"Using Advanced Technology to Better Diagnose Somatic Dysfunction"

Joint Presentation

The American Academy of Osteopathy 2017 Convocation

The Balance Point: Bringing the Science and Art of Osteopathic Medicine Together

Colorado Springs, CO

March 24, 2017

Larry Smarr, PhD.

Director, California Institute for Telecommunications and Information Technology

Harry E. Gruber Professor, Dept. of Computer Science and Engineering, UCSD

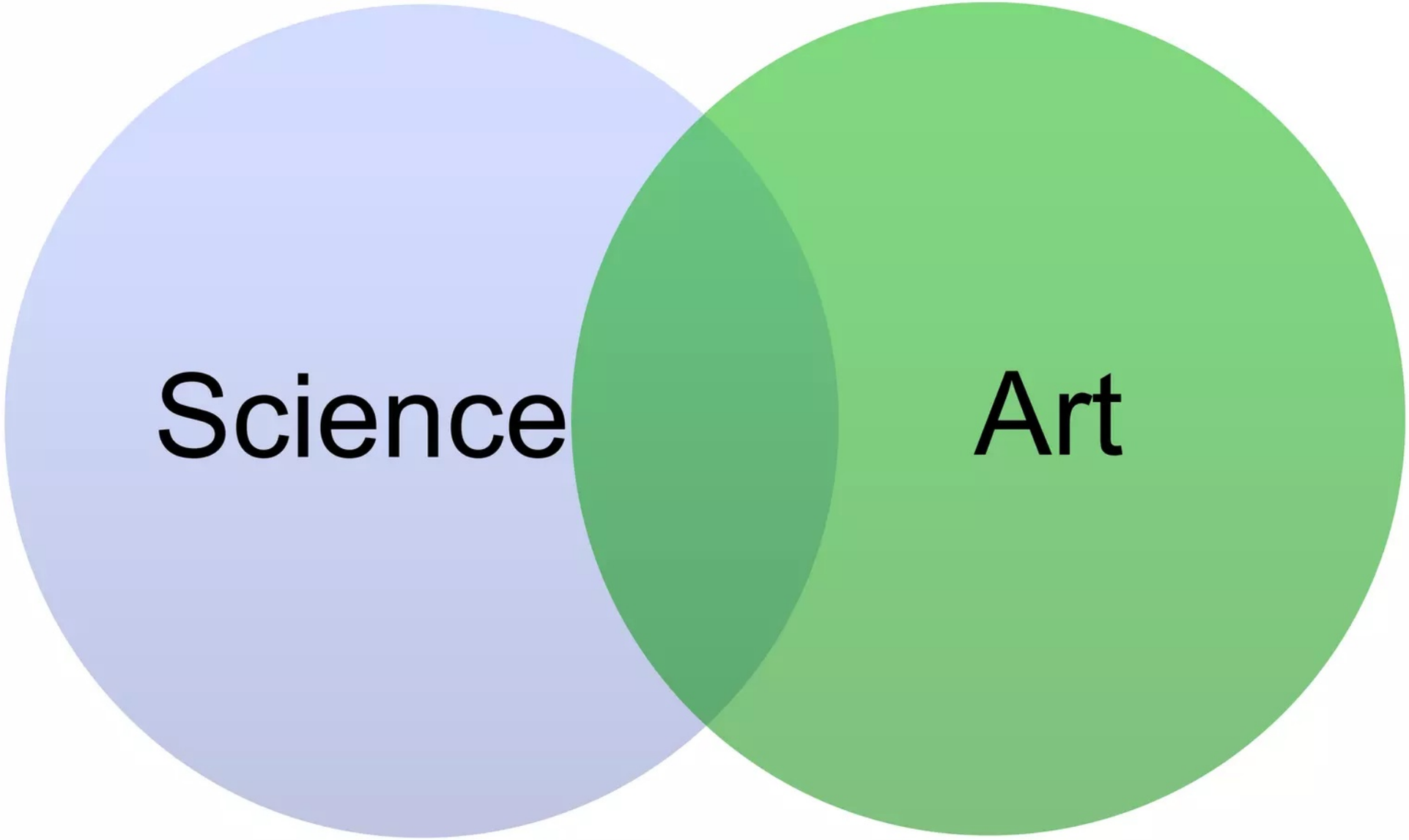
And

Michael Kurisu, D.O.

Clinical Director – UCSD Center for Integrative Medicine

Director of Clinical Training – Osteopathic Center San Diego

Osteopathic Medicine is Both an Art and a Science



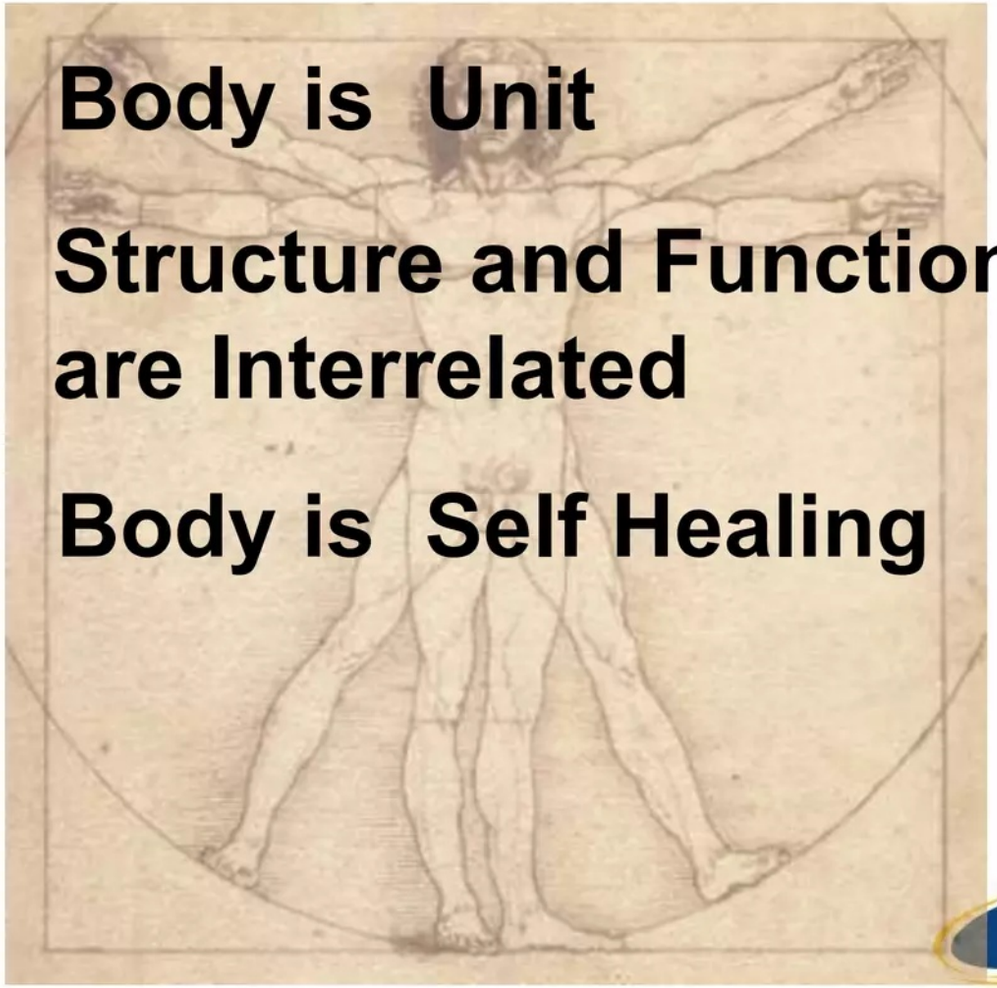
A Common Philosophy
Between the Science of System Dynamics and Osteopathy

"Multi-Component, Nonlinear, Dynamic, Adaptive Systems"



Hawley and Smarr 1985

Tenets of Osteopathy



Larry is Not Your "Typical" Patient: From Supercomputing to Quantified Self



TEDMED2013

NASA

NATIONAL INSTITUTES OF HEALTH

U.S. DEPARTMENT OF ENERGY | Office of Science

NSF

the Atlantic — The Measured Man

Science AAAS

MIT Technology Review — The Patient of the Future

The New York Times

NCSA

it²

It All Started With
Lower Back Pain and Sciatica

PART ONE: THE SPINE

Physical Exam:

