Quantum V Segmental BIA

Eight Electrode Segmental BIA

Measuring the biological resistance and reactance
of each arm, leg, right and left torso including
the upper and lower regions of the human body
where the sum of the parts (segments) equals
equals the whole (whole body)

22 May 2018

RJL SYSTEMS

RJL Systems Quantum V Segmental BIA

The Quantum V Segmental BIA provides quantitative regional body composition assessments that are similar to those produced by Dual-energy X-ray Absorptiometry (DXA) scanners. This is proformed by using eight hand and foot electrodes (left and right side) with the subject in a supine position and measuring 13 resistance and reactance regions on the human body. The comparative characteristics of segmental body composition assessments are highly significant, as segmental muscle atrophy and hypertrophy can be clearly illustrated by analyzing and comparing collected data as a comparative percentage or change over time.

Health care professionals such as physicians who are interested in regional muscle wasting will find the Quantum V Segmental BIA a valuable tool. In addition, physical therapists, sport medicine trainers and nutritionists can monitor and track their patients progress and health improvements on specific regions of the body.

The Quantum V Segmental BIA uses an eight lead 12-channel multiplexer to quickly measure resistance and reactance values from each arm, leg and right and left torso, including the upper and lower regions of the human body in less than 20 seconds. The repeatability and accuracy of the resistance and reactance measurements allow the smallest changes to be recorded with 0.1 ohms of resolution.

A unique and patented feature of the RJL Systems segmental BIA instrument is that the sum of the lean soft tissue (LST) or fat mass is equal to the whole body LST or fat assessment. This is similar to the sum of the DEXA measurements that approximates to body weight.

The Quantum V Segmental BIA built in firmware automatically handles selecting eight leads (eight electrodes), scanning multiple zones and calibrating each zone, making the device exceptionally easy to operate. The 13-zone resistance and reactance data is date & time stamped and saved on the unit, where more than 2,000 records can be stored for downloading to a computer using the built in Bluetooth or USB port - standard on all Quantum V BIA products.

Appendicular and regional lean soft tissue and fat segmental composition

Lean Soft Tissue and Percent	Fat Mass and Percent
1. Right Arm	2. Right Arm
3. Left Arm	4. Left Arm
5. Right Leg	6. Right Leg
7. Left Leg	8. Left Leg
9. Torso	10.Torso
11 Right Half Torso	12. Right Half Torso
13. Left Half Torso	14. Left Half Torso
15. Right Half Body	16. Right Half Body
17. Left Half Body	18. Left Half Body
19. Upper Body	20. Upper Body
21. Lower Body	22. Lower Body
23. Android	24. Android
25. Gynoid	26. Gynoid

The Quantum V Segmental BIA is a highly effective, easy to use, Class II medical device that can quickly and accurately measure segments and total body composition that health care professionals can use to chart patients health goals and progress.

Akern Srl (Florence, Italy) pioneered a BIA system that incorporates an isolated lead switching multi-plexer that can easily make segmental measurements using traditional "stick-on" electrodes. The Akern design was so successful that the company won the FIBO Innovation Award (The European Award of the Fitness and Wellness Industry - 2008). This design was based on RJL Systems OEM modules and BIA printed circuit boards (US Patent 6,631,292 B1).

The Quantum V Segmental BIA

The Quantum V Segmental BIA with its internal multiplexer creates multi-zone calibrated segmental measurements that are scanned in 20 seconds. The internal firmware automatically handles selecting leads and scanning the 13 zones. The time stamped resistance and reactance data is saved in the non-volatile ECC memory where more than 2000 records can be saved. A segmental scan is started by pushing the ON button or by selecting a sampling time interval that can range from seconds to hours. If the interval is more than 1 minute the instrument will automatically turn off and wake up at the specified time. This greatly improves battery life for a long term observation (months).

The BC (Body Comp) software application will retrieve the BIA segmental data from the instrument using the USB connection. It stores not only the BIA data, but height, weight, age, and gender - all the information needed to develop a model for estimating segmental body composition and creating a report. The investigator can view the BIA and body composition history of an individual and export the results to a CSV-formatted spreadsheet file that can be read by applications such as Excel.

What is measured and saved for analysis (13 zones, 26 data points)

1	Right Body resistance	2	Right Body reactance
3	Left Body resistance	4	Left Body reactance
5	Lower Body resistance	6	Lower Body reactance
7	Upper Body resistance	8	Upper Body reactance
9	Right Arm resistance	10	Right Arm reactance
11	Left Arm resistance	12	Left Arm reactance
13	Right Leg resistance	14	Right Leg reactance
15	Left Leg resistance	16	Left Leg reactance
17	Right Torso resistance	18	Right Torso reactance
19	Left Torso resistance	20	Left Torso reactance
21	Transverse RA -> LL resistance	22	Transverse RA -> LL reactance
23	Transverse LA -> RL resistance	24	Transverse LA -> RL reactance
25	Whole Body resistance	26	Whole Body reactance

BC Whole Body software is included

Notice in the table above that the right side of the body is measured[1,2]. This measurement is the same as a whole body resistance and reactance taken with traditional RJL Systems body composition products (Quantum IV, Quantum II and Quantum X). This right side measurement is also continuously displayed on the LCD display when a segmental measurement is not being taken and can be entered into BC Whole Body software. The entry into the whole body application is manual and can not be retrieved from the Quantum IV USB port. Since there are only two values that must be entered, this is a minor inconvenience. A license key to the BC Whole Body application is included with purchase of a Quantum V Segmental BIA. The software and manual are also included on a thumb drive with the instrument.

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1. LESLIE W. ORGAN, GILBERT B. BRADHAM, DWIGHT T. GORE, AND SUSAN L. LOZIER Segmental Bioelectrical impedance analysis: theory and application of a new technique. 0161 7567/94, The American Physiological Society 1994

Typical segmental BIA report

RJL SYSTEMS

Go to Options -> Report Options to change this header.

Name: John Doe
Subject ID: 1JP

Test Date: 2:53 PM; November 16, 2017
Report Printed on: 3:08 PM; November 16, 2017

Height	Weight	Age	Sex	Frame	Target Wt.	Activity Level	Equation Set
64 in	166 lbs	46.0	Male	Medium	134 lbs	Very Light	Segmental

Comment: Report 3

Whole-Body Composition

	Amount			
Weight	166.0 lbs	**% of Weight**		
Fat	58.5 lbs	35.2 %		
Fat-Free Mass (FFM)	107.5 lbs	64.8 %	**% of FFM**	
Lean Dry Mass (LDM)	26.1 lbs	15.7 %	24.2 %	
Total Body Water (TBW)	81.4 lbs	49.1 %	75.8 %	**% of TBW**
Intra-Cellular Water (ICW)	49.0 lbs	29.5 %	45.6 %	60.2 %
Extra-Cellular Water (ECW)	32.4 lbs	19.5 %	30.2 %	39.8 %
Bone Mineral Content (BMC)	8.2 lbs	4.9 %	7.6 %	
Lean Soft Tissue (LST)	99.3 lbs	59.8 %	92.4 %	

BMI: 28.5 **FMI:** 10.0 **FFMI:** 18.5

Segmental Body Composition

	Lean Soft Tissue (LST)	Percentage of total LST	Fat Mass	Percentage of total Fat	Resistance	Reactance	Phase Angle
Right Arm	6.9 lbs	6.9 %	3.1 lbs	5.3 %	235.9 Ω	31.9 Ω	7.7 °
Left Arm	6.3 lbs	6.4 %	2.9 lbs	5.0 %	253.6 Ω	29.3 Ω	6.6 °
Right Leg	15.6 lbs	15.7 %	8.7 lbs	14.9 %	266.3 Ω	33.7 Ω	7.2 °
Left Leg	15.8 lbs	15.9 %	8.5 lbs	14.6 %	262.0 Ω	37.5 Ω	8.1 °
Torso	54.7 lbs	55.0 %	35.2 lbs	60.1 %			
(Right Half)	27.3 lbs	27.5 %	17.3 lbs	29.5 %	25.1 Ω	3.8 Ω	8.6 °
(Left Half)	27.3 lbs	27.5 %	17.9 lbs	30.5 %	24.6 Ω	4.2 Ω	9.7 °

