

Photo Plethysmography

Comparison of Normal and Replantation Digital Blood Flow Using Photo Plethysmography

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The degree of circulatory insufficiency in Raynaud's phenomenon, Buerger's disease or digital replantation has been evaluated only by clinical symptoms and signs or angiograms. Objective evaluation methods of the disability of digits are crucial for proper management of patients with circulatory insufficiency of digits. Angiogram, Doppler, electromagnetic flowmeter, laser blood flowmetry, mechanical blood flowmetry has been used for the evaluation of the circulatory insufficiency, however, the data was affected by time, place, room temperature and patient's emotional state. In fact, many methods are unreliable, expensive and difficult to perform.

Photo plethysmography can measure the absorption amount of light at different wavelength. Summation of the absorbed and emitted amount of light evenly match

the input amount. Photo plethysmography evaluates qualitative blood flow differences by comparing normal fingers and replanted fingers.

So we designed the two channel photo plethysmography to compare digital blood flow between dominant hand to non dominant hand and replanted fingers to opposite normal fingers in 202 pairs of fingers in 44 patients. The average digital blood flow in both hands showed no difference but replanted digits showed 53% compare to opposite normal digits. In each patient, the blood flow of each digit showed significant difference.

In conclusion, photo plethysmography is a sensitive, reliable, and useful tool for evaluating blood flow for circulatory insufficiency of tissues such as fingers and toes.

Key Words: Circulatory insufficiency, Digital blood flow, Replantation, Photo plethysmography

Raynaud's phenomenon Buerger's dis-
ease, ease,
(replanta- tion)
1-4
(ultra-
sound Doppler), (angiogram),
(electromagnetic flowmeter),
5-11

가

(National Instruments)

2004 4 5
2

(photo plethysmography: PPG)

5

5

30

10

(extinction coefficient)

Beer-Lambert

2 PPG (photoplethysmog-

raphy)

13

44

31

43.6 ± 12.2

11.4 ± 11.3

가

20

44

440

71

가 349

가

$44 \times 5 / = 220$

PPG

LED

PPG

2

202

LED 1 ms

500 us

64

138

NELLCOR (DS-100, Durasensor)

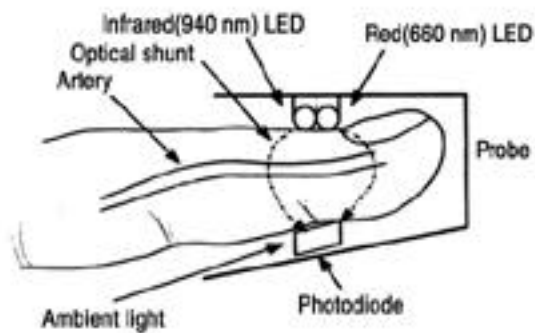
PPG

(Fig. 1).

660 940nm (DAQ-board; PCI-6020E, National Instrument)

12bit

PC



가

44 440

20

420

Fig. 1. Probe of PPG.

Table. 1, Fig. 2 . 71 , p=0.005 , 가
 349 . p=0.01 , 가
 SPSS 8.0(SPSS Inc.) 2-way ANOVA .
 p= 0.000, p=0.026 가 가 가
 Table. 2
 Fig. 3 44 가 440
 20 420
 SPSS 8.0(SPSS Inc.) 2-way ANOVA 202
 64 138 ,
 p=0.000,

Table 1. Blood flow. n=420

	Blood flow of each finger					Sum
	1st	2nd	3rd	4th	5th	
Normal fingers (n=349)	1.7 ± 0.6 (n=77)	2.3 ± 0.8 (n=65)	2.5 ± 1.0 (n=65)	2.6 ± 0.9 (n=69)	2.0 ± 0.8 (n=73)	2.2 ± 0.9 (n=349)
Replanted fingers (n=71)	0.9 ± 0.6 (n=10)	1.4 ± 0.9 (n=15)	0.9 ± 0.5 (n=16)	1.1 ± 0.8 (n=17)	1.4 ± 1.0 (n=13)	1.1 ± 0.8 (n=71)

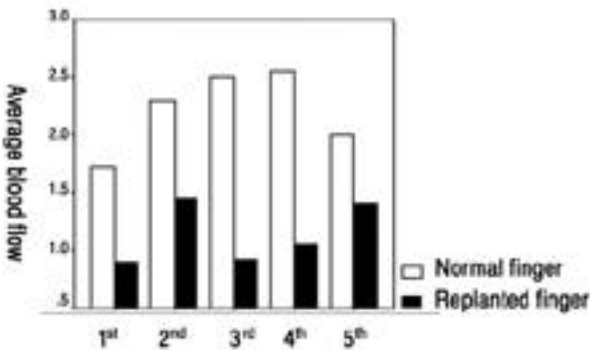


Fig. 2. Average blood flow of normal and replanted fingers.

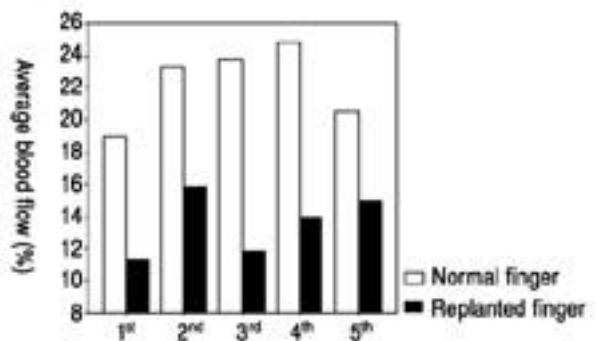


Fig. 3. Distribution of blood flow of each finger [%].

Table 2. Blood flow (%) n=420

	Blood flow of each finger					Sum
	1st	2nd	3rd	4th	5th	
Normal fingers (n=349)	18.9 ± 6.9 (n=77)	23.3 ± 5.3 (n=65)	23.8 ± 4.5 (n=65)	24.8 ± 5.4 (n=69)	20.5 ± 5.8 (n=73)	22.1 ± 6.1 (n=349)
Replanted fingers (n=71)	11.4 ± 7.2 (n=10)	15.8 ± 8.2 (n=15)	11.9 ± 5.7 (n=16)	14.0 ± 7.3 (n=17)	15.0 ± 4.4 (n=13)	13.7 ± 6.7 (n=71)

Table. 3

가

가 가

가
44

Table. 4

44

5

가

가

가

가

가

1

43

가

50%

(impedance plethysmography)

Raynaud's phenomenon, Buerger's

disease,

가

가 가

(non-invasive) 4

16-23

가

가 가

(PPG: photo-plethysmography)

가

Doppler

가

15

(angiogram)

Table 3. Comparison of blood flow ratio of normal and replanted fingers (n=202)

	Blood flow ratio of normal finger (n=138)	Blood flow ratio of replanted finger (n=64)
Average	1.04	0.53
SD	0.16	0.26
Maximum	1.50	1.00
Minimum	0.42	0.09
p=0.000		

Table 4. Individual comparison of blood flow ratio of normal and replanted fingers (n=43)

	Average of blood flow ratio of normal fingers (n=43)	Average of blood flow ratio of replanted fingers (n=43)	Average of blood flow ratio of replanted fingers
			Average of blood flow ratio of normal fingers
Average	1.04	0.51	0.50
SD	0.13	0.24	0.25
Maximum	1.32	0.93	1.06
Minimum	0.59	0.12	0.12

가
24.
가
가
3, 2, 5, 1
1
4, 1, 3
4, 3, 1
가
가
가
53%
가

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