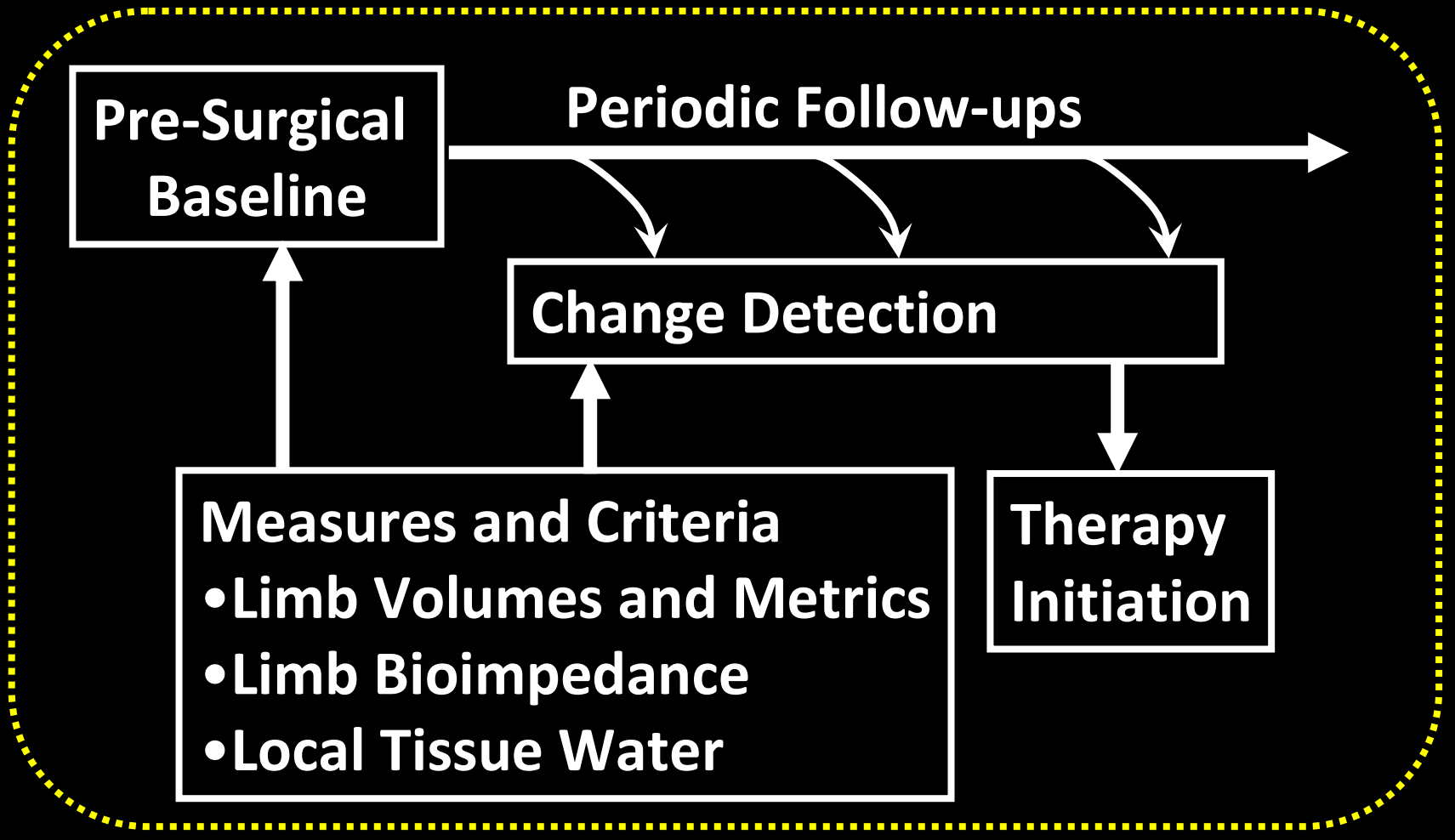
Biophysical Assessments for Lymphedema Detection in Patients with Breast Cancer before and One Year after Breast Cancer Surgery

Dr. Harvey N. Mayrovitz
College Medical Sciences
Nova SE University
Ft. Lauderdale FL
mayrovit@nova.edu

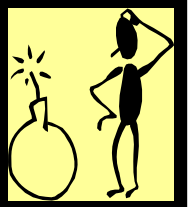
Goal: Earlier Detection and Intervention Women Diagnosed with Breast Cancer

A Rationale and Sensible Approach



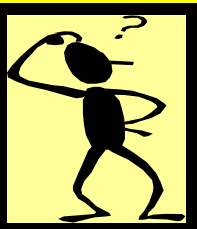
Dr. HN Mayrovitz

Goal: Earlier Detection and Intervention



Not Often Done

Can We Characterize?



Pre-Surgical Baseline

Periodic Follow-ups

3 months

3 months

Change Detection?

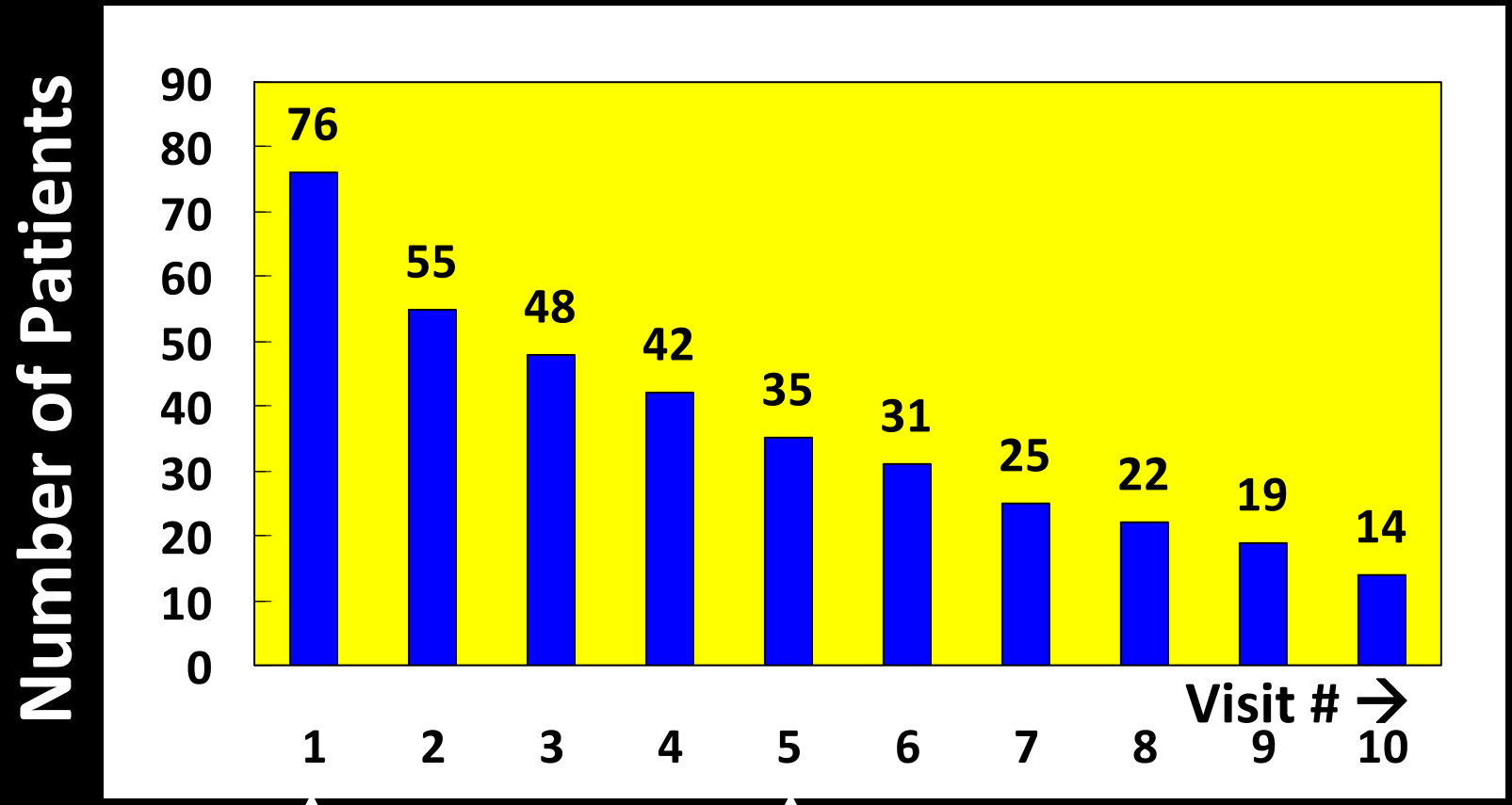
N=76

Measures and Criteria
- Limb Volumes and Metrics
- Limb Bioimpedance
- Local Tissue Water