Body Regions

	Lean Soft Tissue (LST)	Percentage of total LST	Fat Mass	Percentage of total Fat	Resistance	Reactance	Phase Angle
Right Side	49.8 lbs	50.1 %	29.1 lbs	49.8 %	527.6 Ω	66.3 Ω	7.2 °
Left Side	49.5 lbs	49.8 %	29.4 lbs	50.2 %	541.5 Ω	66.0 Ω	6.9 °
Upper Body	13.2 lbs	13.3 %	6.0 lbs	10.3 %	490.8 Ω	57.6 Ω	6.7 °
Lower Body	31.4 lbs	31.7 %	17.3 lbs	29.7 %	529.5 Ω	67.6 Ω	7.3 °
Android	7.0 lbs	7.0 %	5.0 lbs	8.6 %			
Gynoid	15.0 lbs	15.1 %	8.2 lbs	14.0 %			

Other BIA Measurements

	Resistance	Reactance	Phase Angle
Right Arm -- Left Leg	524.7 Ω	65.3 Ω	7.1 °
Left Arm -- Right Leg	545.6 Ω	66.5 Ω	6.9 °
"Whole Body" (Left Side and Right Side in parallel)	279.8 Ω	35.3 Ω	7.2 °

Complete Comment History:

An individual history of segmental body composition is saved in the BC database management software.

Report for John Doe 1JP Tested: 2:53 PM; November 16, 2017

History

	11/16/2017	11/16/2017	11/16/2017
Height	64.0	64.0	64.0
Weight	166.0	166.0	166.0
Age	46.0	46.0	46.0
Gender	Male	Male	Male
Frame	Medium	Medium	Medium
Activity Level	Very Light	Very Light	Very Light
equation_set	Segmental	Segmental	Segmental
Target Weight	134.0	134.0	134.0
BMI	28.5	28.5	28.5
FMI	9.9	10.0	10.0
FFMI	18.6	18.5	18.5
Fat	57.8	58.3	58.5
Fat % of Weight	34.8 %	35.1 %	35.2 %
FFM	108.2	107.7	107.5
FFM % of Weight	65.2 %	64.9 %	64.8 %
BMC	8.1	8.2	8.2
BMC % of Weight	4.9 %	4.9 %	4.9 %
BMC % of FFM	7.5 %	7.6 %	7.6 %
LST	100.0	99.5	99.3
LST % of Weight	60.2 %	60.0 %	59.8 %
LST % of FFM	92.5 %	92.4 %	92.4 %
LDM	26.2	26.1	26.1
LDM % of Weight	15.8 %	15.7 %	15.7 %
LDM % of FFM	24.3 %	24.2 %	24.2 %
TBW	81.9	81.6	81.4
TBW % of Weight	49.4 %	49.2 %	49.1 %
TBW % of FFM	75.7 %	75.8 %	75.8 %
ICW	49.2	49.1	49.0
ICW % of TBW	60.1 %	60.2 %	60.2 %
ECW	32.7	32.5	32.4
ECW % of TBW	39.9 %	39.8 %	39.8 %
Right Arm LST	6.9	6.9	6.9
Right Arm Fat	3.1	3.1	3.1
Left Arm LST	6.4	6.4	6.3
Left Arm Fat	2.9	2.9	2.9
Right Leg LST	15.7	15.6	15.6
Right Leg Fat	8.7	8.7	8.7
Left Leg LST	15.9	15.8	15.8
Left Leg Fat	8.5	8.5	8.5
Torso LST	55.1	54.8	54.7
Torso Fat	34.7	35.0	35.2
Right Torso LST	27.5	27.4	27.3
Right Torso Fat	17.1	17.2	17.3
Left Torso LST	27.5	27.4	27.3
Left Torso Fat	17.7	17.8	17.9
Right Side LST	50.1	49.9	49.8
Right Side Fat	28.8	29.0	29.1
Left Side LST	49.8	49.6	49.5
Left Side Fat	29.0	29.3	29.4
Upper Body LST	13.3	13.2	13.2
Upper Body Fat	5.9	6.0	6.0
Lower Body LST	31.6	31.5	31.4
Lower Body Fat	17.2	17.3	17.3
Android LST	7.0	7.0	7.0
Android Fat	4.9	5.0	5.0
Gynoid LST	15.1	15.0	15.0
Gynoid Fat	8.1	8.1	8.2

Note small changes on the above historical report. This is due to the physiological changes of the human body coming to rest. This kind of physiological event can be taken by pushing the "ON" button that saves a complete segmental (26 values) into the internal memory of the instrument. A complete segmental BIA scan is done in less than 20 seconds. More than 2000 complete time stamped records can be saved. The human body is never at complete rest and the Quantum V Segmental BIA is sensitive enough to measured these changes to 0.1 ohms resolution resistance and reactance.

The sum of the parts equals the whole (Whole Body) from the report above

Segment	LST (lb)	Fat Mass (lb)	Segment	LST (lb)	Fat Mass (lb)
Left Arm	6.3	2.9	Right Arm	6.9	3.1
Left Leg	15.8	8.5	Right Leg	15.6	8.7
Left Torso	27.3	17.9	Right Torso	27.3	17.3
Left Sum Σ	**49.4**	**29.3**	**Right Sum Σ**	**49.8**	**29.1**
Left Body Estimate	49.5	29.4	Right Body Estimate	49.8	29.1
Left Body Sum	49.4	29.3			
Right Body Sum	49.8	29.1			
Rt & Lt Body Sum Σ	**99.2**	**58.4**			
Whole Body Estimate	99.3	58.5			

Only the RJL Segmental BIA is able to have the **sum of the parts equal the whole (whole body)**. A four electrode whole body assessment would be the same as adding the segmental regions from an eight electrode assessment. This is the only way a segmental BIA system should work.. *The sum of the segments equals the whole body.* A brief statistical summery of the right body follows where subject was measured in a supine position.

Charts and graphs:

There are pie and bar charts in BC 4.x whole body software including historical graphing of most body composition parameters (lean and fat mass, etc). There are no charts or graphs at this time in our segmental BIA software. There is, however, an export function that will export an individual patient or an entire database available in the segmental BIA software product. All regional body composition values including regional resistance and reactance values can be exported as a CSV file. This file is read by most spread sheet programs including Excel and Libre office. Graphs and charts can then be made using spread sheet graphic tools. Also the segmental BIA instrument can be used with BC 4.x whole body software (charts and graphs) or segmental Quantum V software. When using with BC 4.x only the right body connector is used.

As mentioned, one feature of the segmental BIA product is that the sum of the points equals the whole (whole body). Therefore, a right and left body pie chart could easily be made that contains the percent of each arm and leg including the right or left torso. This is planned for the near future. There are also other developments in progress to improve the usefulness of the segmental BIA product. Any customer input is appreciated.

Reproducibility

When the subject is in a supine position and measured with a calibrated and portable segmental BIA instrument repeatable measurement can be made. Accurate electrode placement is important when assessing changes of lean soft tissue (LST) in appendicular body segments. This is especially important with the detecting electrodes that bisect the ulnar head (bone on the little finger side of the wrist) and the medial malleolus (bone on the big toe side of ankle).

