subjects (72%) with U-shaped loops between 2 and 5/mm and tortuous loops ≤2/mm and cluster 2 with 21 subjects (21%) with U-shaped loops ≥5/mm. Other profiles were rare as demonstrated by the number of healthy subjects in each cluster: cluster 3 (2 subjects) with meandering loops (at least one); cluster 4 (2 subjects) with crossed loops (>4/mm); cluster 5 (2 subjects) with microhemorrhages (at least one); and cluster 6 (1 subjects) with bushy loops (at least one). The last four clusters are represented by a low number of peculiar subjects which are very heterogeneous. Microhemorrhages were present only in cluster 5; sub-papillary plexus was visible in 16 (22%) subjects in cluster 1, 9 (43%) subjects in cluster 2, 1 (50%) subject in cluster 4 and in none in the remaining clusters. The number of males was as follows: 26 (37%) in cluster 1, 13 (62%) in cluster 2, 2 (100%) in cluster 3, 1 (50%) in cluster 4, 1 (50%) in cluster 5 and 0 (0%) in cluster 6.

Based on the capillary dimensions and the total number of capillaries, two clusters have been identified. Cluster A (82 subjects) is characterized by shorter capillary lengths and diameters, less intercapillary distance and a greater number of total capillaries than cluster B (17 subjects) (Table 5). 36 (44%) subjects in cluster A and 7 (41%) subjects in cluster B were male.

The joint distribution of the six clusters (1–6) based on morphologic aspects and the two clusters (A and B) based on capillary dimensions is reported in Table 6. The proportion of subjects in cluster B is greater in cluster 1 with respect to the remaining morphological clusters. This is evident after grouping morphological clusters 2 − 6; in fact a significant association between morphologic and capillary dimension clusterings (Fisher test $p = 0.04$) is observed.

Based on this analysis we could depict three major "normal" morphologic capillaroscopic patterns:

1. the "normal" pattern mainly with 2 to 5 U-shaped loops/mm and ≤2 tortuous loops/mm (cluster 1)
2. the "perfect normal" pattern with ≥5 U-shaped loops/mm (cluster 2)
3. the "unusual normal" with at least 1 meandering or bushy loop, or at least 1 microhemorrhage, or with >4 crossed loops/mm (clusters 3–4–5–6)

Regarding the loop measurements, the majority of subjects had a median of 7 capillaries/mm with a median length of 198 μm (cluster A).

Table 2
Summary statistics of the total number per mm of capillaries and the number of capillaries per mm of each morphological types in the fourth and fifth fingers of both hands.

	Finger	Minimum	1st quartile	Median	Mean	3rd quartile	Maximum
Overall	4th right	3	6.0	7.0	6.8	8.0	13
	4th left	4	6.0	7.0	7.4	8.5	14
	5th right	3	5.0	7.0	6.8	8.0	14
	5th left	3	5.0	6.5	6.7	8.0	12
U-shaped loops	4th right	0	1.0	3.0	3.1	5.0	9
	4th left	0	1.0	4.0	3.5	5.0	10
	5th right	0	0.8	2.0	2.8	4.2	10
	5th left	0	1.0	3.0	2.8	4.0	10
Tortuous loops	4th right	0	0.0	1.0	1.6	2.0	8
	4th left	0	0.0	1.0	1.5	2.5	8
	5th right	0	0.0	1.0	1.4	2.0	7
	5th left	0	0.0	1.0	1.8	3.0	9
Loops with one cross	4th right	0	0.0	1.0	1.3	2.0	8
	4th left	0	0.0	1.0	1.7	3.0	10
	5th right	0	0.0	1.0	1.6	2.0	10
	5th left	0	0.0	1.0	1.4	2.0	8
Loops with ≥2 crosses	4th right	0	0.0	0.0	0.5	0.0	6
	4th left	0	0.0	0.0	0.4	0.0	6
	5th right	0	0.0	0.0	0.8	1.0	10
	5th left	0	0.0	0.0	0.4	0.0	4
Bizarre loops	4th right	0	0.0	0.0	0.1	0.0	4
	4th left	0	0.0	0.0	0.1	0.0	2
	5th right	0	0.0	0.0	0.1	0.0	2
	5th left	0	0.0	0.0	0.2	9.0	4
Meandering loops	4th right	0	0.0	0.0	0.0	0.0	1
	4th left	0	0.0	0.0	0.0	0.0	1
	5th right	0	0.0	0.0	0.1	0.0	2
	5th left	0	0.0	0.0	0.0	0.0	2
Bushy loops	4th right	0	0.0	0.0	0.0	0.0	1
	4th left	0	0.0	0.0	0.0	0.0	0
	5th right	0	0.0	0.0	0.0	0.0	0
	5th left	0	0.0	0.0	0.0	0.0	1

Table 3
Summary statistics of nailfold capillary dimensions (in μm) in the fourth and fifth fingers of both hands.

