

The Role of Ultrasound Elastography and Mispredicted Lymphedema Volume by Bioimpedance: Case Reports

Hyeonwoo Jeon*, Namoo Jeon, Si-Woon Park, Bum-Suk Lee, Daham Kim, Hyeong-Wook Han, Doo Young Kim*

Department of Rehabilitation Medicine, International St Mary's Hospital, Catholic Kwandong University College of Medicine, Incheon 22711, Korea

Background

- Lymphedema refers to the accumulation of lymph in the interstitial tissue caused by decreased lymphatic circulation and there have been many attempts to measure lymphedema using multi-frequency bioimpedance analysis (MFBIA)
- However, MFBIA only provides information of extracellular water (ECW), but does not reflect all characteristics of lymphedema
- In the initial stage of lymphedema, only fluid retention may occur, but as the course of lymphedema progresses, fibrotic tissue change may be accompanied
- ECW and inverse ratio of impedance at 5 kHz are known to positive correlate with arm volume of lymphedema
- In this case series report, we describe patients who showed paradoxical relationship between MFBIA values and arm volume
- All of cases, stiffness of the subcutaneous tissue was observed by ultrasound elastography

Cases

➢ General characteristics are described in Table 1

Table 1. General characteristics of 3 cases

	Patient 1	Patient 2	Patient 3
Age	53	50	38
Weight	72.2	57.7	62
Height	166	159	163.9
BMI	26.20	22.82	23.07
Surgical method	Whole ablation	Partial ablation	Whole ablation
Axillary dissection	Yes	Yes	Yes
Side of lesion	Left	Right	Right
Stage of lymphedema	2	2	1
Affected side volume	1439.17	1123.32	1106.13
Unaffected side volume	1255.65	1053.42	1066.71
ICW affected side	2.52	1.16	1.57
ECW affected side	1.19	0.76	0.93
ICW unaffected side	4.15	1.62	1.65
ECW unaffected side	1.97	1.01	0.95
Volume ratio*	1.14	1.06	1.03
ICW ratio*	0.24	0.71	0.95
ECW ratio*	0.60	0.75	0.97
Elastography ratio*	0.23	0.42	0.68
RR 1K †	0.93	0.99	0.98
RR 5K †	0.69	0.80	0.98
RR 50K †	0.25	0.51	0.90
RR 250K †	0.61	0.66	0.93
RR 550K †	0.35	0.45	0.87
RR 1MK †	0.61	0.59	0.87

* Ratio, affected side / unaffected side

† Ratio of inverse impedance at each frequency

Intracellular water (ICW), Extracellular water (ECW), Body mass index (BMI)

- Case 1
- The patient with stage 2 lymphedema about 1234 days after breast cancer surgery, the arm volume was 1255.65cm³ on the unaffected side and 1439.17cm³ on the affected side
- The volume ratio(affected side/ unaffected side) was 1.14
- The ECW ratio(affected side/ unaffected side) was 0.60
- The inverse ratio of impedance at 5kHz was 0.69
- **The ratio of arm volume was greater than 1, but the ECW ratio and the inverse ratio of impedance at 5kHz were less than 1**
- The elastography ratio(affected side/ unaffected side) was 0.23

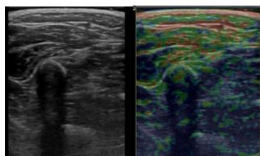


Fig.1 Case 1

(A) Ultrasound image at above elbow level
(B) Strain image of ultrasound elastography

- Case 2
- The patient with stage 2 lymphedema about 1481 days after breast cancer surgery, the arm volume was 1053.42cm³ on the unaffected side and 1123.32cm³ on the affected side
- The volume ratio(affected side/ unaffected side) was 1.06
- The ECW ratio(affected side/ unaffected side) was 0.75
- The inverse ratio of impedance at 5kHz was 0.80
- **The ratio of arm volume was greater than 1, but the ECW ratio and the inverse ratio of impedance at 5kHz were less than 1**
- The elastography ratio(affected side/ unaffected side) was 0.42

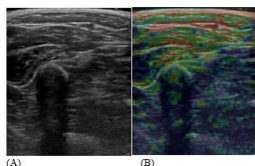


Fig.2 Case 2

(A) Ultrasound image at above elbow level
(B) Strain image of ultrasound elastography

- Case 3
- The patient with stage 1 lymphedema about 909 days after breast cancer surgery, the arm volume was 1066.71cm³ on the unaffected side and 1106.13cm³ on the affected side
- The volume ratio(affected side/ unaffected side) was 1.03
- The ECW ratio(affected side/ unaffected side) was 0.97
- The inverse ratio of impedance at 5kHz was 0.98
- **The ratio of arm volume was greater than 1, but the ECW ratio and the inverse ratio of impedance at 5kHz were less than 1**
- The elastography ratio(affected side/ unaffected side) was 0.68

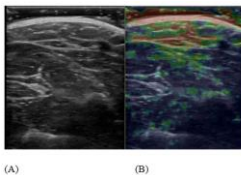


Fig.3 Case 3

(A) Ultrasound image at above elbow level
(B) Strain image of ultrasound elastography

- **The ultrasound elastography strain ratio of each case was under 0.7 Which means that the affected arm was more than 30% stiff compared to the unaffected arm**

Conclusion

- Theoretically, the volume of the arm in the early stages of lymphedema should be directly proportional to ECW, and should also be directly proportional to the inverse ratio of impedance at 5kHz. Therefore, it is expected that the ECW ratio and the inverse ratio of impedance at 5kHz for cases of lymphedema should be greater than 1, but they have shown paradoxical results with a value less than 1
- In our case group, the relationship between MFBIA value and arm circumference was unexpected for patients who showed stiffness through elastography
- Fibrotic changes may be present even in patients whose fibrosis is not confirmed on clinical physical examination
- Ultrasound elastography may be helpful for these patients
- Further research is needed to develop appropriate evaluation methods and criteria for classifying lymphedema according to stiffness, considering the characteristics of lymphedema