Segmental BIA Test Re-test

Segmental BIA test re-test of resistance and phase angle measurement on the same subject Friday and Monday

Test	Name	Subject ID	Gender	Age	Test Date	RA res	LA Res	RL Res	LL Res	RT res	LT Res
Each test started with 8 new electrods and end by disposing of all electodes											
1	Mike Cooper	Test-retest	M	43	06/08/2018	194.7	204.3	218.8	215.9	25.0	25.0
2	Mike Cooper	Test-retest	M	43	06/08/2018	199.1	200.6	218.3	219.5	25.1	25.1
3	Mike Cooper	Test-retest	M	43	06/082018	197.7	201.8	221.7	214.6	25.1	25.2
4	Mike Cooper	Test-retest	M	43	06/08/2018	198.0	202.4	221.2	216.6	25.1	25.1
5	Mike Cooper	Test-retest	M	43	06/08/2018	197.7	203.5	220.5	212.5	26.0	25.9
Subject walked for 10 minutes before test. Used new electrodes											
6	Mike Cooper	Test-retest	M	43	06/08/18	193.9	202.1	218.7	214.5	26.0	26.0
					Means	**196.9**	**202.5**	**219.9**	**215.6**	**25.4**	**25.4**
					+/- Std	2.1	1.3	1.5	2.4	0.5	0.4
					Percent	1.0	0.6	0.6	1.0	1.9	1.7
Subject ran for 10 miles the day before test. Used new electrodes before each test											
7	Mike Cooper	Test-retest	M	43	06/11/2018	194.5	193.8	212.3	193.7	24.5	24.3
8	Mike Cooper	Test-retest	M	43	06/11/2018	195.0	200.5	211.8	192.0	24.8	24.8
9	Mike Cooper	Test-retest	M	43	06/11/2018	194.7	195.6	208.7	192.2	24.5	24.5
					Total Means	**196.3**	**200.6**	**217.2**	**208.7**	**25.2**	**25.1**
					Total +/- Std	1.9	3.4	4.6	11.3	0.5	0.5
					Percent	1.0	1.7	2.1	5.4	2.0	2.0

Segmental BIA Phase Angle

Test	Name	Subject ID	Gender	Age	Test Date	RA Reac	LA Reac	RL Reac	LL Reac	RT reac	LT Reac
Each test started with 8 new electrods and end by disposing of all electodes											
1	Mike Cooper	Test-retest	M	43	06/08/2018	9.8	9.1	9.9	10.5	13.1	13.1
2	Mike Cooper	Test-retest	M	43	06/08/2018	9.7	9.1	9.8	10.4	13.2	13.2
3	Mike Cooper	Test-retest	M	43	06/08/2018	9.7	9.1	9.8	10.6	13.2	13.2
4	Mike Cooper	Test-retest	M	43	06/08/2018	9.7	9.0	9.9	10.5	13.2	13.2
5	Mike Cooper	Test-retest	M	43	06/08/2018	9.7	9.2	9.8	10.6	12.6	12.6
Subject walked for 10 minutes before test. Used new electrodes											
6	Mike Cooper	Test-retest	M	43	06/0 8/2018	9.8	9.2	9.8	10.4	12.8	12.8
					Means	**9.74**	**9.12**	**9.84**	**10.49**	**13.02**	**13.02**
					+/ Std	0.1	0.1	0.0	0.1	0.3	0.3
					Percent	0.6	1.0	0.2	0.7	2.2	2.0
Subject ran for 10 miles the day before test. Used new electrodes before each test											
7	Mike Cooper	Test-retest	M	43	06/11/2018	9.9	9.1	9.5	10.3	12.7	12.8
8	Mike Cooper	Test-retest	M	43	06/11/2018	9.7	9.1	9.5	10.4	12.7	12.7
9	Mike Cooper	Test-retest	M	43	06/11/2018	9.6	9.2	9.7	10.6	12.7	12.7
					Total Means	**9.73**	**9.13**	**9.75**	**10.46**	**12.9**	**12.91**
					Total +/- Std	0.1	0.1	0.1	0.1	0.3	0.3
					Percent	0.8	0.9	1.4	1.0	2.2	1.9

Lean Soft Tissue of the Right arm, leg and torso

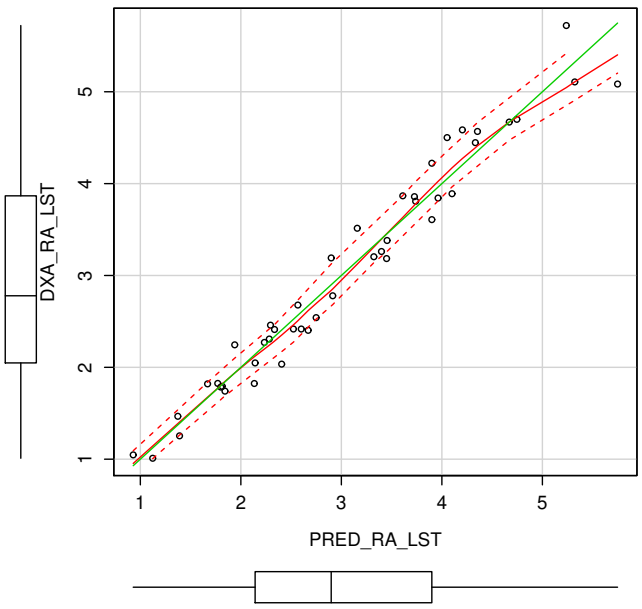
Right Arm (RA) Lean Soft Tissue (LST)

Analysis

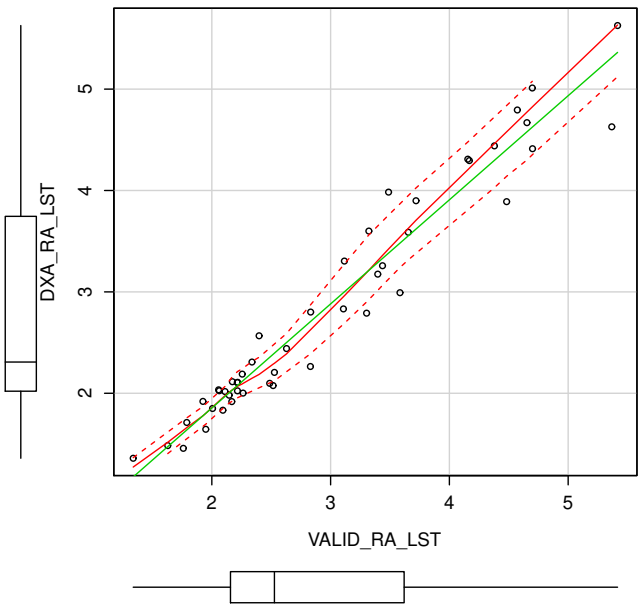
Methods - Compare DXA RA LST to BIA segmental RA resistance and stature height with a small weight correction. Gender was not significant

Control - DXA RA comparison to BIA predicted RA lean soft tissue (LST)						
Equation	means	± Std	n	r^2 (r)	SEE	Y = mx + c
DXA RA LST	3.04	1.21	45	-	-	Y =
BIA RA LST	3.04	1.19	45	0.96 (.98)	0.238 (7.82 %)	0.999 X - 0.000
Validation - DXA RA comparison to BIA predicted RA lean soft tissue (LST)						
DXA RA LST	2.85	1.12	47	-	-	Y =
BIA RA LST	2.97	1.07	47	0.95 (.97)	0.260 (8.76 %)	1.027 X - 0.199