Therapy Initiation

Dr. HN Mayrovitz

Unilateral Breast Cancer Patients



Age range: 28 – 82 (59.6 ± 13.3 years)
BMI range: 17.8 – 48.1 (28.3 ± 6.4 Kg/m²)
Cancer: Dominant Arm Side 36/76 (47.4%)

Data as of 8/25/2011

Dr. HN Mayrovitz

Measurement Methods

Girth and Limb Volume Measurements

Girth at 4 cm intervals

Segment Length (cm)	Total # Segments	Full Screen	Reset Screen		
▶ 4		Right		Left	
		Proximal	Distal	Proximal	Distal
0	12	1390	722	1390	731

Proximal - Distal Option

Limb Volumes	Right	Left	Edema	%Edema
Total Volume (ml)	2112	2122	-10	-0.5
Limb only (ml)	2112	2122	1	
Hand only (ml)	0	0		

Arm Volumes

Visit 3

Affected Limb	Limb Length
Right Limb	▶ 48

From data there are 12 full segments plus one partial segment of length = 0

Enter Circumferences in yellow cells below (columns C and D)

cm — Note that the first circumference pair to be entered for "0" cm corresponds to either the wrist or ankle

cm from wrist or ankle	Circumferences (cm) Right	Left	segment number	Volume (ml) Right	Left
0	15.2	15.6			
4	15.3	15.4	1	74	77
8	16.5	16.6	2	81	82
12	19.4	19.5	3	103	104
16	21.7	21.9	4	135	137
20	22.9	23	5	158	161
24	23.5	23.5	6	171	172
28	24.7	24.5	7	185	183
32	25.5	25.5	8	201	199
36	26.4	26.2	9	214	213
40	28.4	28.1	10	239	235
44	29.2	30	11	264	269
48	30.8	30.5	12	287	291

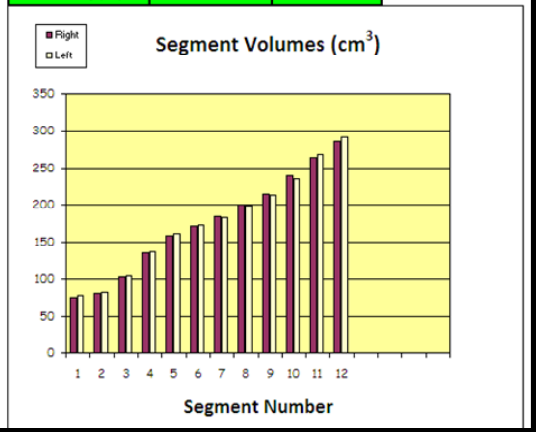
www.limbvolumes.org

Full Screen | Reset Screen

Segment Length (cm)	Total # Segments	Right Proximal	Right Distal	Left Proximal	Left Distal
▶ 4					
0	12	1390	722	1390	731

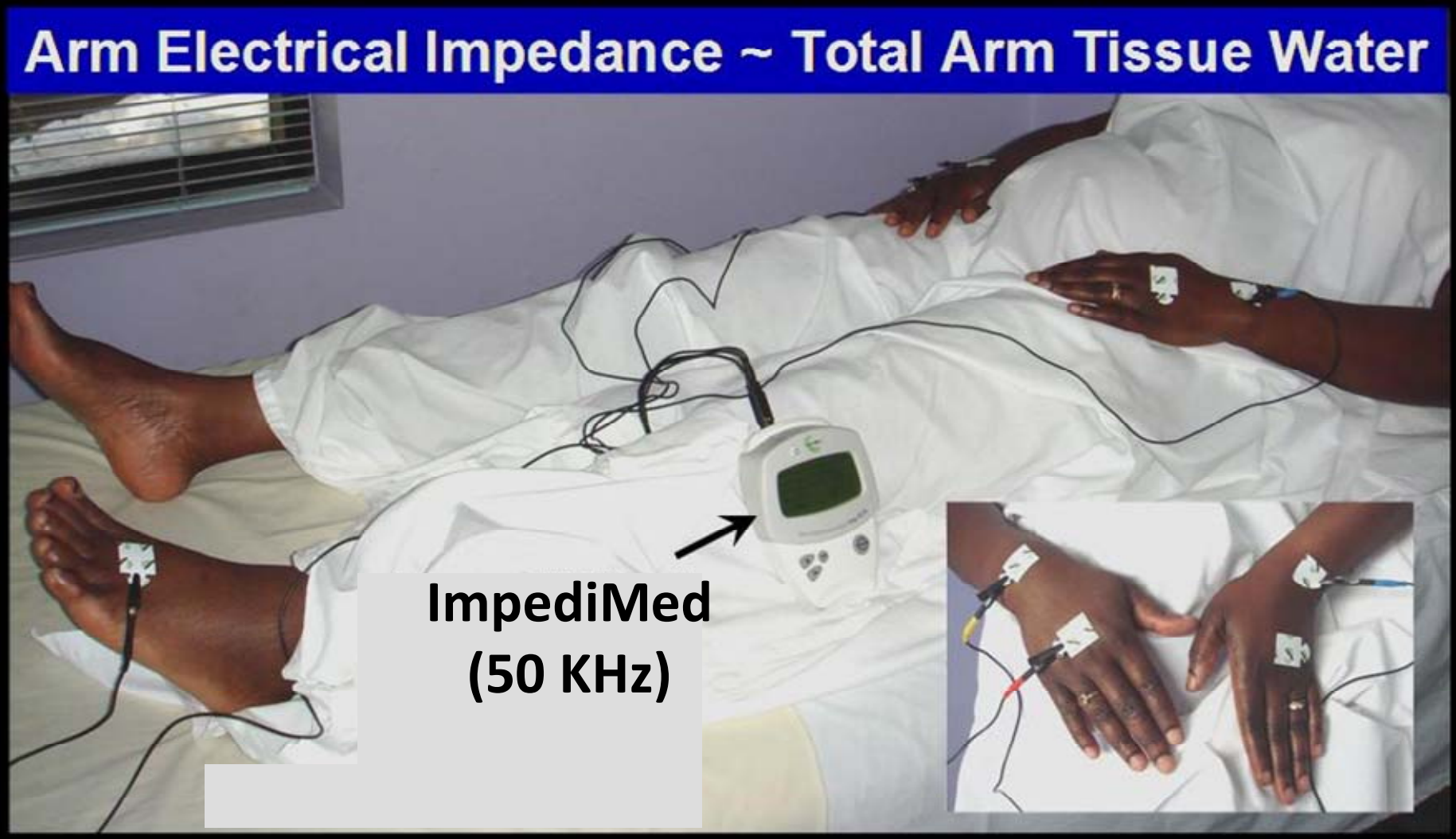
Proximal - Distal Option

Limb Volumes	Right	Left	Edema	%Edema
Total Volume (ml)	2112	2122	-10	-0.5
Limb only (ml)	2112	2122	1	
Hand only (ml)	0	0		