Cranial: Vagus compression R

Lumbar: L3 RR, L4 L5 E, RL

Sacrum: R/L, R SI joint dsfxn

LE: Bil ankle stiffness

GI: Fascial Restriction Spleen, Colon

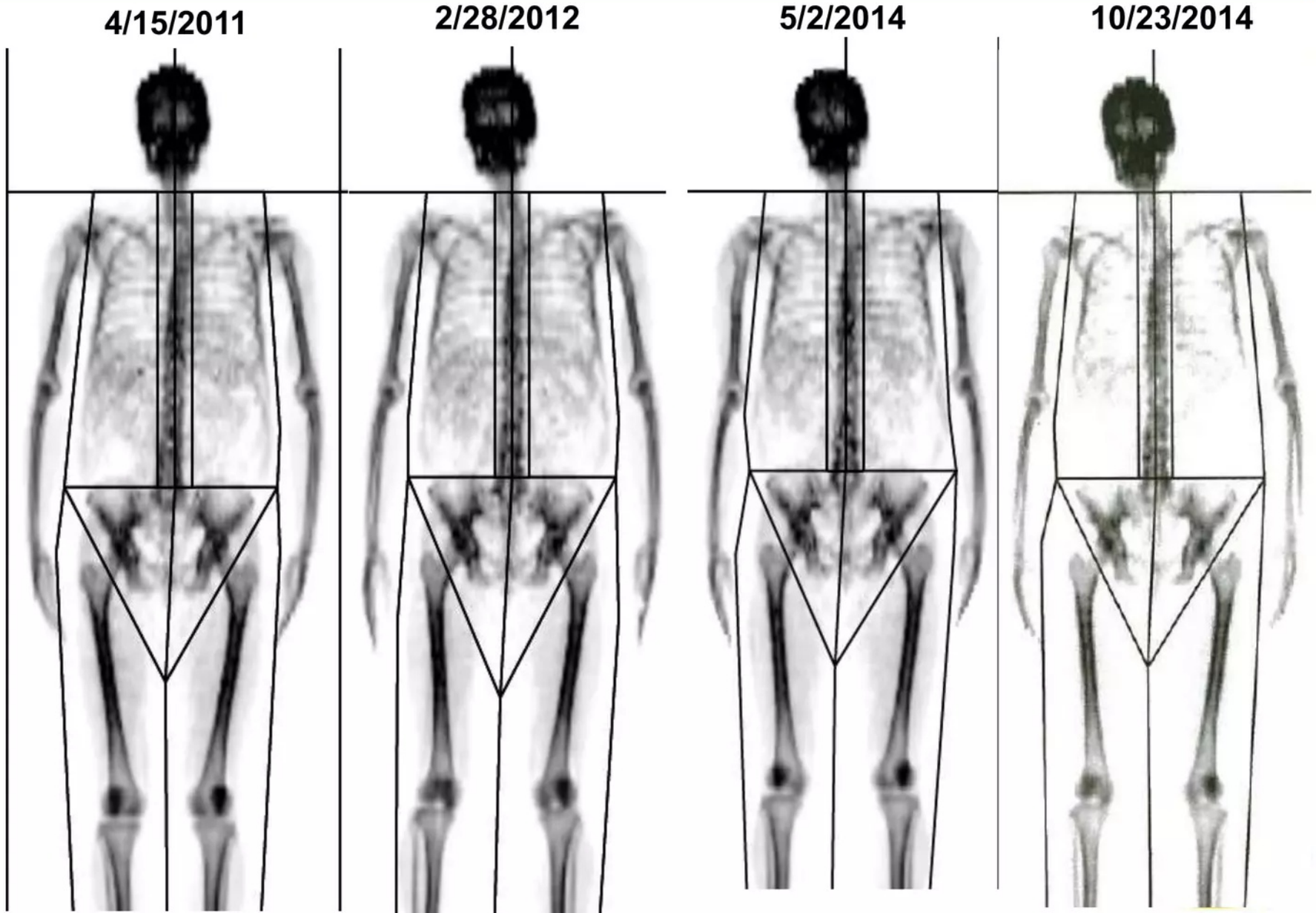
Aug 2014

But There Was a Deeper Problem: Thoracic/Cervical Scoliosis of LS Spine



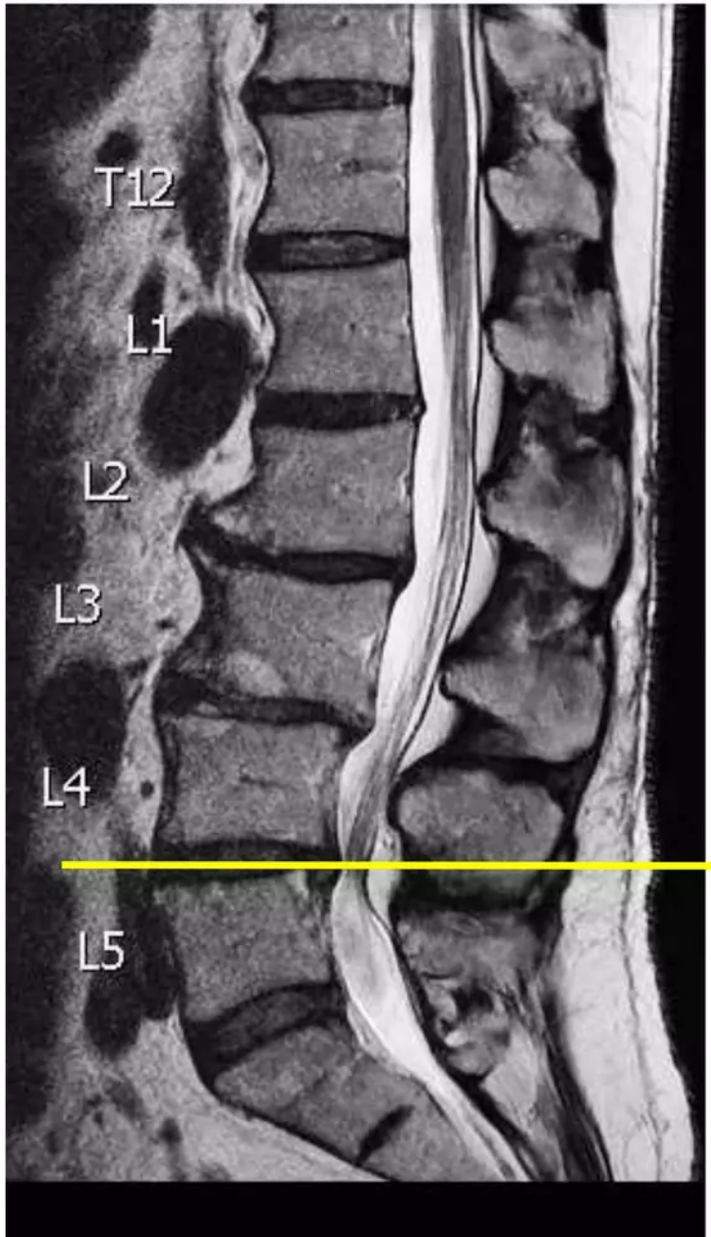
2D CT Scans
At Calit2
Using GE Lunar
Densitometer