Prediction equation data set



Validation of equation data set



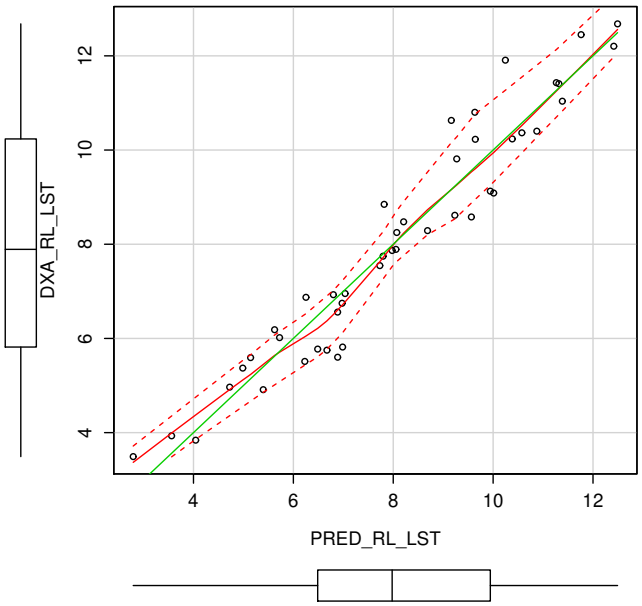
Right Leg (RL) Lean Soft Tissue (LST)

Analysis

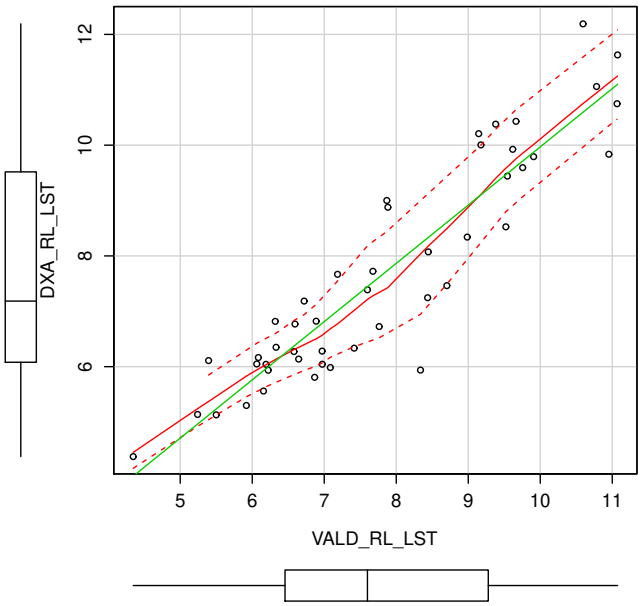
Methods - Compare DXA RL LST to BIA segmental RL resistance and stature height with a small weight correction. Gender was not significant

Control - DXA RL comparison to BIA predicted RL lean soft tissue (LST)						
Equation	means	± Std	n	r^2 (r)	SEE	Y = mx + c
DXA RL LST	8.06	2.49	45	-	-	Y =
BIA RL LST	8.06	2.79	45	0.93 (.96)	0.6709 (8.32 %)	1.000 X - 0.000
Validation - DXA RL comparison to BIA predicted RL lean soft tissue (LST)						
DXA RL LST	7.68	1.99	47	-	-	Y =
BIA RL LST	7.82	1.74	47	0.85 (.92)	0.7827 (10.00 %)	1.052 X - 0.5490

Prediction equation data set



Validation of equation data set



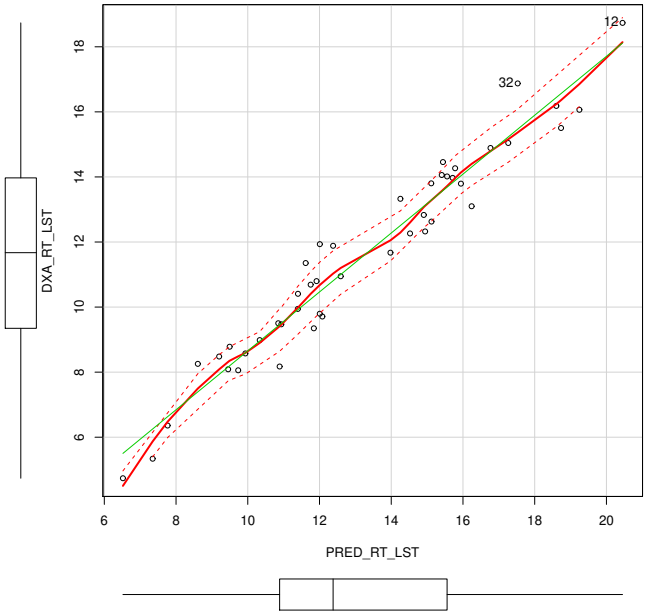
Right Torso (RT) Lean Soft Tissue (LST)

Analysis

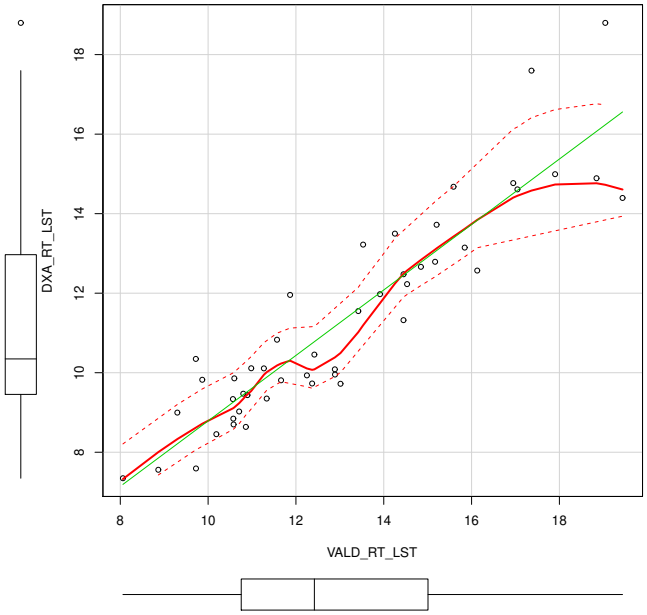
Methods - Compare DXA RT LST to BIA RT by subtracting the RA and RL LST from the RS LST.

Control - DXA RT comparison to BIA predicted RT lean soft tissue (LST)						
Equation	means	± Std	n	r^2 (r)	SEE	Y = mx + c
DXA RT LST	11.54	3.13	45	-	-	Y =
BIA RT LST	13.19	3.37	45	0.95 (.97)	0.7186 (5.45 %)	0.9054 X - 0.3993
Validation - DXA RT comparison to BIA predicted RT lean soft tissue (LST)						
DXA RT LST	11.31	2.60	47	-	-	Y =
BIA RT LST	13.05	2.90	47	0.84 (.92)	1.035 (7.93 %)	0.8233 X + 0.5555

