

Reliability test of a bio-electrical impedance device with varying contact area of electrodes

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Bioelectrical Impedance Analysis (BIA)

- The bioelectrical impedance analysis (BIA) is a recently developed technique that estimates body compositions based on the non-invasive measurements of the distribution of water and electrolytes in the body by analyzing body's electrical responses to source voltages.
- Some devices based on the BIA technique attempted to estimate ionogram, hormones, biochemical substances, neurotransmitters, oxidative stress, and so on.

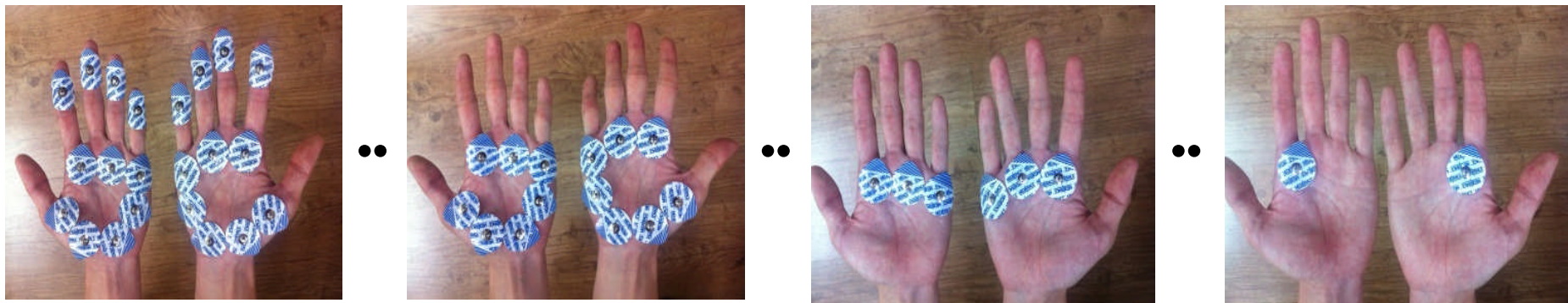
New BIA-based device

- One of these new BIA-based devices include the DDFAO (MEDI.L.D, France), which applies a low voltage across pairs of the six electrodes that are contacted symmetrically to the forehead, both hands and both feet.
- By the current response for a given voltage, it estimates the concentration of interstitial gas that reflects acidity level of internal body, oxygenation of blood and equilibrium pH.

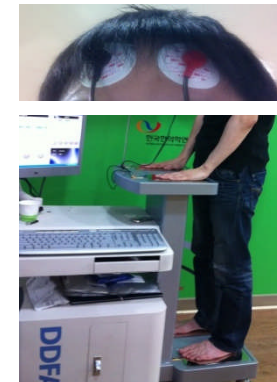
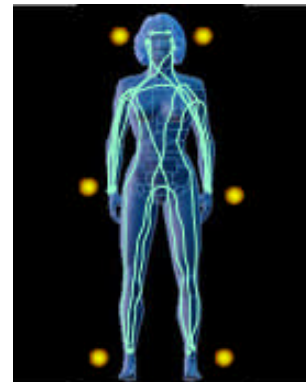
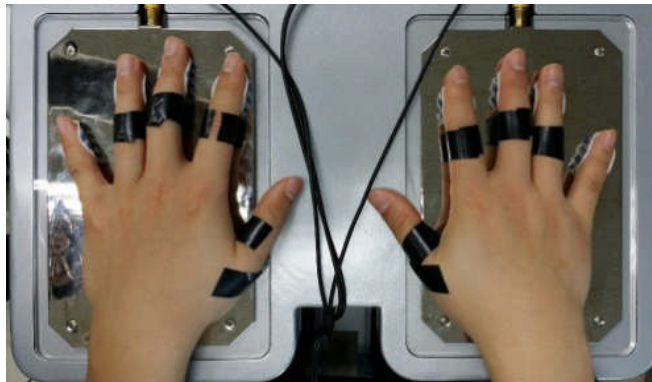


- To accurately measure the electrolytes or some substances in the body using BIA, **measurement guideline related on variability of contact area between electrodes and body** is required to maintain constant measurement conditions.
- In this study, we evaluate the repeatability of some interstitial gas parameters with varying contact area of palm electrodes of the DDFAO and show that **a stable estimation values can be obtained when the contact areas between the electrodes and the palms are larger than the cross-sectional area of the wrist** of subjects.

- To modulate the contact area of the palm electrodes, disposable Ag-AgCl electrodes (with the contact area of $1\pi \text{ cm}^2$ for a single electrode) were used.
- We changed the contact area from $10\pi \text{ cm}^2$ down to $1\pi \text{ cm}^2$ by removing the electrode one by one sequentially.
- The contact areas of the forehead electrodes and feet electrodes were kept constant.



- 3 times repeat, 3 subjects, each 10 levels of contact area of the palm electrodes
- DDFAO-estimated values for five interstitial gas parameters
: pH, H⁺, HCO₃⁻, PCO₂, PO₂.
- The study assumption was that the average values of the interested parameters were constant if contact area was bigger than a threshold value.
- To test this assumption, we carried out K-means clustering analysis to determine the threshold of the contact area (number of clusters: 2).



- For subject 1, the interstitial gas parameters were segmented into two parts of the contact area ($1\sim 4\pi\text{cm}^2$ and $5\sim 10\pi\text{cm}^2$).
- The area clustering was $1\sim 6\pi\text{cm}^2$ and $7\sim 10\pi\text{cm}^2$ for subject 2, $1\sim 7\pi\text{cm}^2$ and $8\sim 10\pi\text{cm}^2$ for subject 3.
- We found that the threshold value of the contact area existed, which was approximately each subject's wrist area. ($3.72\pi\text{ cm}^2$, $5.56\pi\text{ cm}^2$, $6.71\pi\text{ cm}^2$, respectively)

subject	Clustering : contact area of the palm electrodes ($\pi\text{ cm}^2$)	Cross-sectional area of the wrist ($\pi\text{ cm}^2$)
1	1, 2, 3, 4 5, 6, 7, 8, 9, 10	3.72
2	1, 2, 3, 4, 5, 6 7, 8, 9, 10	5.56
3	1, 2, 3, 4, 5, 6, 7 8, 9, 10	6.71

- **This feasibility study implies that the contact area of palm electrodes should be comparable or larger than the wrist area to show repeatability and accuracy of the BIA technique of the device at hand.**
- **Clinical test with more subjects is required to confirm the above results.**

Thank you for your attention

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