Note
Curvature

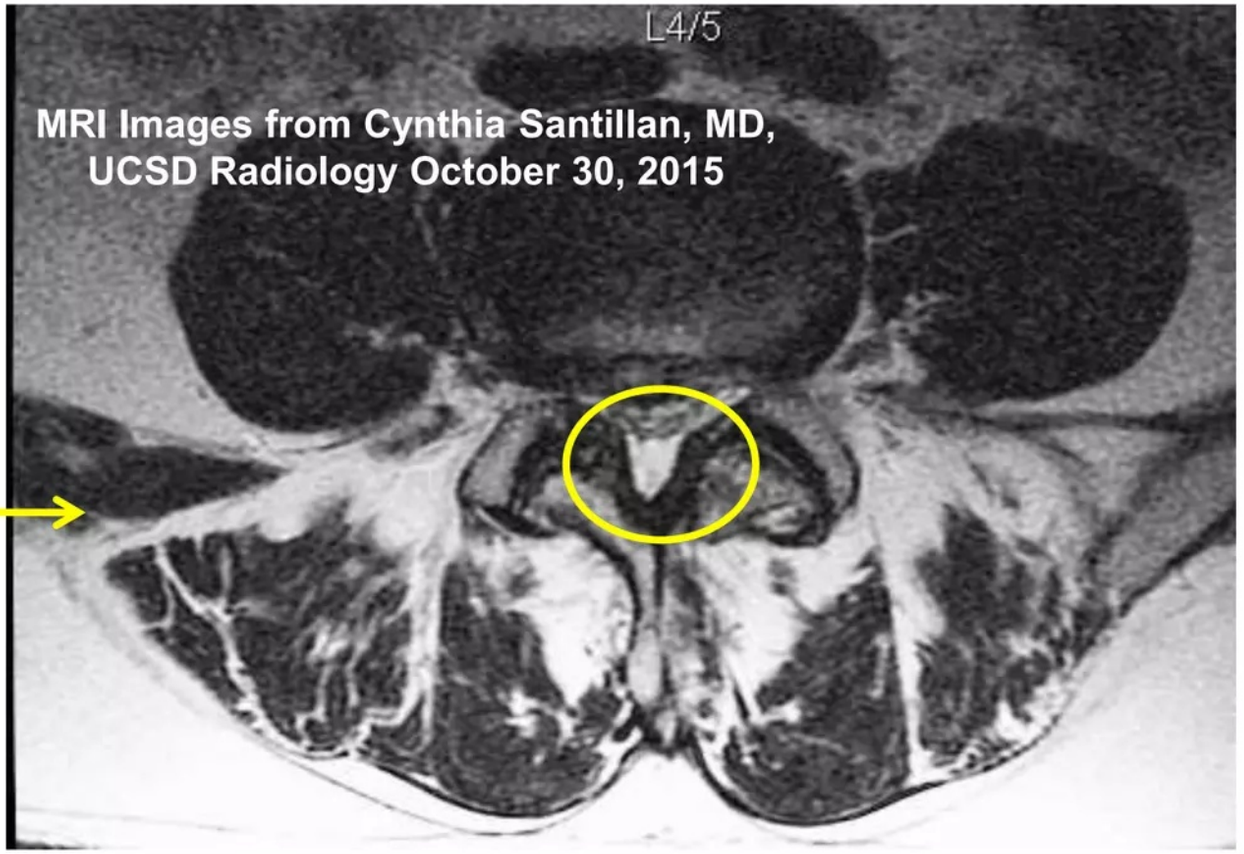


"You will notice
that there is a substantial
scoliotic curvature of your
upper mid-thoracic
and lower cervical spine."
-David Wing,
Calit2 EPARC
8/18/2014

MRI Shows Central Canal Stenosis



L4-L5: Circumferential disc bulge extends slightly inferiorly in an area of deficiency of the posterior aspect of the L5 superior endplate. Combined with moderate facet arthropathy and ligamentum flavum redundancy, **there is severe central canal stenosis with near complete effacement of Cerebrospinal Fluid (CSF) and mass effect on the cauda equina**. **Severe bilateral foraminal stenosis, with compression of the exiting bilateral L4 nerve roots**.

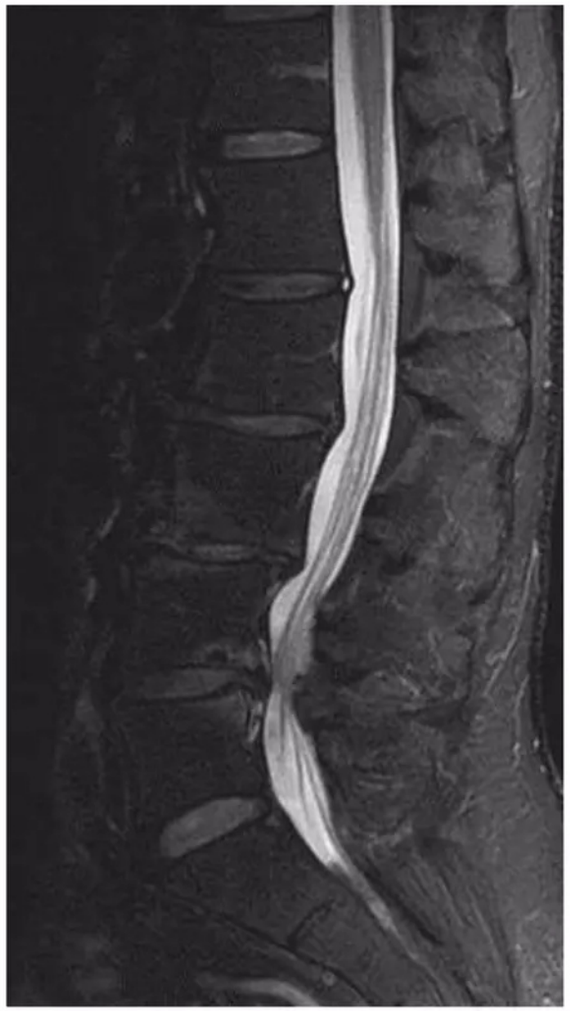


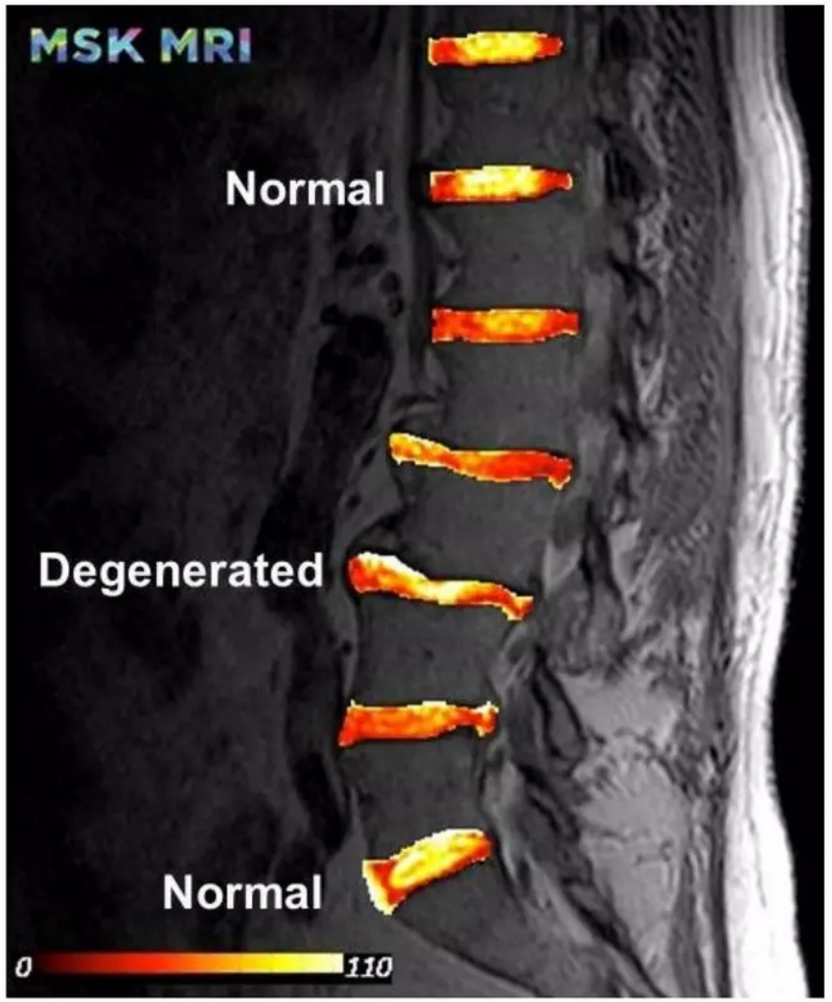
Advanced MRI:
Adjusting T1/T2 to Bring Out Regions of Interest

T1 has contrast with fat bright
(shows bone and alignment well)