Prediction equation data set



Validation of equation data set

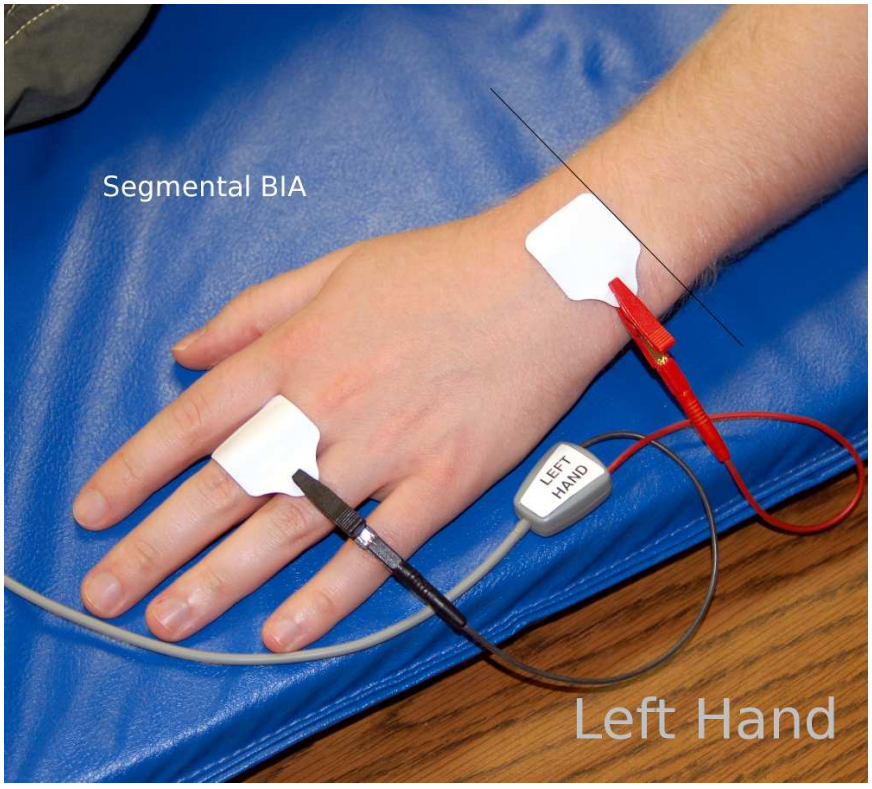


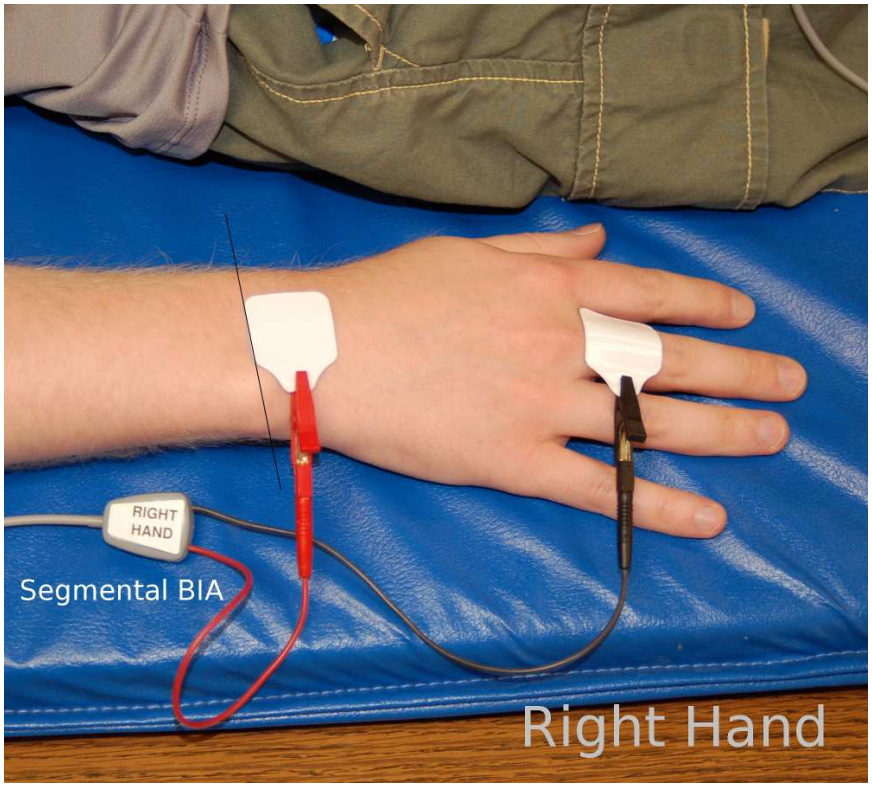
Statistics -

All statistical procedures were done with R and R Commander."R" is a language and environment for statistical computing and graphics and is similar to the award-winning "S" system, which was developed at Bell Laboratories by John Chambers et al. It provides a wide variety of statistical and graphical techniques including linear and nonlinear modeling, statistical tests, time series analysis, classification, clustering and more.

Segmental BIA left and right hand electrode placement

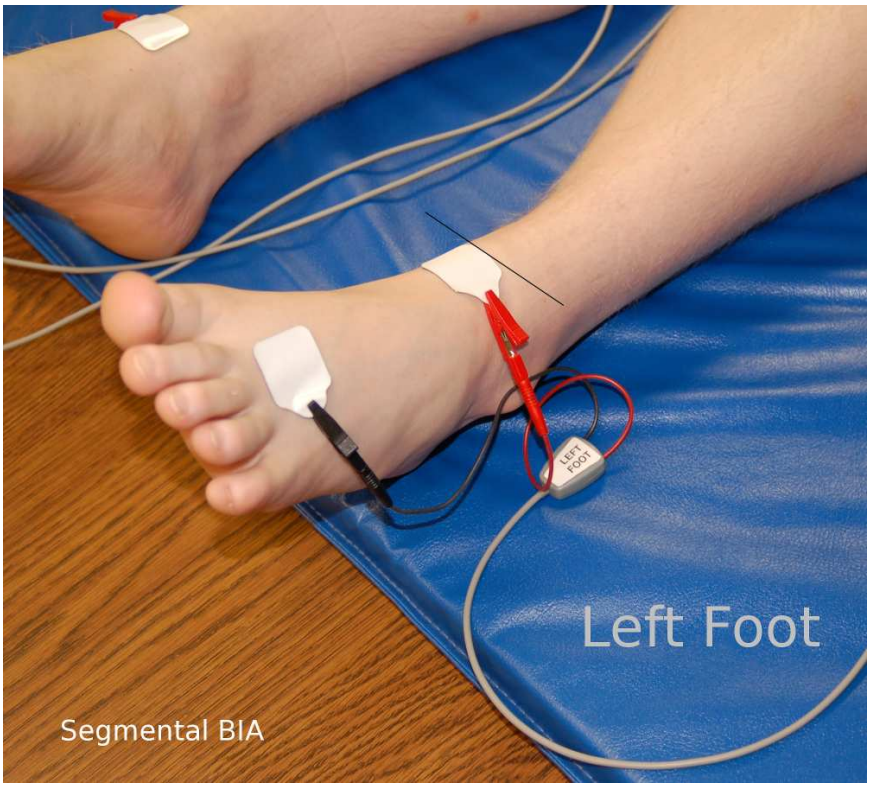
The detecting electrode edge is placed on an imaginary line bisecting the ulnar head (bone on the little finger side of the wrist).

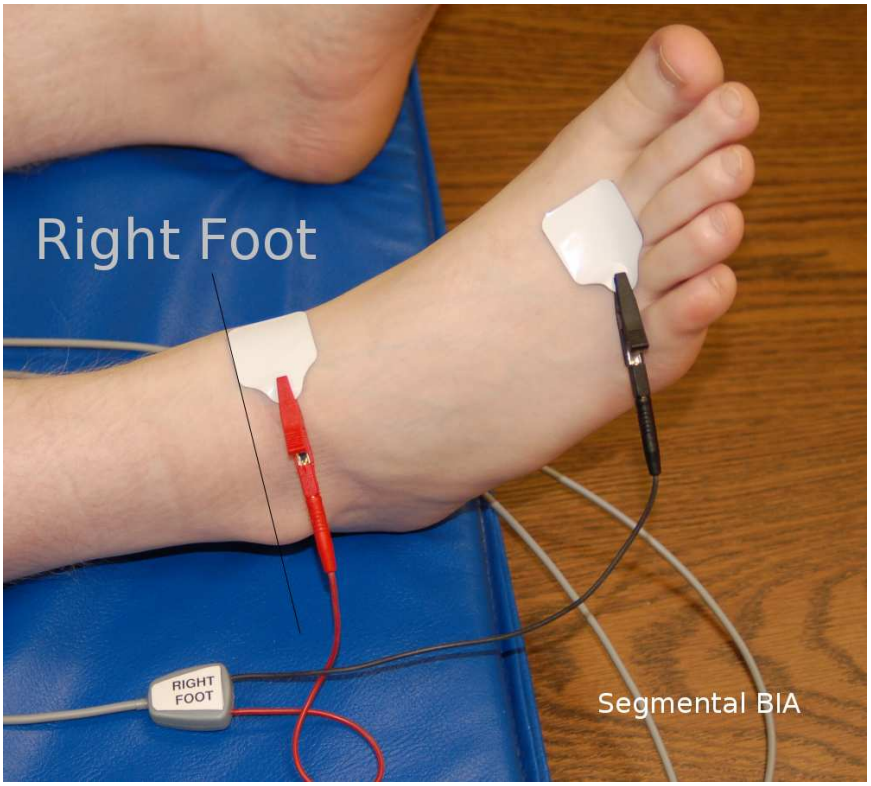




Segmental BIA left and right foot electrode placement

The detecting electrode edge is placed on an imaginary line bisecting the medial malleolus (bone on the big toe side the ankle).