	Finger	Minimum	1st quartile	Median	Mean	3rd quartile	Maximum
Capillary length	4th right	75	168	207	233	280	552
	4th left	67	169	227	238	301	628
	5th right	89	172	222	239	303	474
	5th left	72	169	220	239	299	654
External diameter	4th right	14	30	39	41	45	98
	4th left	16	29	36	39	46	84
	5th right	15	31	36	43	44	197
	5th left	12	30	35	41	44	167
Internal diameter	4th right	5	13	17	20	24	56
	4th left	6	13	17	21	23	153
	5th right	5	14	17	23	25	165
	5th left	5	14	17	21	24	85
Apex diameter	4th right	6	14	17	18	20	44
	4th left	6	13	16	17	19	66
	5th right	5	13	16	17	20	34
	5th left	6	13	16	18	19	106
Intercapillary distance	4th right	56	116	143	153	181	446
	4th left	66	107	132	145	174	314
	5th right	62	120	147	156	186	386
	5th left	63	120	147	160	174	384

Discussion

Clinicians often come across some difficulties in the final medical report of capillaroscopic examination because some findings may be considered on the border between normal and pathological. An attempt to describe the heterogeneity of nailfold capillary parameters observed in healthy subjects was the starting point of our investigation.

As previous studies have shown that decreased capillary density may be detected very early in patients with “scleroderma spectrum” disorders (Houtman et al., 1986; Ingegnoli et al., 2008, 2010; Lefford and Edwards, 1986; Maricq et al., 1983), we analyzed the number of capillaries per mm, which inversely relates to their inter-peak distance. A direct comparison with some previous reports is not reliable as different devices and magnifications have been used (Andrade et al., 1990; Kabasakal et al., 1996; Rouen et al., 1972). Nevertheless, from the literature 7–10 capillaries/mm are considered the mean reference value (Andrade et al., 1990; Hoerth et al., 2012; Kabasakal et al., 1996), this is consistent with our results. Even if the inter-peak distance was studied, it has been previously demonstrated that counting the number of capillaries is the most accurate way of defining the degree of normality; it also allows quantitative assessments to be made over time and could therefore be useful in monitoring disease progress (Ingegnoli et al., 2009).

Data obtained from the measurement of capillary diameters confirmed previous results (Anderson et al., 2005; Bukhari et al., 1996, 2000; Redisch et al., 1970). The apex diameter resulted as the less reproducible among loop measurements, particularly when the apex is smaller than 10 μm, despite a magnification of 200×.

Furthermore, we measured loop length as the projection of the visible part of the capillary as suggested by earlier studies (Fahrig et al., 1995; Hoerth et al., 2012) that also reported a range between

Table 4
Summary statistics of the total number per mm of capillaries and the number of capillaries per mm of each morphological types in the fourth finger of the right hand, stratified by morphological cluster.

	Cluster	Minimum	1st quartile	Median	Mean	3rd quartile	Maximum
U-shaped loops	1	0	1.0	2.0	2.2	4.0	5
	2	6	6.0	6.0	6.8	7.0	9
	3	1	1.2	1.5	1.5	1.8	2
	4	0	0.0	0.0	0.0	0.0	0
	5	1	1.8	2.5	2.5	3.2	4
	6	0	0.0	0.0	0.0	0.0	0
Tortuous loops	1	0	0	1.0	2.0	3.5	8
	2	0	0	0.0	0.2	0.0	2
	3	1	1.2	1.5	1.5	1.8	2
	4	0	1.0	2.0	2.0	3.0	4
	5	0	0.2	0.5	0.5	0.8	1
	6	0	0	0.0	0.0	0	0
Loops with one cross	1	0	0.0	1.0	1.6	2.0	8
	2	0	0.0	0.0	0.6	1.0	3
	3	1	1.0	1.0	1.0	1.0	1
	4	0	0.0	0.0	0.0	0.0	0
	5	0	0.8	1.5	1.5	2.2	3
	6	2	2.0	2.0	2.0	2.0	2
Loops with ≥2 crosses	1	0	0.0	0.0	0.4	0.0	4
	2	0	0.0	0.0	0.14	0.0	3
	3	0	0.0	0.0	0.0	0.0	0
	4	6	6.0	6.0	6.0	6.0	6
	5	0	0.0	0.0	0.0	0.0	0
	6	4	4.0	4.0	4.0	4.0	4
Bizarre loops	1	0	0.0	0.0	0.1	0.0	4
	2	0	0.0	0.0	0.0	0.0	0
	3	1	1.0	1.0	1.0	1.0	1
	4	0	0.0	0.0	0.0	0.0	0
	5	0	0.0	0.0	0.0	0.0	0
	6	0	0.0	0.0	0.0	0.0	0
Meandering loops	1	0	0.0	0.0	0.0	0.0	0
	2	0	0.0	0.0	0.0	0.0	0
	3	1	1.0	1.0	1.0	1.0	1
	4	0	0.0	0.0	0.0	0.0	0
	5	0	0.0	0.0	0.0	0.0	0
	6	0	0.0	0.0	0.0	0.0	0
Bushy loops	1	0	0.0	0.0	0.0	0.0	0
	2	0	0.0	0.0	0.0	0.0	0
	3	0	0.0	0.0	0.0	0.0	0
	4	0	0.0	0.0	0.0	0.0	0
	5	0	0.0	0.0	0.0	0.0	0
	6	1	1.0	1.0	1.0	1.0	1