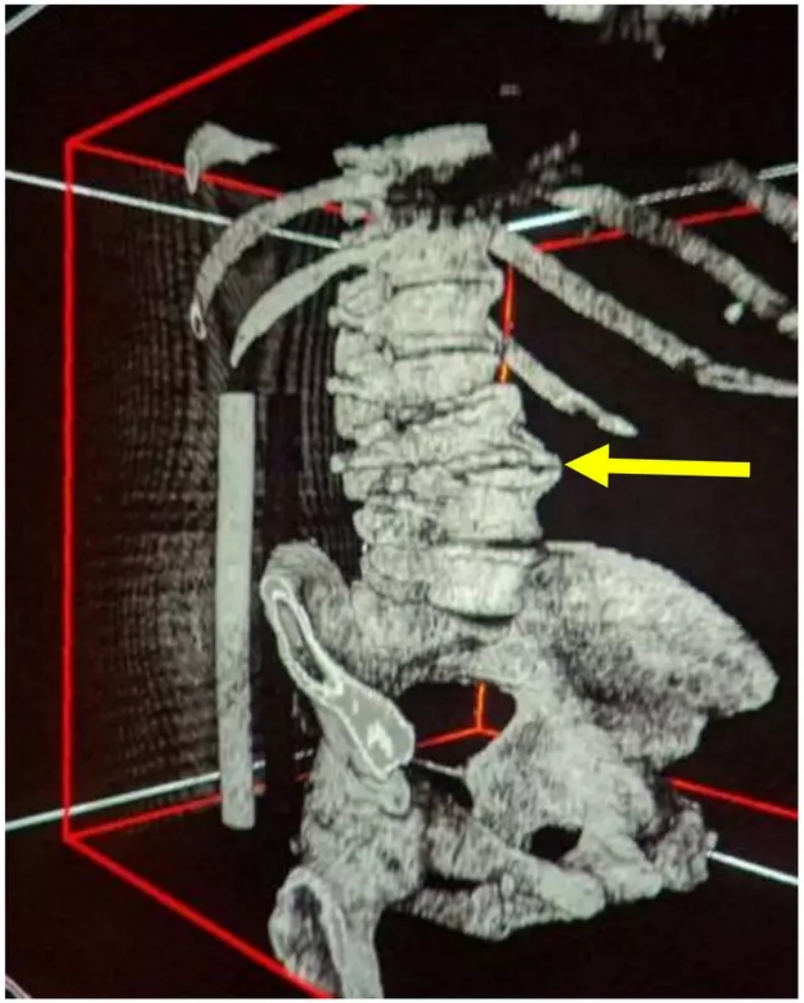
T2 with fat suppression: makes fat dark and fluid bright
(emphasizes disc and fluid around spinal cord/roots)





Images courtesy of Christine Chung MD, UCSD MSK Imaging Research Lab (www.MSKMRI.com)