LEFT FOOT
Left Foot
Segmental BIA

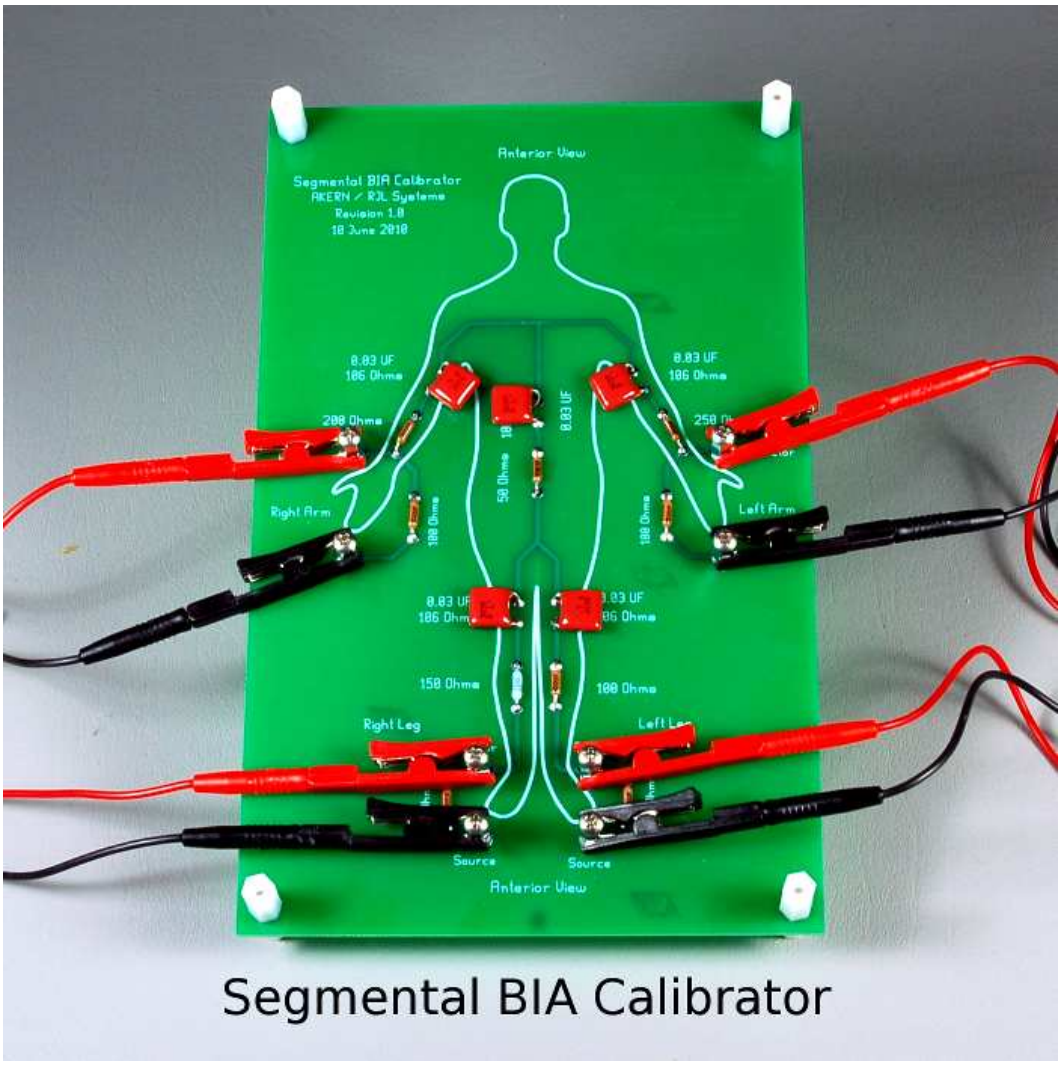

Right Foot
RIGHT FOOT
Segmental BIA

The Quantum V Segmental BIA systems contains the following:

- Quantum V Segmental BIA instrument as pictured.
- Two 6 ft subject leads for right and left body.
- USB cable that connects the Quantum V to a PC
- Two "Stay Fresh Packs" (400 electrodes) 50 segmental tests.
- Newest version of BC (Body Comp) software - thumb drive.
- Quantum V battery charger.
- Quantum V carrying case (black).
- One year warranty.

Validating the measurements

A fundamental human simulation using electronic standards is included to prove the Quantum V Segmental BIA and internal switching multiplexer are working properly and accurately. All 13 zones are individually calibrated at the factory.

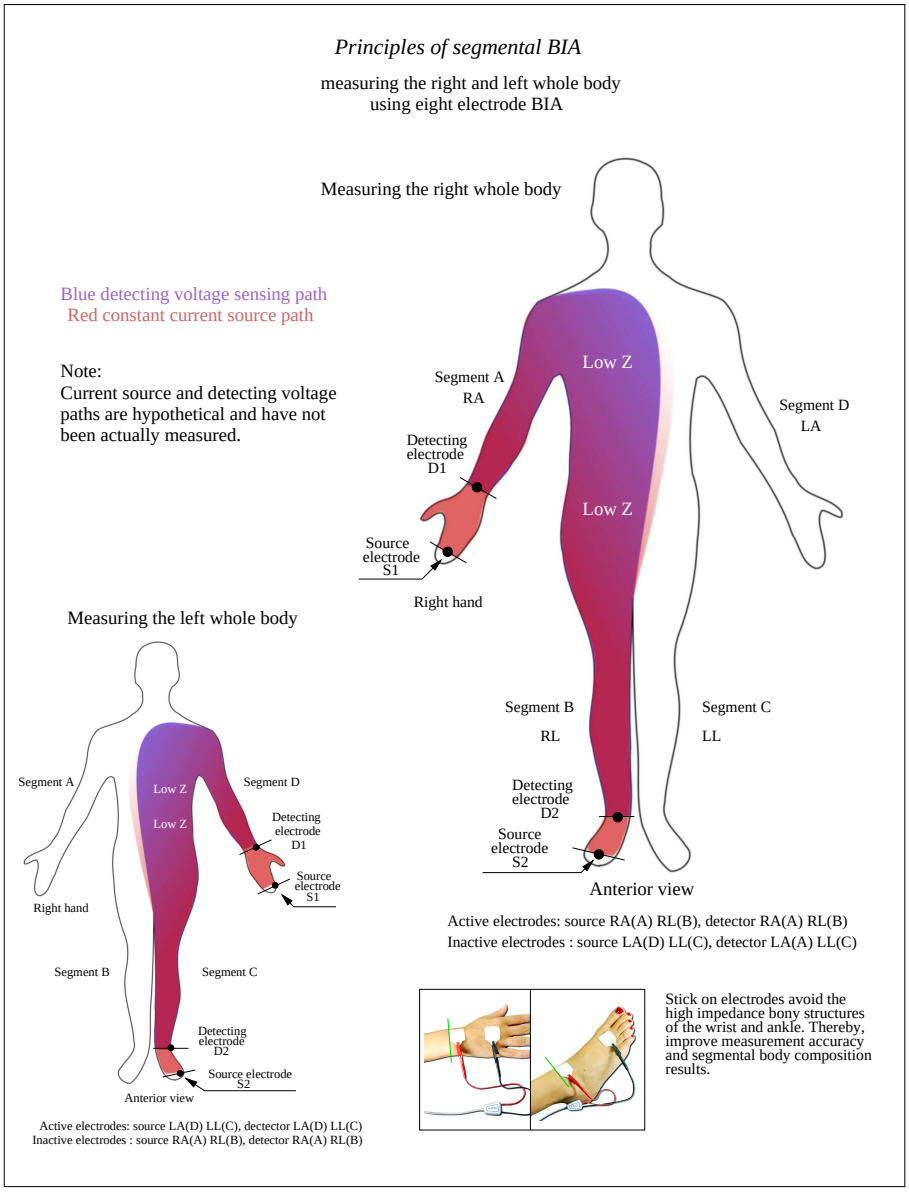


This standard is a combination of series resistors and capacitors that simulate each arm and leg including the torso with known values. Each capacitor and resistor is hand selected to be better than ± 2 percent accurate. The standard used is the same as a human model and returns the same 26 values (13 zones) of resistance and reactance precisely measured for validation. A tolerance acceptance spread sheet is also included for comparison. The segmental BIA validation board is a $150 option.