Dr. HN Mayrovitz

Bioimpedance Measurements



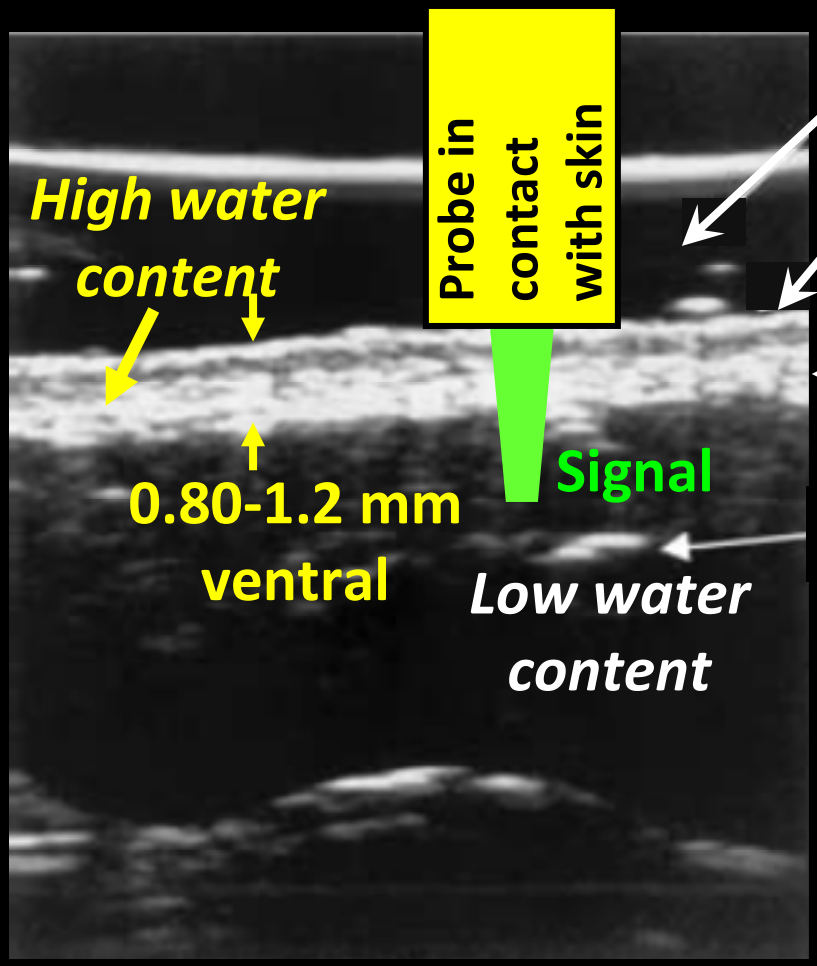
Dr. HN Mayrovitz

Tissue Water via Dielectric Constant (TDC)

- Low power 300 MHz incident wave
- Reflected wave depends on the tissue's dielectric constant
- Dielectric constant depends on total tissue water (free + bound)
- Pure water has a dielectric constant of about 78
- Can measure at almost any anatomic site

Dr. HN Mayrovitz

TDC: Tissue Sampling Principle

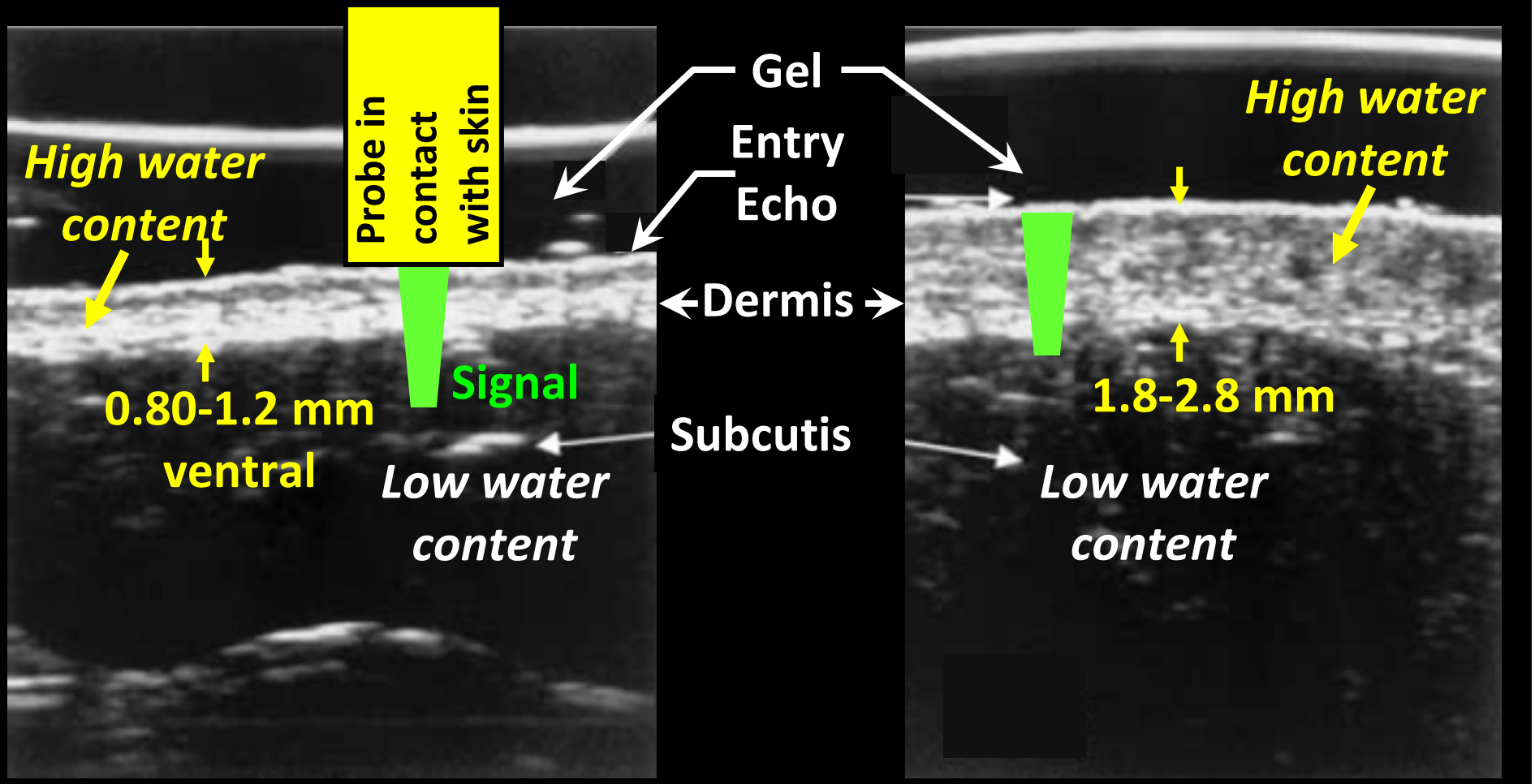


Normal Arm

Ultrasound images (20 MHz) modified from Mellor et al. 2004 (The Breast Journal, 2004;10:496-503)