Validating My Osteopathic Findings with 3D MRI Virtual Reality

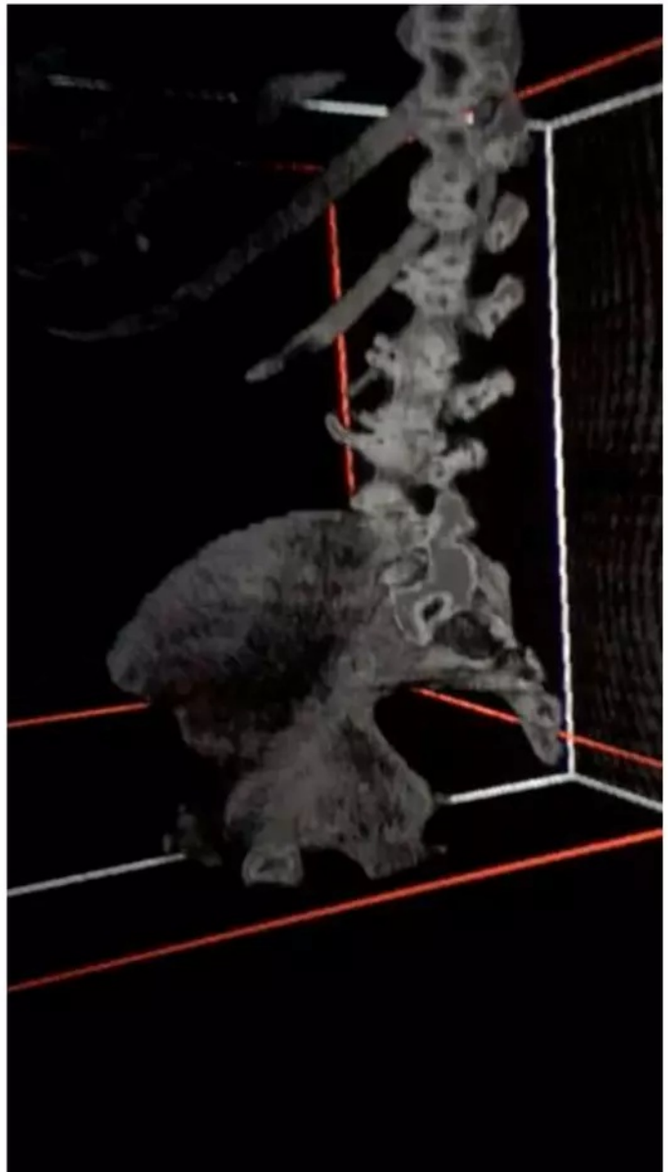


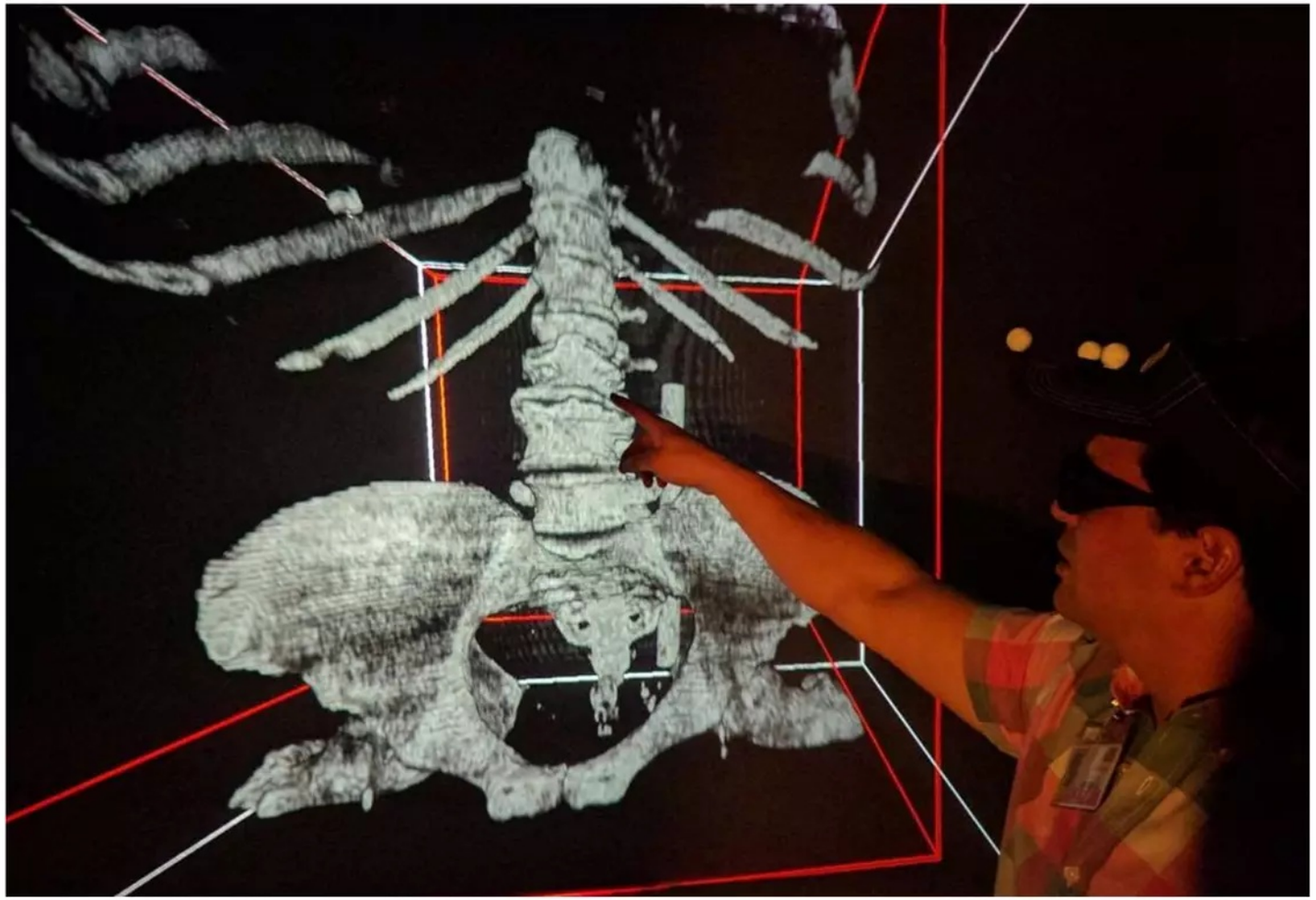




Visualizations from MRI by Jurgen Schulze, Calit2, UCSD

Mike Kurisu Examining Larry Smarr's Spine in the Calit2 Virtual Reality CAVE





Visualizations from MRI by Jurgen Schulze, Calit2, UCSD

Combining an Osteopathic Examination With 3D Visualization of the Patient

Recreating the Anatomy Lesson
Using 3D “Visible Larry” to Guide DO Manipulation

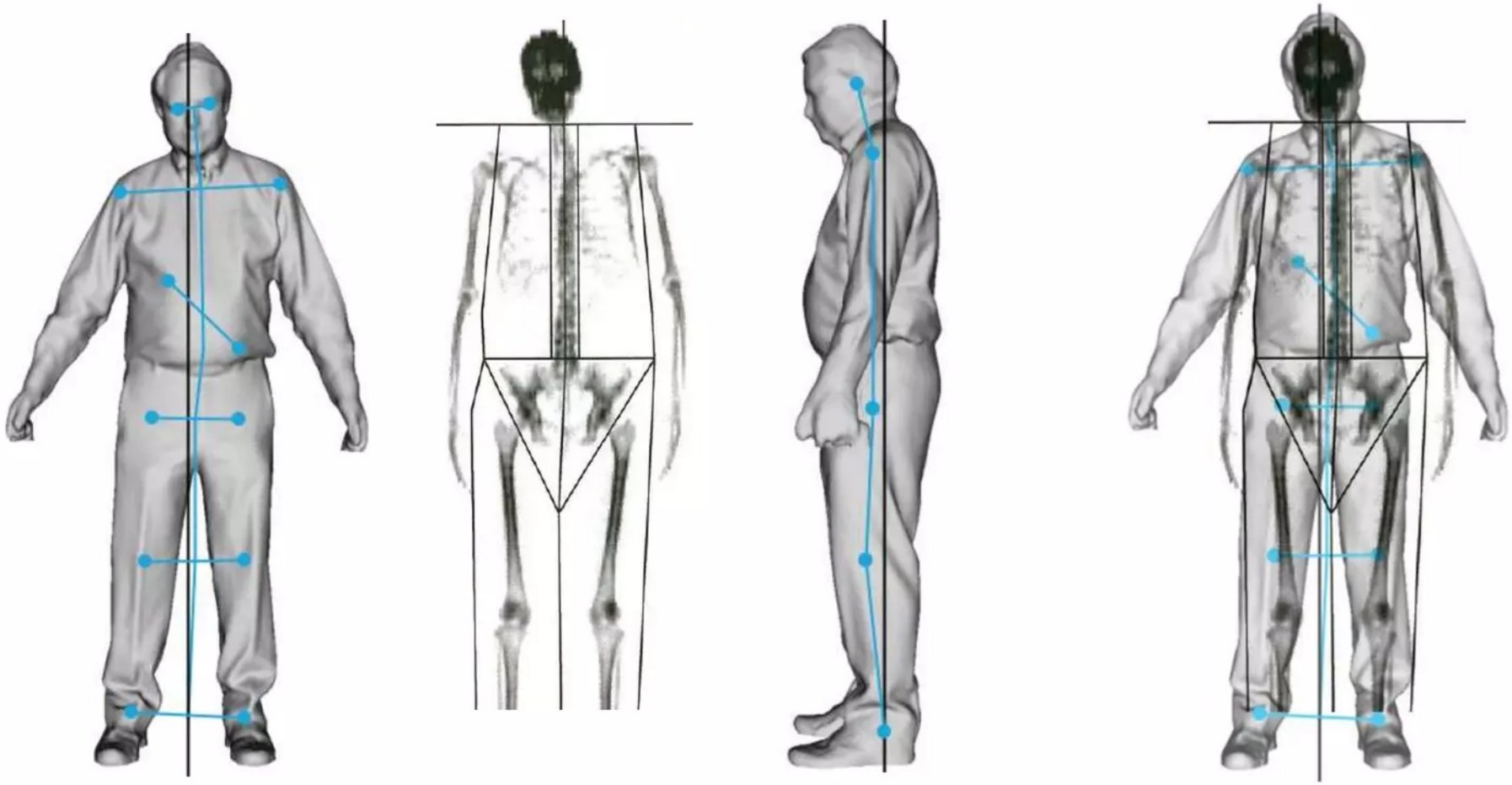




This is what we will be doing in our breakout session

Internal Spinal Abnormalities Detected
Using Spiral Technology Adapted from Mass Market Gaming Technologies

The Inside/Out Comparison

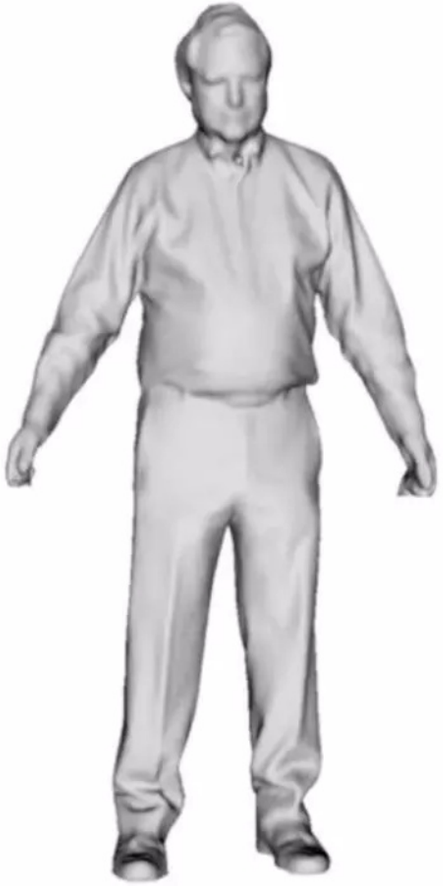


Slides from: Spencer Stein, President, Spiral Therapy, Inc &
Stephen Moxey MPT, OCS, FAAOMPT 2017

Discussion at breakout session

Tracking Somatic Dysfunction with External Spiral Technology

March 2016



February 2017



Slides from: Spencer Stein, President, Spiral Therapy, Inc &
Stephen Moxey MPT, OCS, FAAOMPT 2017

Tracking Body Shape Data

February 2017

Body Composition	
Name	**Value**
Weight	195 lbs
Body Fat Percentage	26.1 %
Fat Mass	50.9 lbs
Lean Mass	144.1 lbs

Metabolic Syndrome Tracking

Additional	
Name	**Value**
Waist Circumference	40.8 inches
Waist to Hip Ratio	1.01

MEASUREMENTS

Name	Value (Inches)
Neck	17.9
Chest	42
Waist	40.8
Hips	41.4
Left Biceps	12.7
Right Biceps	12
Left Forearm	12.1
Right Forearm	11.4
Left Thigh	22
Right Thigh	21.7
Left Calf	15.5
Right Calf	14.8

Slide from: Spencer Stein, President, Spiral Therapy, Inc &
Stephen Moxey MPT, OCS, FAAOMPT 2017

Then There Was Knee Pain

PART TWO: THE KNEE

Physical Exam:

Cranial: Vagus compression R

Lumbar: L4 L5 E, RL (still mobile)

Sacrum: R/L, (more mobility)