How Segmental BIA Works

Segmental BIA is the impedance (resistance and reactance) measurement of each arm, leg and torso using eight electrodes. The eight electrodes are positioned the same as a whole body measurement except both the right and left side are used. The selection or switching of the individual detecting and source electrodes allow the limbs (arms and legs) to be used as virtual electrodes that measure the opposite side of the body.

These illustrations demonstrates how the the BIA leads are switched to measure the arms, legs, upper body, lower body, torso and whole body.

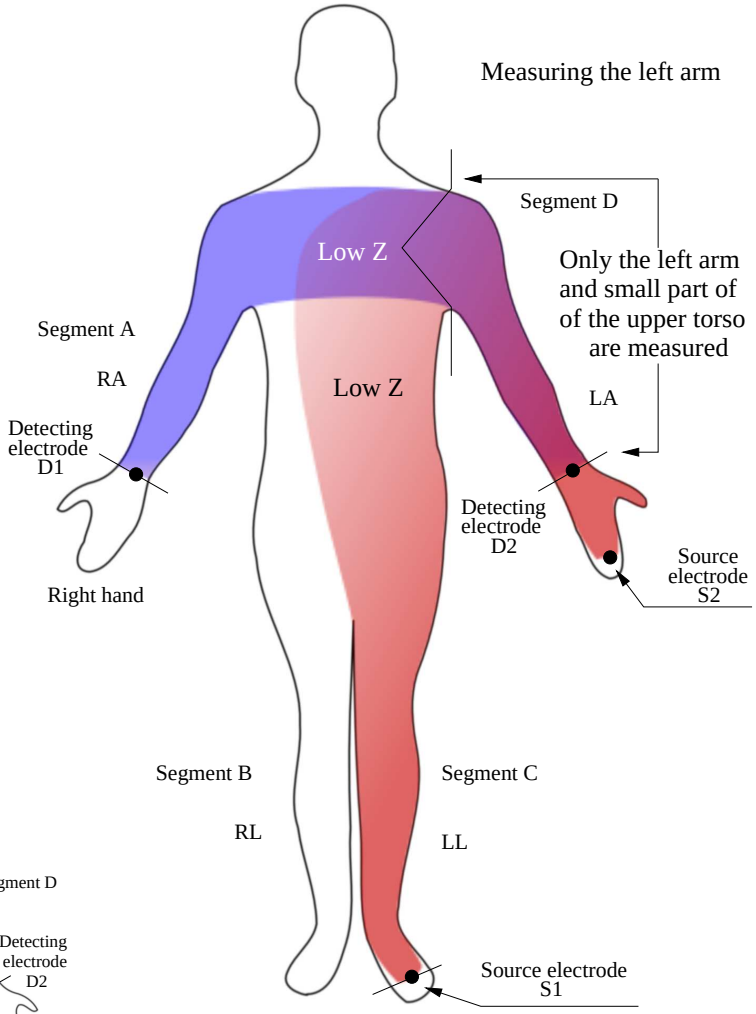


Principles of segmental BIA

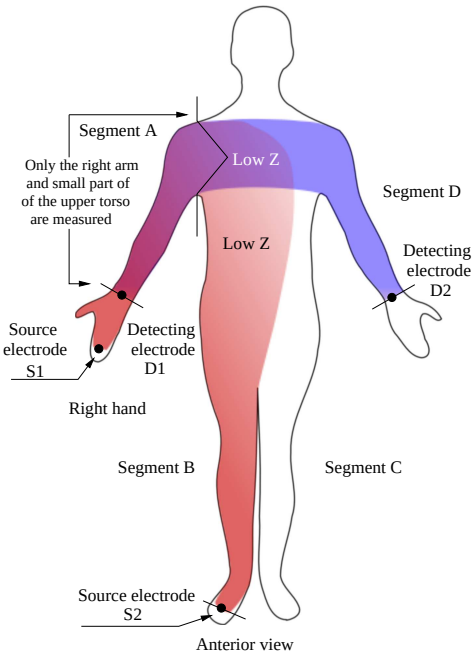
measuring the left and right arm
using eight electrode BIA

Blue detecting voltage sensing path
Red constant current source path

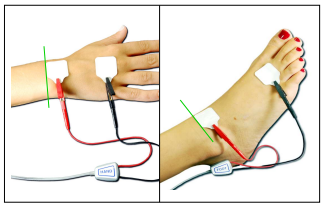
Note:
Current source and detecting voltage paths are hypothetical and have not been actually measured.



Active electrodes: source LL(C) LA(D), detector RA(A) LA(D)
Inactive electrodes : source RA(A) RL(B), detector RL(B) LL(C)



Active electrodes: source RA(A) RL(B), detector RA(A) LA(D)
Inactive electrodes : source LL(C) LA(D), detector RL(B) LL(C)



Stick on electrodes avoid the high impedance bony structures of the wrist and ankle. Thereby, improve measurement accuracy and segmental body composition results.

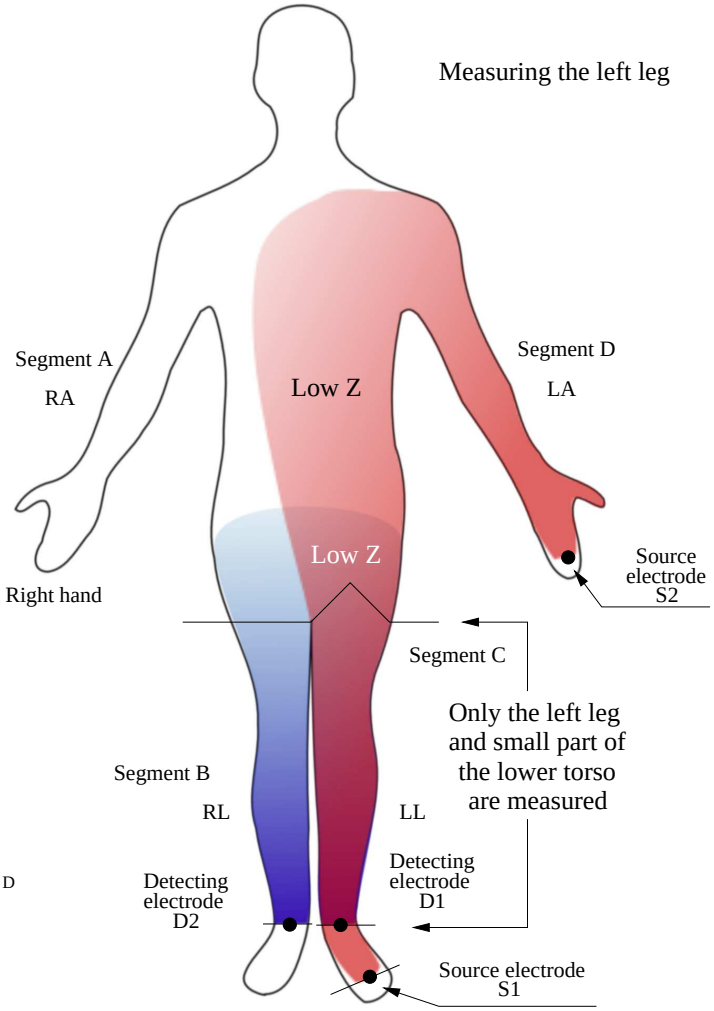
Principles of segmental BIA

measuring the left and right leg
using eight electrode BIA

Blue detecting voltage sensing path
Red constant current source path

Note:
Current source and detecting voltage paths are hypothetical and have not been actually measured.