Dr. HN Mayrovitz

TDC: Tissue Sampling Principle



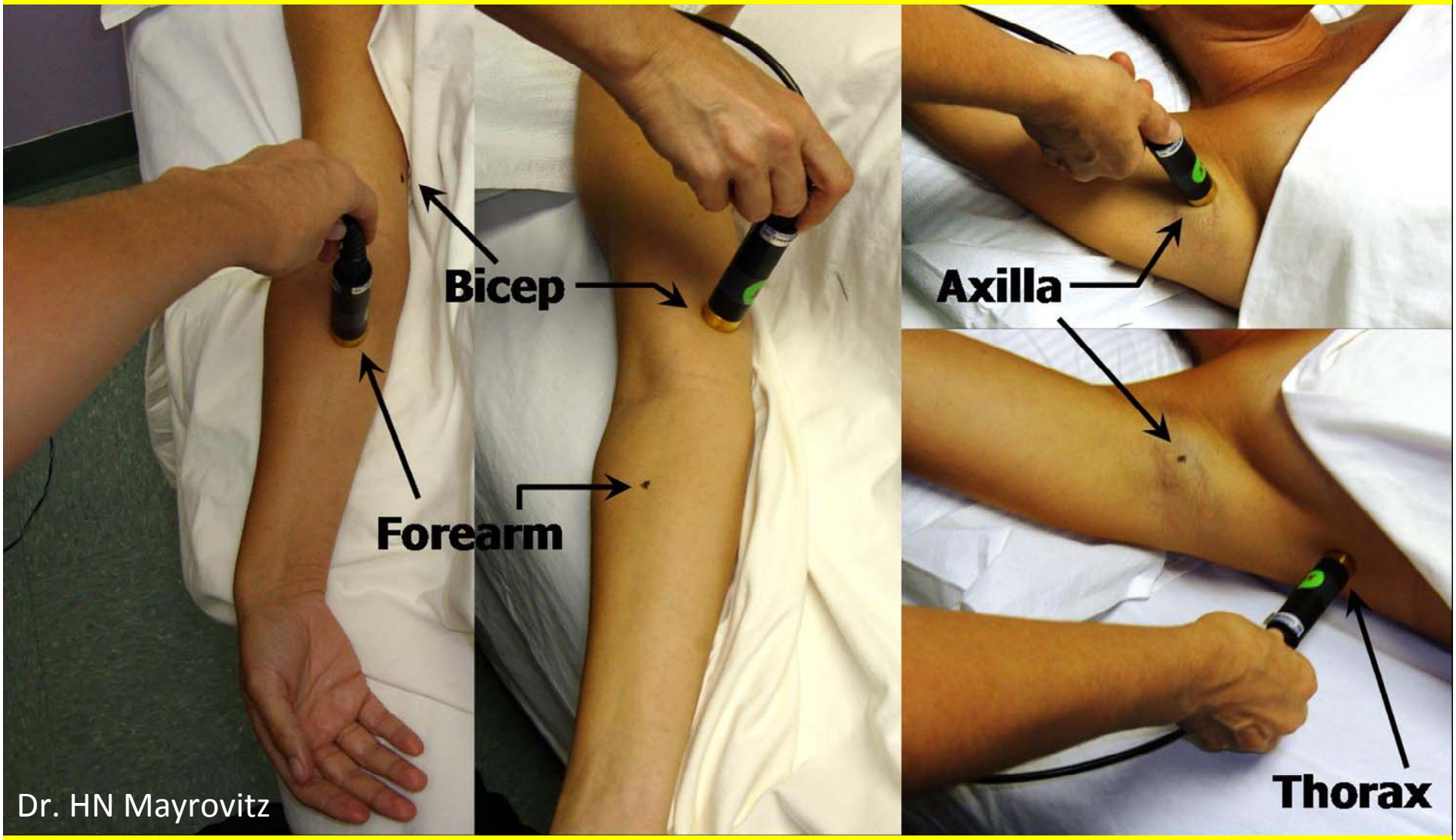
Normal Arm

Lymphedematous Arm

Ultrasound images (20 MHz) modified from Mellor et al. 2004 (The Breast Journal, 2004;10:496-503)

Dr. HN Mayrovitz

TDC Measurement Sites



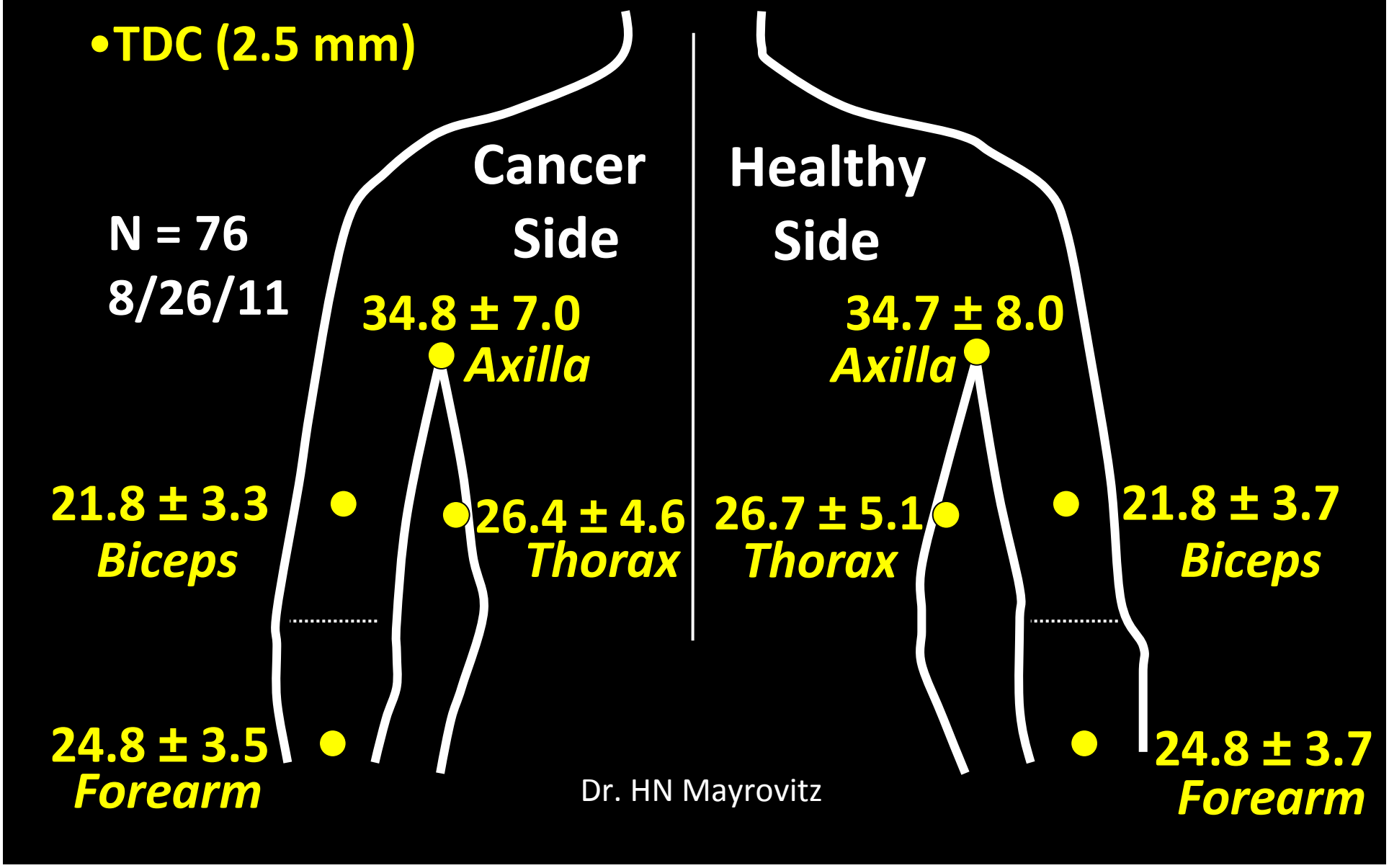
Each site measured to an effective depth of 2.5 mm