LE: Bil ankle stiffness

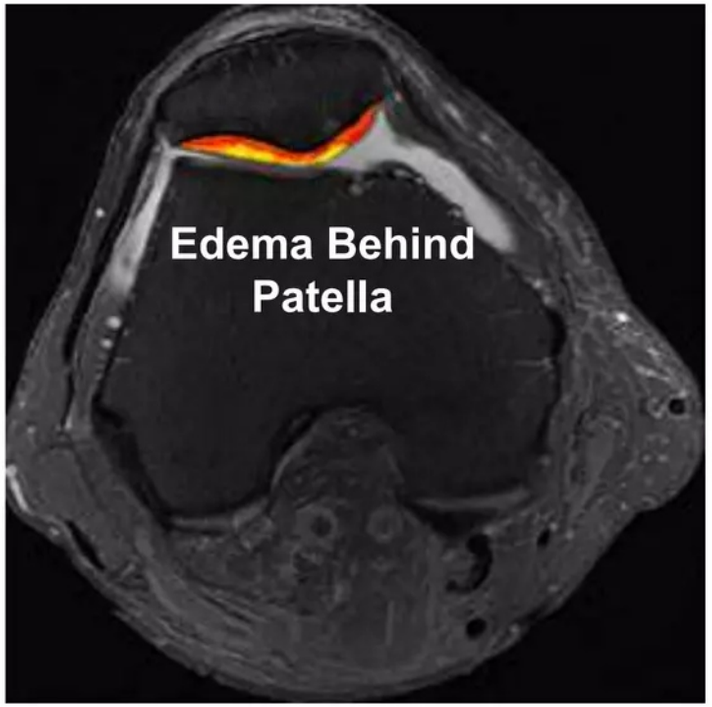
Knee: Distal tracking on patella, swelling and MF strain inferior

GI: Fascial Restriction Spleen, Colon

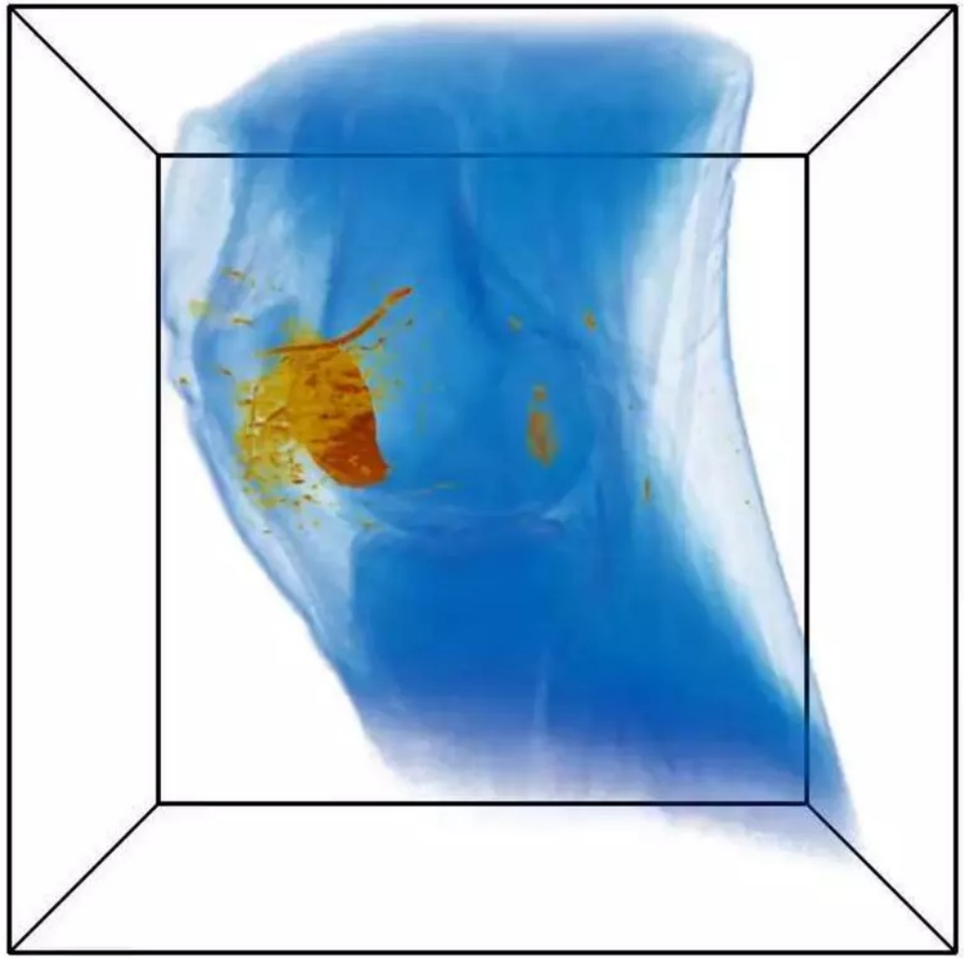
Using Enhanced MRI to Detect Regions of Inflammation in Joint

196 Slices, 512x512 Slice Resolution

Inflammation in Bursa in Front of Patella



MRI and Annotation
Christine Chung, MD, UCSD





Visualization by Jurgen Schulze, Calit2, UCSD

Finally, I Could Detect Abdominal Dysfunction

PART THREE: THE ABDOMEN

Physical Exam:

Cranial: Vagus compression bilaterally

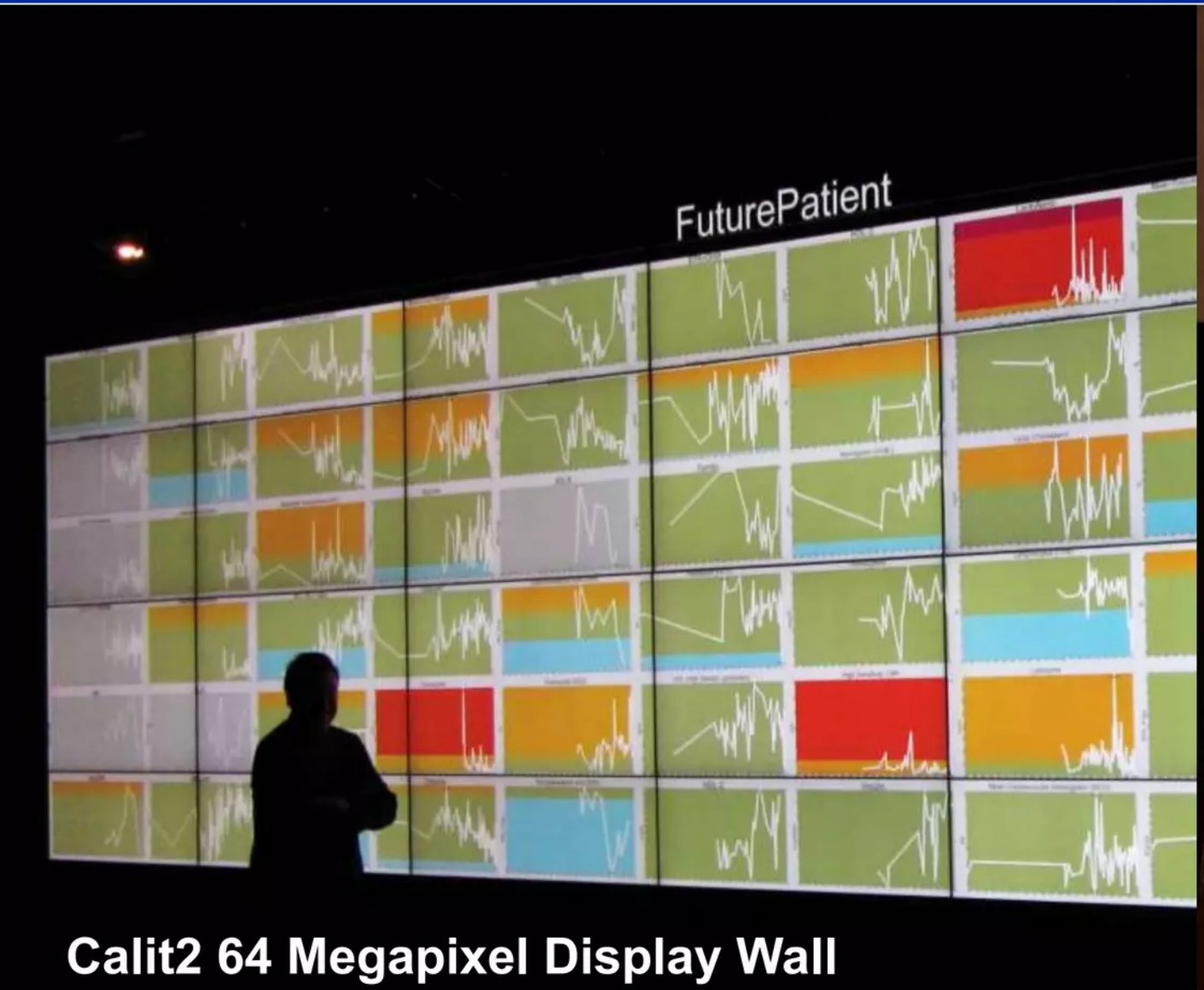
Lumbar: L5 compressed on R

Sacrum: stabalized

LE: Bil ankle stiffness R>L

GI: Fascial Restriction Spleen, moderately distended descending colon, warmth, mass effect felt sigmoid junction with increasing density

