

# Value of multifrequency bioelectrical impedance in assessing fluid disturbances in patients undergoing major abdominal surgery

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## Introduction:

The ability of bedside multifrequency bioelectrical impedance analysis to monitor fluid disturbance and predict patients at risk of developing oedema after major surgery was assessed.

## Methods:

- 22 ward-based patients (11 M, 11 F; aged 28-85 yrs) had their whole body bioelectrical impedance (Z) assessed before and on days 1, 3 and 5 after major abdominal surgery, to examine the relationship between Z and fluid balance.
- Measures of Z were obtained at four frequencies (5, 50, 100 and 200kHz) with the Quadscan 4000<sup>®</sup> (Bodystat Limited, Isle of Man, UK). No patient had oedema prior to surgery.
- Administration of fluids intra- and post-operatively followed routine protocols.
- After surgery, some patients developed oedema (OD group, n=9); the other patients were consistently non-oedematous (NOD group, n=13) throughout the study.
- Parametric tests were used for statistical analysis.

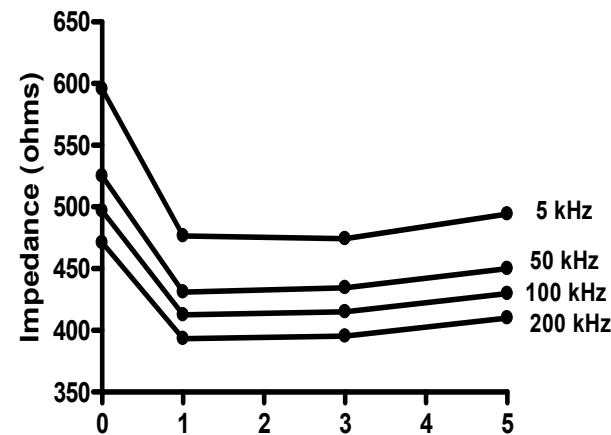
## Results:

Preoperative BMI was similar in OD and NOD groups ( $25.8 \pm 3.1$  vs  $27.2 \pm 6.5$  kg/m<sup>2</sup>;  $p = 0.560$ ).

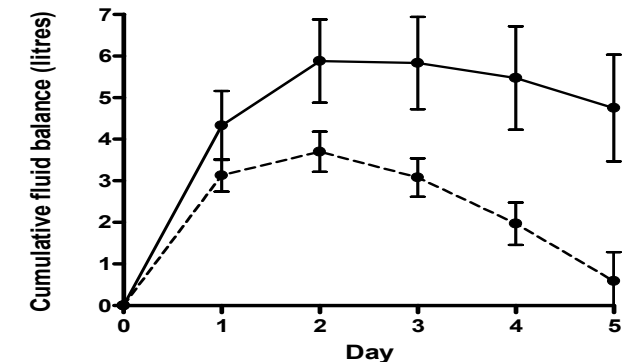
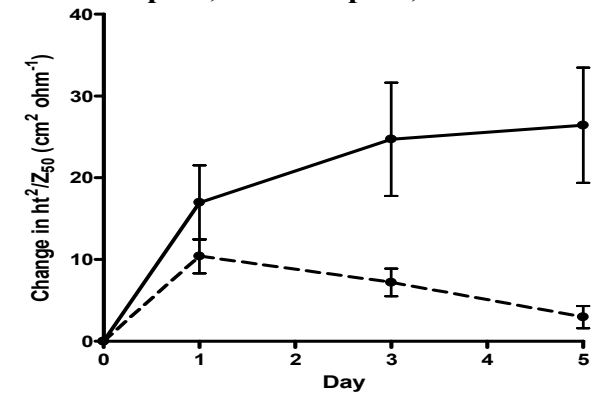
- A reduction in impedance and an increase in impedance index ( $\text{height}^2/Z$ ; ZI) occurred at all frequencies (Figure 1).
- The increase in ZI was greater in OD group compared to NOD group (e.g. at 50kHz, this was 21.3 vs 6.86 cm<sup>2</sup>/ohm for average increments in ZI on days 1, 3 and 5;  $p < 0.001$ ) (Figure 2).
- The intraindividual changes in ZI were related to fluid balance ( $r = 0.86$  using analysis of covariance with subject as fixed factor).
- $Z_5/Z_{200}$  (the ratio of impedance at 5kHz, mainly influenced by extracellular water, to impedance