Forearm site measured to effective depths of 0.5, 1.5, 2.5 and 5.0 mm

Pre-Surgery
Measurement Results

Pre-Surgery by Site – TDC values

No significant differences between sides

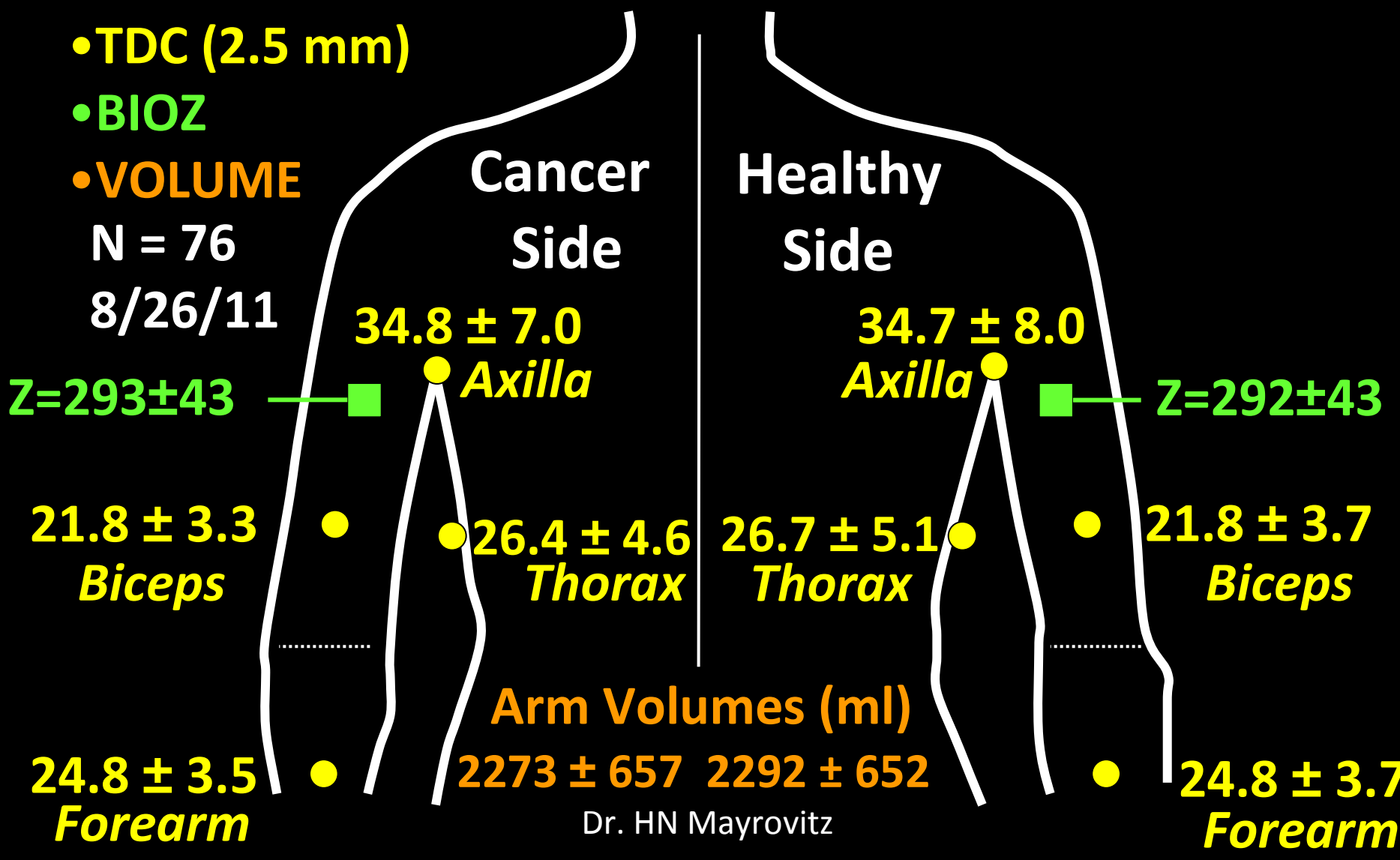


Pre-Surgery by Site – All Parameters

No significant differences between sides

- TDC (2.5 mm)
- BIOZ
- VOLUME

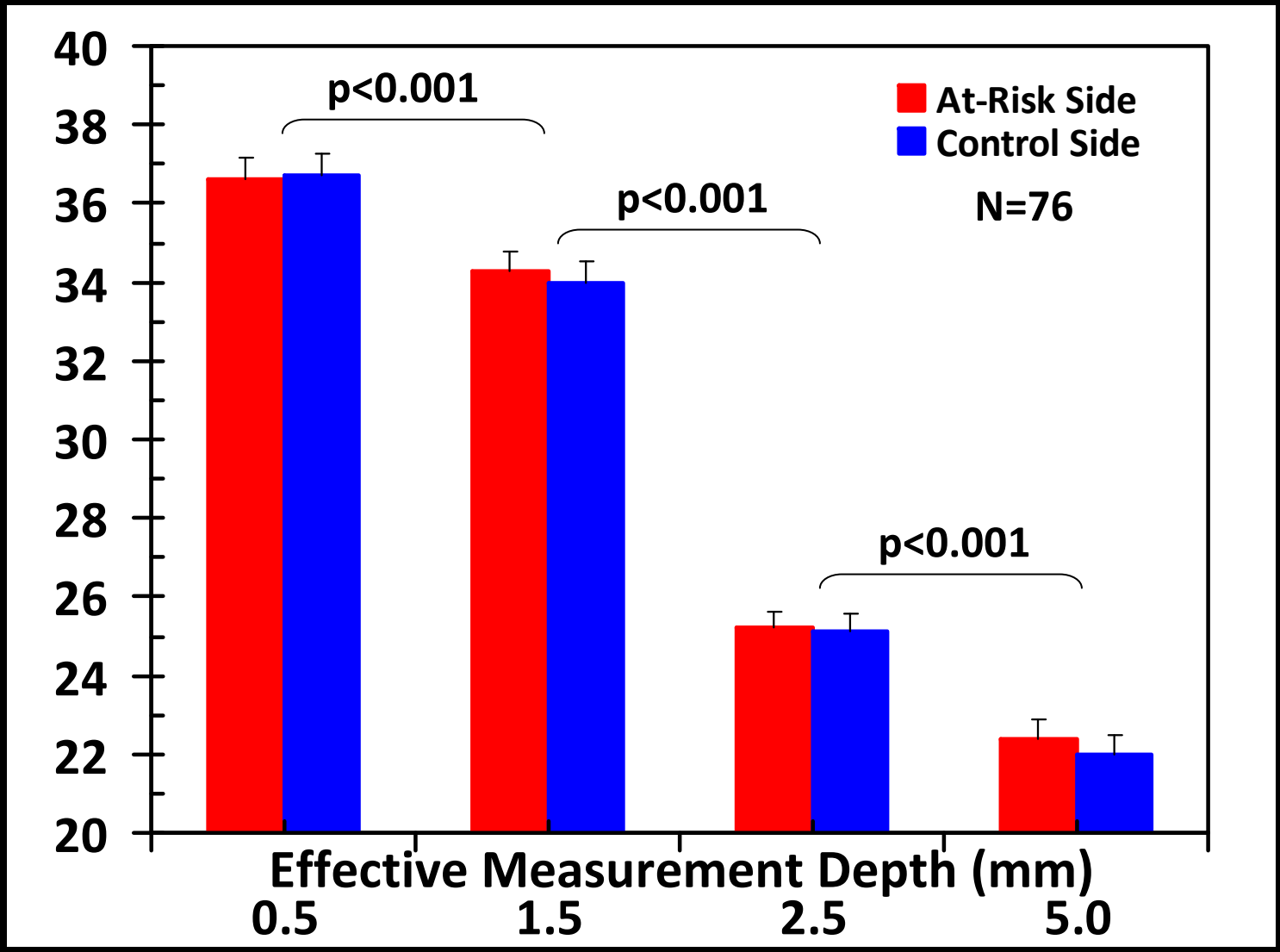
N = 76
8/26/11



Dr. HN Mayrovitz

Forearm TDC by Depth: Pre-Surgery

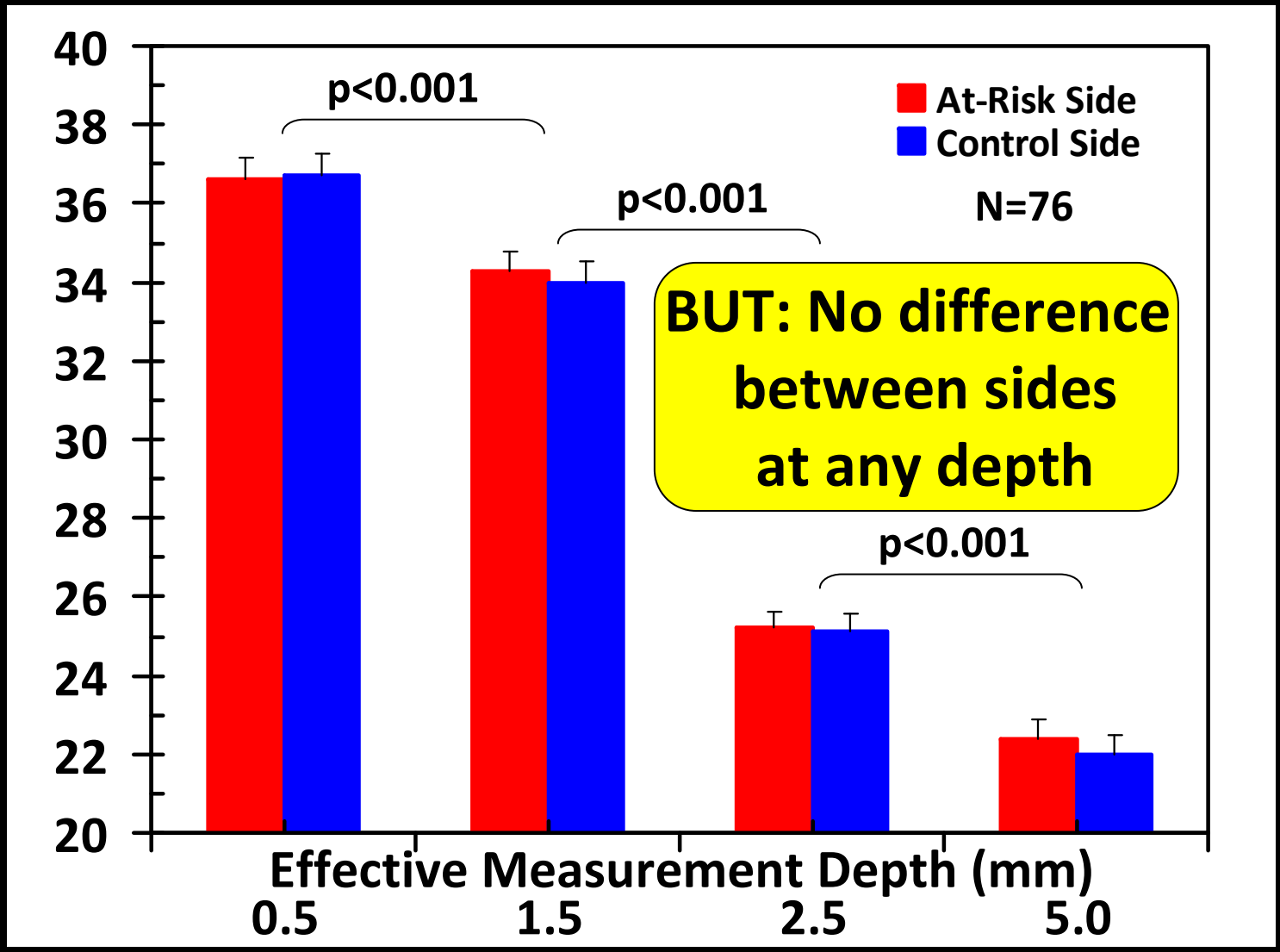
Significant differences among all depths