A Decade Ago I Started Tracking My Internal Biomarkers To Understand My Body's Dynamics

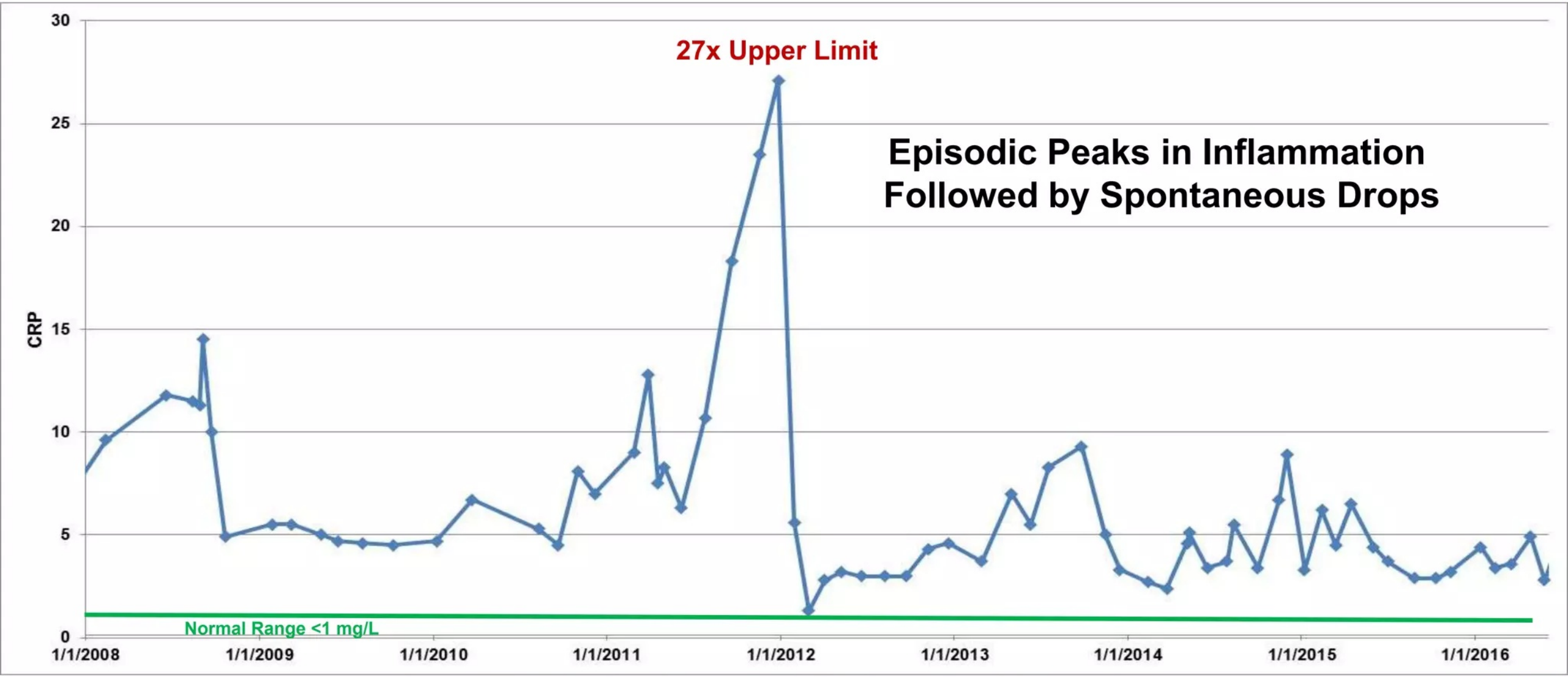


Calit2 64 Megapixel Display Wall



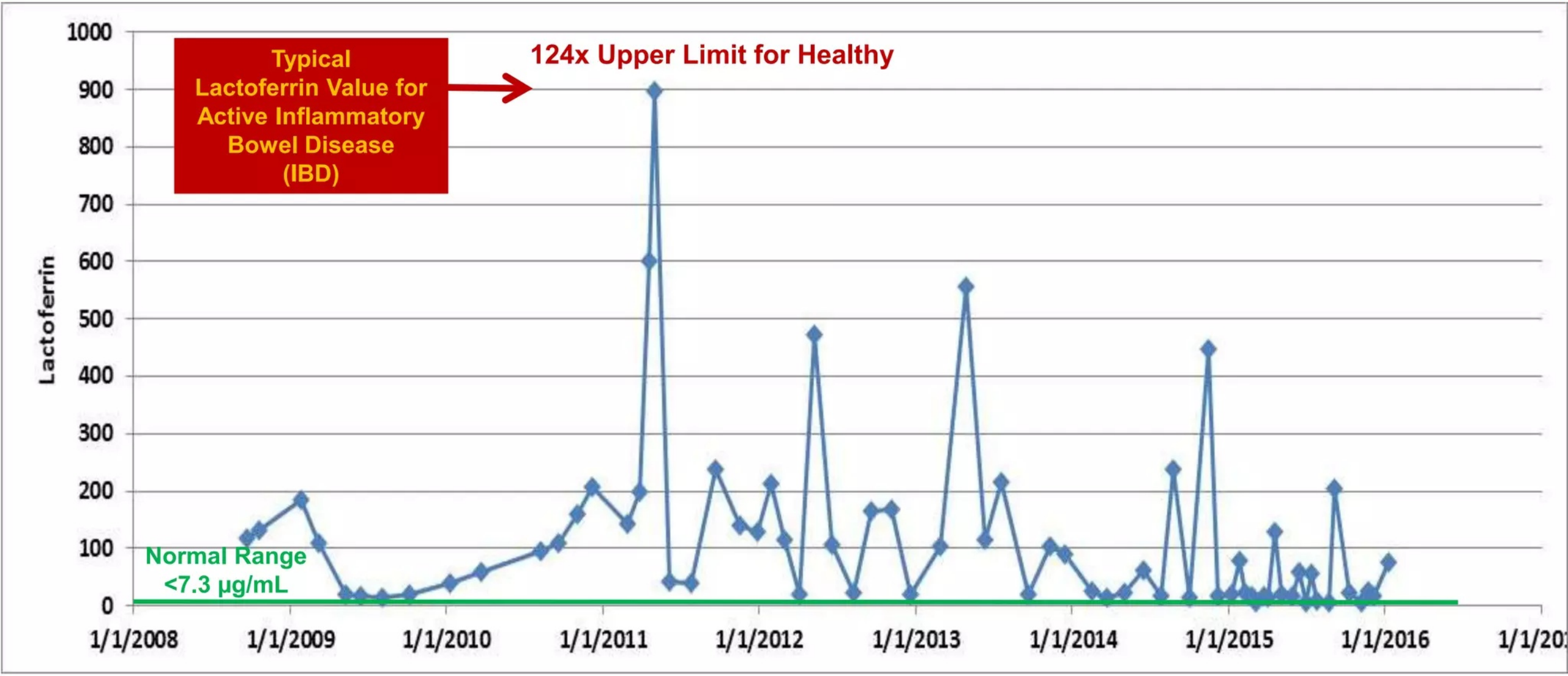
My Quarterly Data Collection

Only One of My Blood Measurements Was Far Out of Range--Indicating Chronic Inflammation