200 and 500 μm. These data are in agreement with our results, even if this measurement is imprecise because there is a loss of focus at the loop base. It has, in fact, been demonstrated that the apparent loop length is determined by the obliquity of the angle at which the loop apex approaches the skin surface, thus leading to a distortion of its real length (Lefford and Edwards, 1986). To make the measurement of the loop length more precise, the visible part of the capillary in relation to the venular plexus should be measured (Ingegnoli et al., 2009; Kabasakal et al., 1996).

Table 5
Summary statistics of nailfold capillary dimensions (in μm) in the fourth finger of the right hand, stratified by capillary dimension cluster.

	Cluster	Minimum	1st quartile	Median	Mean	3rd quartile	Maximum
Capillary length	A	75	165	198	209	257	445
	B	163	249	362	348	435	553
External diameter	A	14	29	35	35	42	56
	B	42	61	66	67	70	98
Internal diameter	A	6	12	15	16	22	28
	B	24	34	39	39	44	56
Apex diameter	A	7	14	16	16	19	34
	B	13	17	28	26	30	44
Intercapillary distance	A	56	112	134	136	158	228
	B	118	188	240	238	276	446
Number of capillaries	A	4	6.0	7.0	7.2	8.0	13
	B	3	4.0	5.0	4.8	6.0	6

Table 6
The association between clusters. Six clusters based on morphologic aspects (1 to 6) and two clusters based on capillary dimensions (A and B).

	1	2	3	4	5	6	
A	55 (77%)	20 (95%)	2 (100%)	2 (100%)	2 (100%)	1 (100%)	82 (83%)
B	16 (23%)	1 (5%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	17 (17%)
	71 (100%)	21 (100%)	2 (100%)	2 (100%)	2 (100%)	1 (100%)	99 (100%)

The sub-papillary venous plexus was visible only in 26% of subjects (Kabasakal et al., 1996; Maricq, 1977). This parameter is mainly related to skin transparency, which is influenced by local conditions such as hyperkeratosis, skin pigmentation, injuries, and/or edema. It may be important in terms of the overall quality of the examination as it makes viewing the distal row loops more or less difficult (Ingegnoli et al., 2009).

In line with other published data, we found that bushy, crossed and meandering capillaries, as well as pericapillary hemorrhages are not frequently observed in healthy subjects (Jouanny et al., 1993; Kabasakal et al., 1996; Kiesewetter et al., 1986). Only in a recent study (Hoerth et al., 2012), hemorrhages have been reported in nearly half of the cases, but they were probably related to manual work or other habits such as onychophagia. Anyway, these isolated abnormalities do not usually have a "pathological" meaning and should not be considered in a differential diagnosis of microangiopathy, but as part of the intra-individual variability. In our study any age-related differences in capillary parameters were not observed; this is probably due to the exclusion of medications and/or disease that can modify microcirculation.

From the second part of the study by cluster analysis we could depict the different aspects of normality. In fact, as expected, we did not observe only one unique pattern, but different profiles. Among these profiles, the first two, that we called "perfect normal" and "normal" were more common but showed different characteristics mainly due to the frequency of U-shaped loops. Concerning to the overall patterns, it can be stated that the most frequent morphologic features were U-shaped loops and tortuous loops (Andrade et al., 1990; Kabasakal et al., 1996; Rouen et al., 1972). The majority of our subjects (82%) had less than 8 capillaries/mm, a median capillary length of 207 μm, a median internal diameter of 17 μm, a median external diameter of 39 μm, and a median apical diameter of 17 μm. Additional information can be derived from the cluster analysis, since the morphologic features and the capillary measurements were grouped in two capillaroscopic patterns. The majority of subjects grouped in cluster 1 (71 subjects) and cluster 2 (21 subjects) showed U-shaped loops and/or very few tortuous loops (≤2/mm). This study using video-capillaroscopy technique may be a starting point to help clinicians in understanding the different aspects of normality in nailfold capillaries. The presence in a limited number of healthy subjects of a capillaroscopic pattern mainly characterized by crossed, meandering and bushy loops and/or microhemorrhages, may be considered part of the so-called "normal range" and included in the context of an inter-individual variability. If these characteristics should represent a potential risk factor for future onset of any disease may be considered to be followed up in view to an early diagnosis. This issue cannot be afforded in this study, but it could be considered in a planned survey to evaluate the potential risk for subjects classified in the rare clusters.

Conclusion

Our study is an effort to define which capillary parameters should be considered part of the "normal" capillaroscopic pattern. It is a starting point to help clinicians realize the range of normality

so that microangiopathy, which may underlie a lot of diseases, may be easily identified or ruled out.

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