Dr. HN Mayrovitz

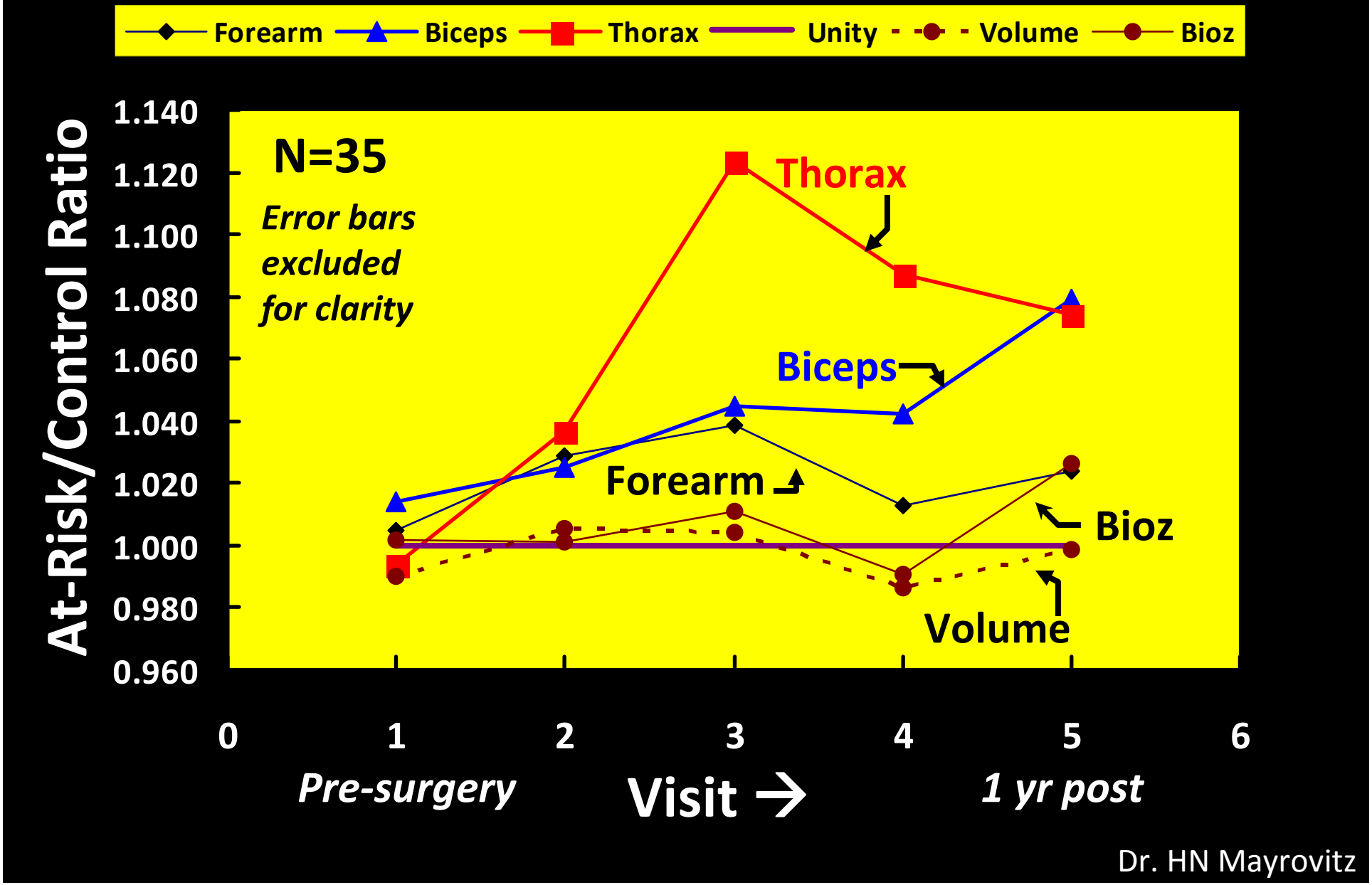
Forearm TDC by Depth: Pre-Surgery

Significant differences among all depths



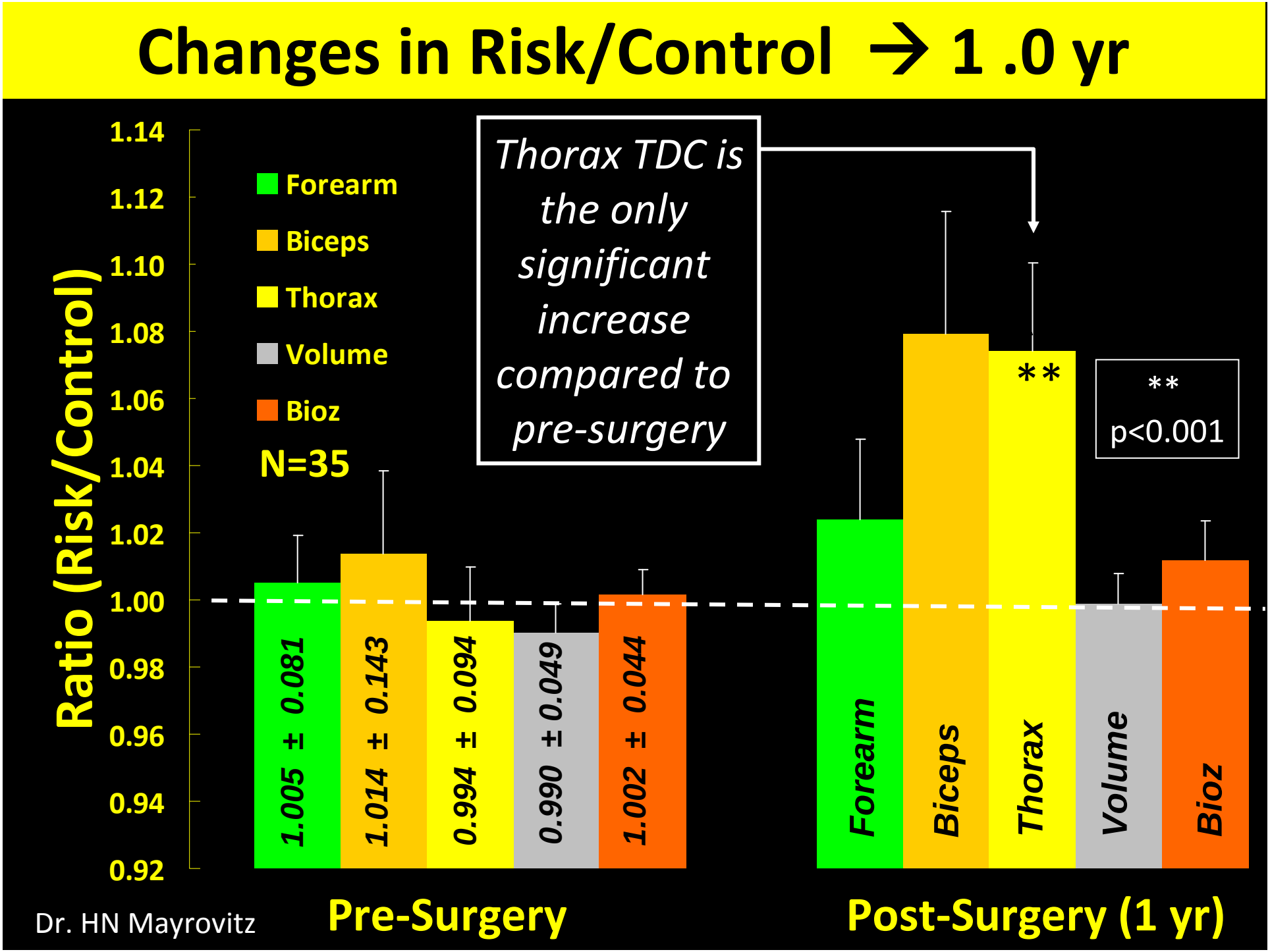
Dr. HN Mayrovitz

Sequential: Pre-Surgery → One Year Post



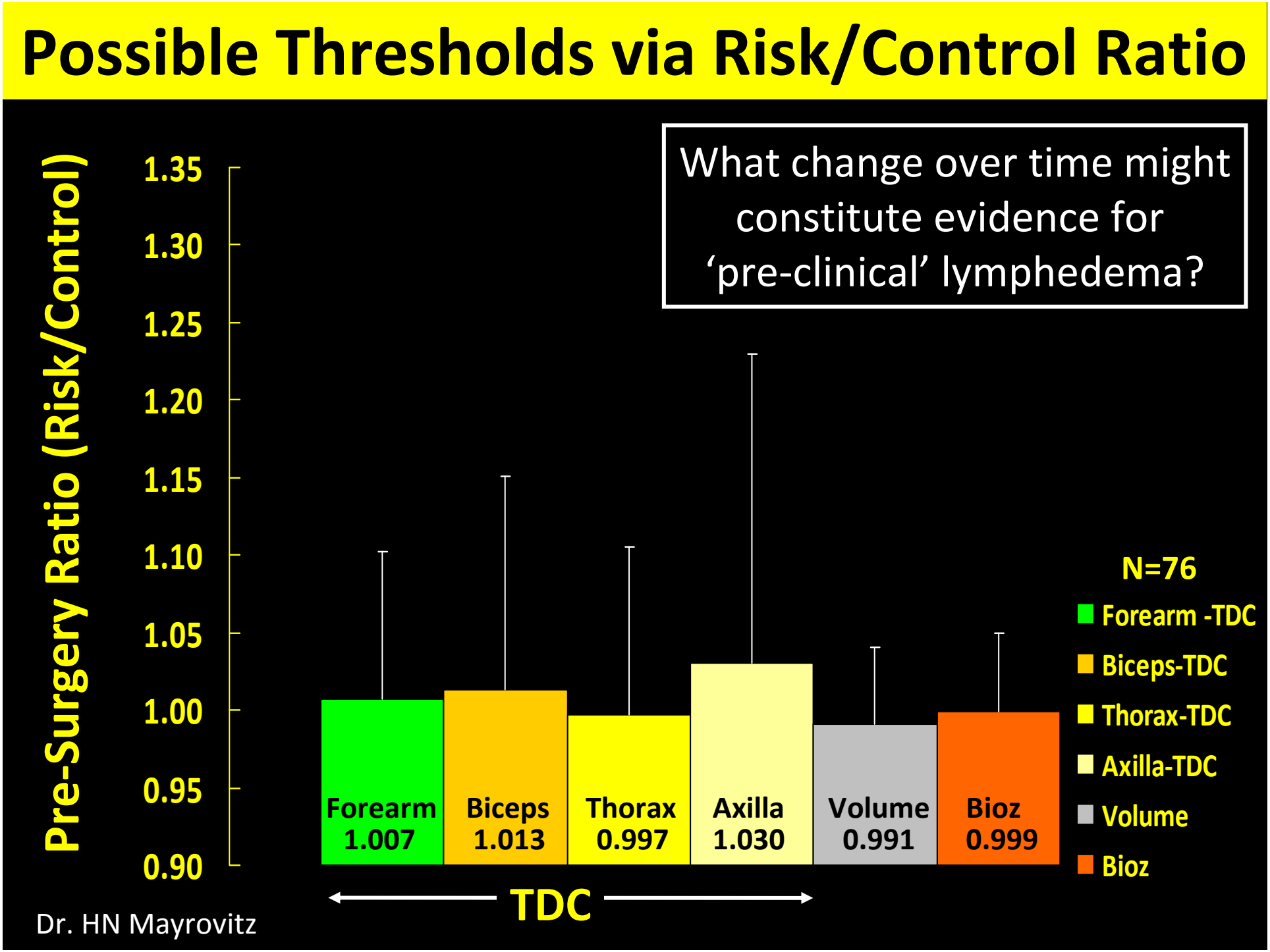
Dr. HN Mayrovitz

Changes in Risk/Control → 1 .0 yr

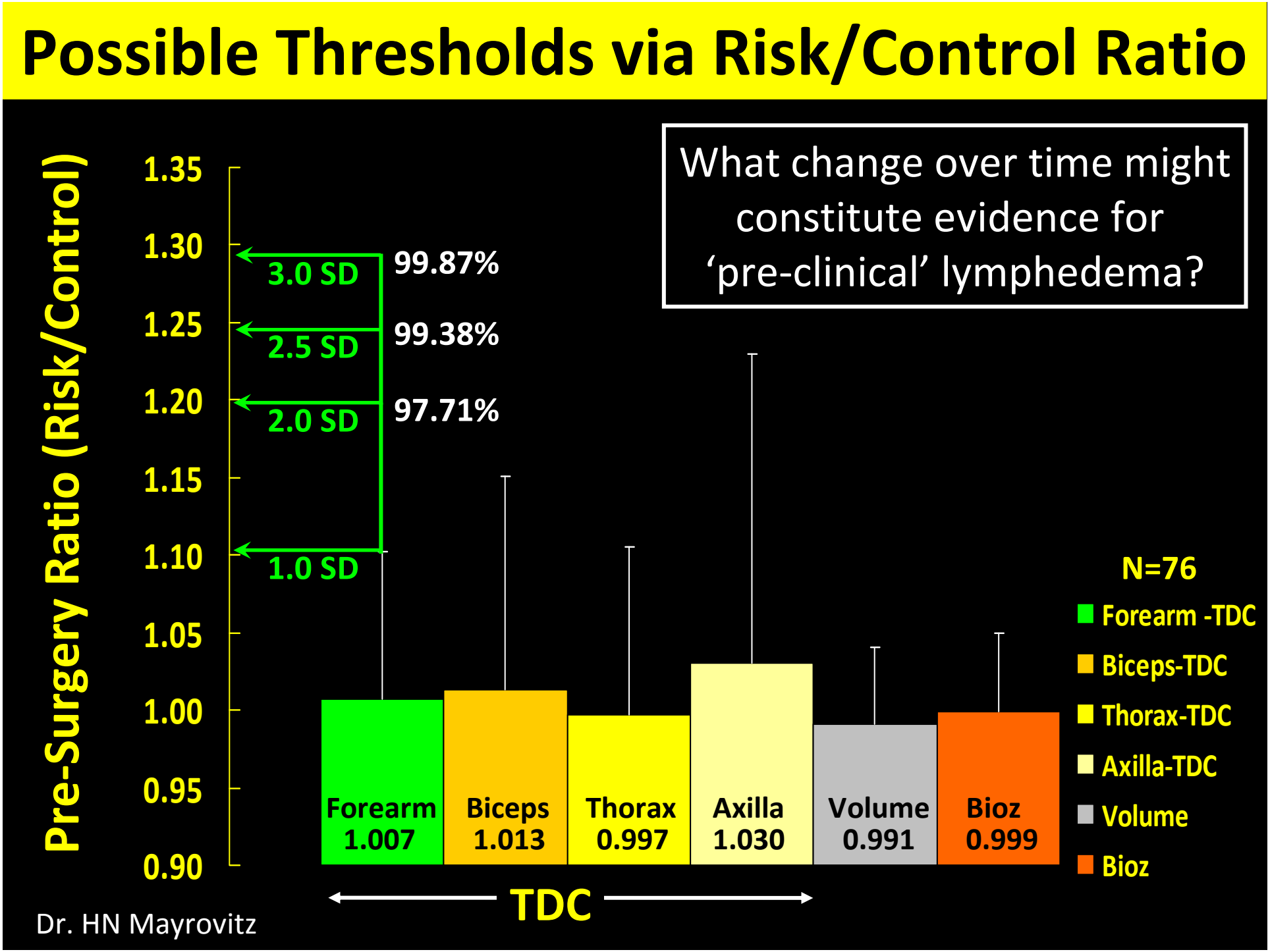


Dr. HN Mayrovitz

Possible Thresholds via Risk/Control Ratio



Possible Thresholds via Risk/Control Ratio



TDC Thresholds (Risk/Control)

2.5 mm Effective Measurement Depth (N=76)

Threshold Level	Forearm	Thorax	Biceps	Axilla
2 SD (97.7%)	1.20	1.21	1.29	1.43
2.5 SD (99.38%)	1.24	1.26	1.36	1.53
3.0 SD (99.87%)	1.29	1.32	1.43	1.63

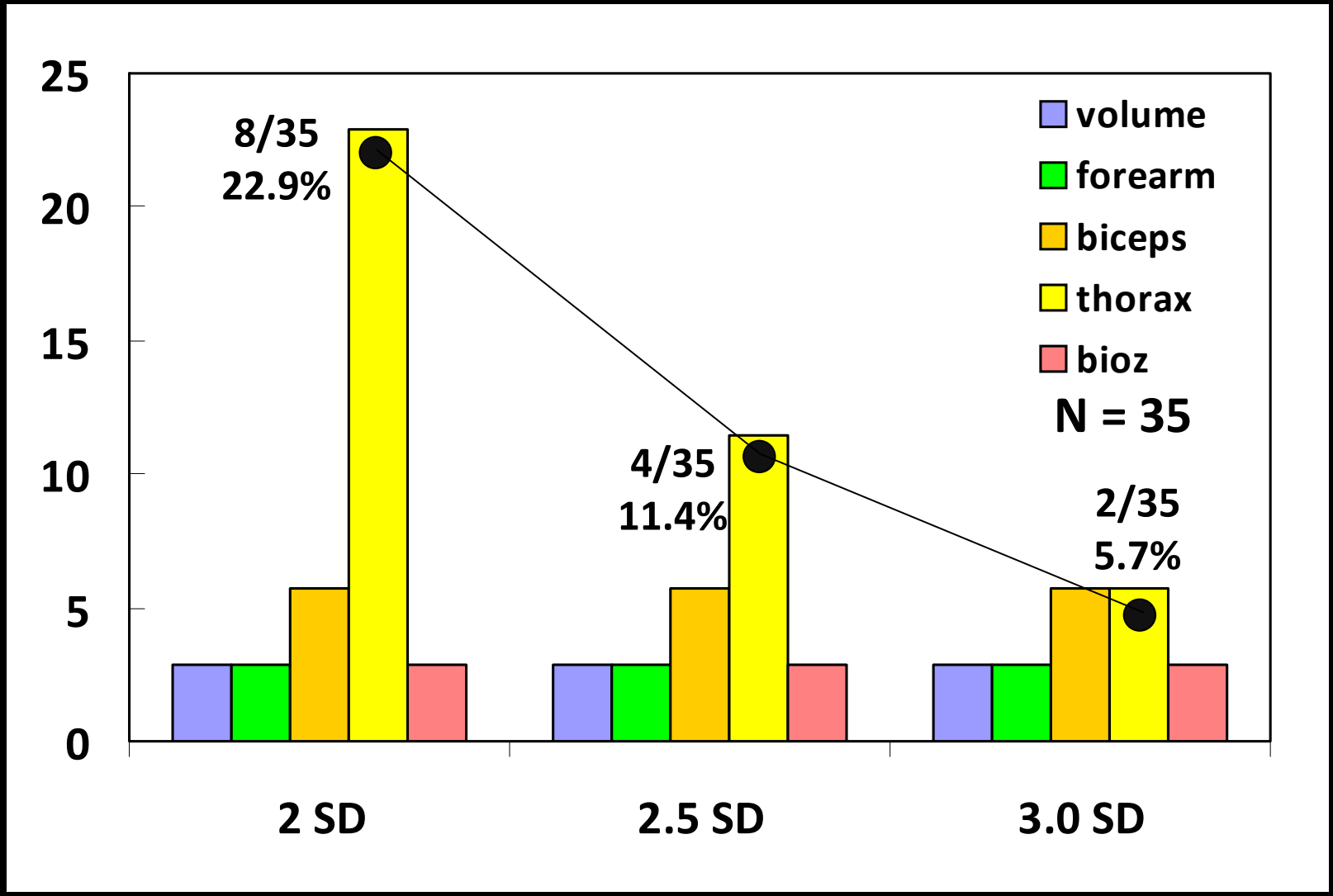