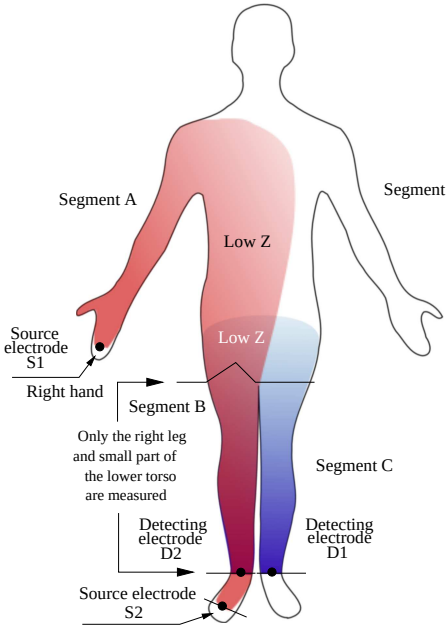
Measuring the left leg



Anterior view

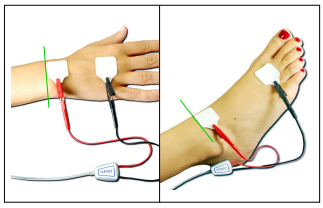
Active electrodes: source LL(C) LA(D), detector LL(C) RL(B)
Inactive electrodes : source RA(A) RL(B), detector RA(A) LA(D)

Measuring the right leg



Anterior view

Active electrodes: source RA(A) RL(B,) detector LL(C) RL(B)
Inactive electrodes : source LL(C) LA(D), detector RA(A) LA(D)



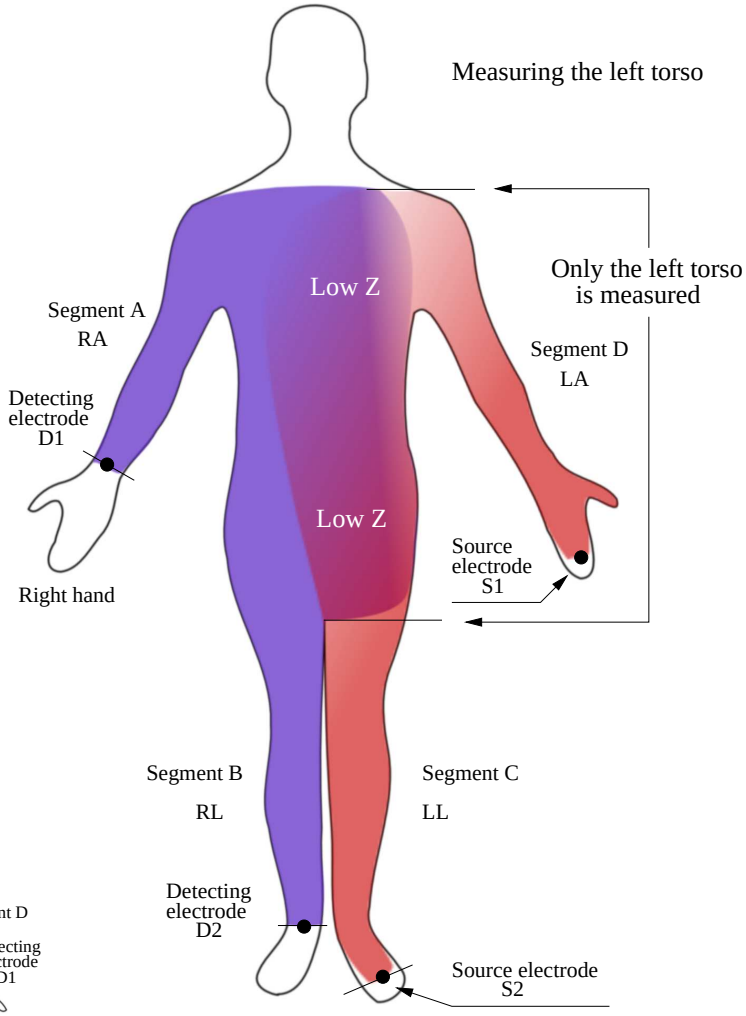
Stick on electrodes avoid the high impedance bony structures of the wrist and ankle. Thereby, improve measurement accuracy and segmental body composition results.

Principles of segmental BIA

measuring the left and right torso
using eight electrode BIA

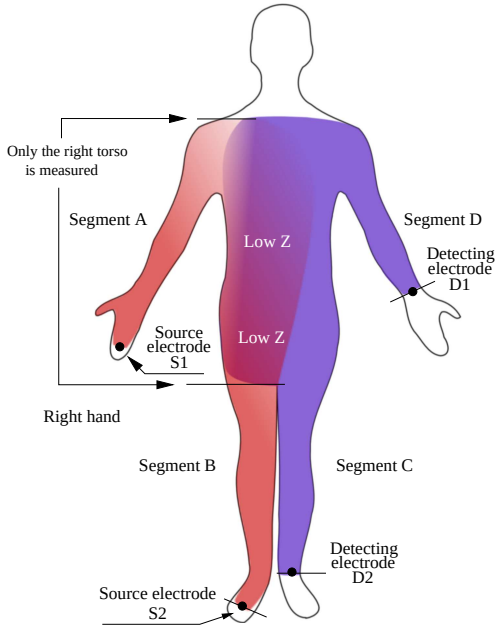
Blue detecting voltage sensing path
Red constant current source path

Note:
Current source and detecting voltage paths are hypothetical and have not been actually measured.

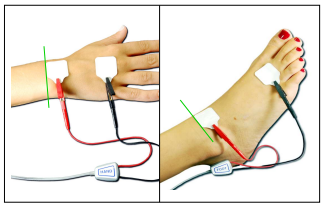


Active electrodes: source LL(C) LA(D), detector RA(A) RL(B)
Inactive electrodes : source RA(A) RL(B), detector LL(C) LA(D)

Measuring the right torso



Active electrodes: source RA(A) RL(B), detector LL(C) LA(D)
Inactive electrodes : source RL(C) RA(D), detector RA(A) RL(B)



Stick on electrodes avoid the high impedance bony structures of the wrist and ankle. Thereby, improve measurement accuracy and segmental body composition results.

Final Note

Common segmental body composition analyzers (Tanita, Omron, BioSpace) incorporate foot and hand contact points that are a result of standing on four metal plates and holding two rods with the fingers and thumb of each hand. These devices have a significant disadvantage because the high resistance of the bony ankle and wrist are included in the measurement. The ankle, wrist, lower leg and forearm have very little to do with whole body composition yet contribute more than 50 percent of the measurement[2]. In addition, the inconsistent surface of the hands and feet bottoms also cause repeatability problems.

2. MARC R. SCHELTINGA, M.D., DANNYO.JACOBS, M.D., THOMAS D. KIMBROUGH, M.D., and DOUGLAS W. WILMORE, M.D. Alterations in Body Fluid Content Can Be Detected by Bioelectrical Impedance Analysis. JOURNAL OF SURGICAL RESEARCH 50,461-468 (1991)