at 200 kHz, influenced by extra and intracellular water), decreased in all subjects (from  $1.266 \pm 0.047$  preoperatively to  $1.201 \pm 0.064$  post operatively (mean of days 1, 3 and 5);  $p < 0.001$ ), and tended to change more in the oedematous patients ( $0.0788$  v  $0.055$ ;  $p = 0.078$ ) (Figure 3).

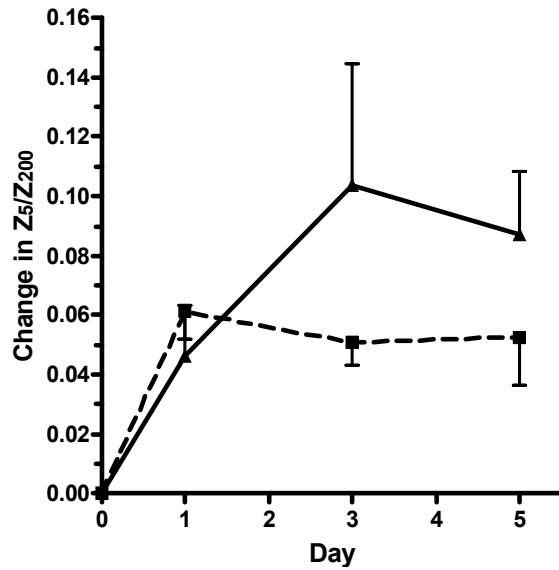
- Preoperatively,  $Z_5/Z_{200}$  ratio was significantly lower in those that went on to develop oedema compared to those that did not ( $1.237 \pm 0.044$  v  $1.285 \pm 0.039$ ;  $p = 0.015$ ).



**Figure 1**  
Change in impedance at 5kHz, 50kHz, 100 kHz, and 200kHz following surgery (mean values shown). The reduction was significant at each frequency ( $p < 0.001$ ) and at all time points.



**Figure 2**  
*Upper:* Change in the impedance quotient  $\text{height}^2/Z_{50}$  (mean  $\pm$  standard error (cm<sup>2</sup>ohm<sup>-1</sup>)) following surgery. The increments in the oedematous group (solid line) were significantly greater than in the non-oedematous group (dashed line) (SPANOVA,  $p < 0.001$ ).  
*Lower:* Daily cumulative fluid balance following surgery (mean  $\pm$  standard error (litres)). The overall fluid balance in oedematous (solid line) was significantly more positive than in the non-oedematous patients (dashed line) (SPANOVA;  $p = 0.009$ ).



**Figure 3**  
 Change in the impedance ratio  $Z_5/Z_{200}$  (impedance at 5kHz to impedance at 200kHz) following surgery (mean  $\pm$  standard error). The decrease/change in the ratio  $Z_5/Z_{200}$  on day of assessment compared to the preoperative  $Z_5/Z_{200}$  ratio in the oedematous group (solid line) was greater than the non-oedematous group (dashed line) but was not statistically significant (SPANOVA,  $p = 0.07$ ).

### Discussion:

This study suggests:

- Postoperative fluid balance can be detected by changes in whole body bioelectrical impedance, even in patients who do not develop oedema.
- The ratio  $Z_5/Z_{200}$  became exaggerated post-operatively in those that developed oedema.
- A predisposition to developing post-operative oedema is suggested by measurements of a bio-electrical impedance ratio ( $Z_5/Z_{200}$ ) obtained pre-operatively.