Dr. HN Mayrovitz

Threshold Comparison (Risk/Control)

Threshold Level	Forearm TDC	Thorax TDC	Volume	Bioz
2 SD (97.7%)	1.20	1.21	1.09	1.10
2.5 SD (99.38%)	1.24	1.26	1.12	1.13
3.0 SD (99.87%)	1.29	1.32	1.14	1.16

Dr. HN Mayrovitz

Exceeding Threshold 1-Year Post-surgery



Dr. HN Mayrovitz

Main Points Summary

- In 76 newly diagnosed breast cancer patients, biophysical measures showed no difference between cancer and control sides prior to surgery.

- In 35 pts followed for one year a significant increase was found only in TDC of at-risk thorax suggesting early increased thorax tissue water.

- Exploratory lymphedema thresholds based on pre-surgery variances indicate thorax thresholds are exceeded in 5.7% -22.9% of patients by 1 year depending on the threshold criteria employed.

Main Point Conclusions

- **Pre-surgery side-to-side similarities suggest that if pre-surgery data are unavailable, differentials measured later can still be diagnostically useful.**

- **Tracking of thorax tissue water changes via TDC measurements emerges as a potentially new and useful parameter to detect incipient lymphedema.**

- **The validity of the exploratory lymphedema thresholds is not yet established but depends on method, TDC site and its measurement depth.**


This presentation is available at
www.lymphedema-research.org
In Flash and PDF formats
Thanks for your Attention
My sincere thanks to Dr. Tapani Lahtinen
for his heroic efforts on my behalf!