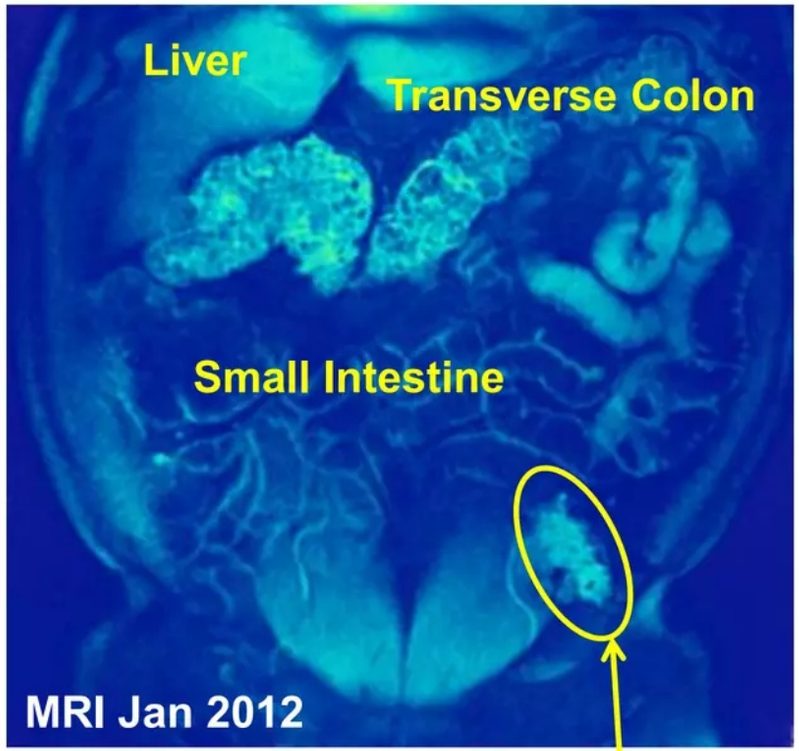
Complex Reactive Protein (CRP) is a Blood Biomarker for Detecting Presence of Inflammation

Adding Stool Tests Revealed Oscillatory Behavior in an Immune Variable Which is Antibacterial



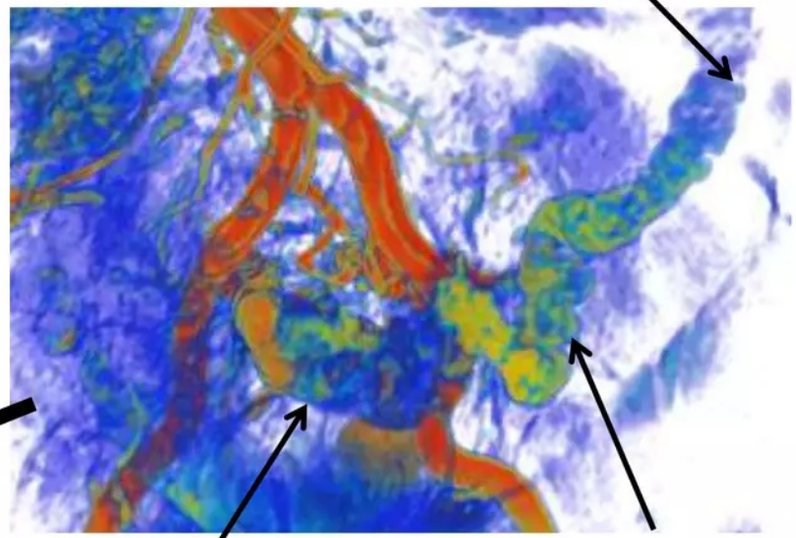
Lactoferrin is a Protein Shed from Neutrophils - An Antibacterial that Sequesters Iron

Confirming the IBD (Colonic Crohn's) Hypothesis: Finding the "Smoking Gun" with MRI Imaging



I Obtained the MRI Slices From UCSD Medical Services and Converted to Interactive 3D Working With Calit2 Staff

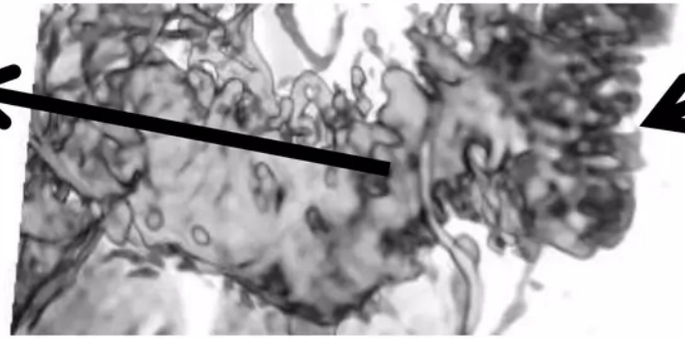
Descending Colon



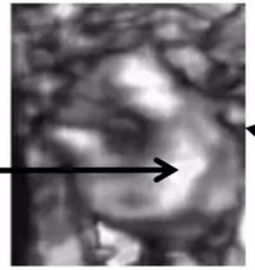
Major Kink

Sigmoid Colon Threading Iliac Arteries

Diseased Sigmoid Colon



Cross Section



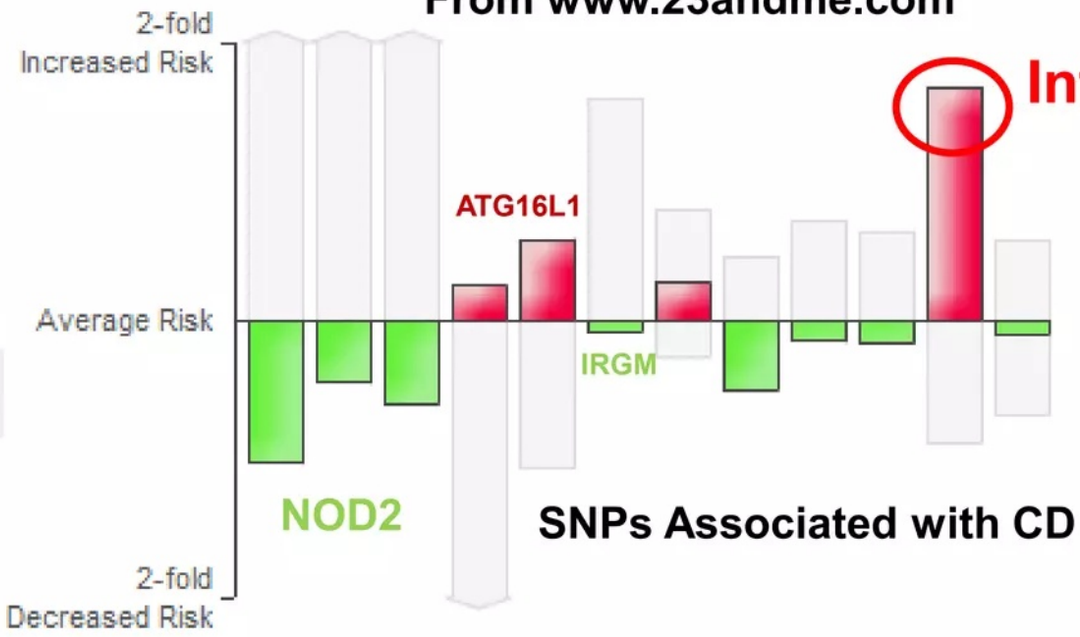
Severe Colon Wall Swelling

MRI Animation of LS GI Tract
Verifies Sigmoid Colon is Far from Healthy



Why Did I Have IBD?
I Found I Had a SNP Associated with Crohn's Disease

From www.23andme.com



Polymorphism in Interleukin-23 Receptor Gene — 80% Higher Risk of Pro-inflammatory Immune Response

~200 Human DNA SNPs Associated with IBD.

Analysis Indicated I Had Colonic Crohn's, Not Ileal Crohn's

A Genome-Wide Association Study Identifies *IL23R* as an Inflammatory Bowel Disease Gene

Richard H. Düerr, *et al.*
Science **314**, 1461 (2006)

To Understand the Interaction of Genetics and the Immune System We Must Consider the Human Microbiome

Your Body Has 10 Times
As Many Microbe Cells As
DNA-Bearing Human Cells

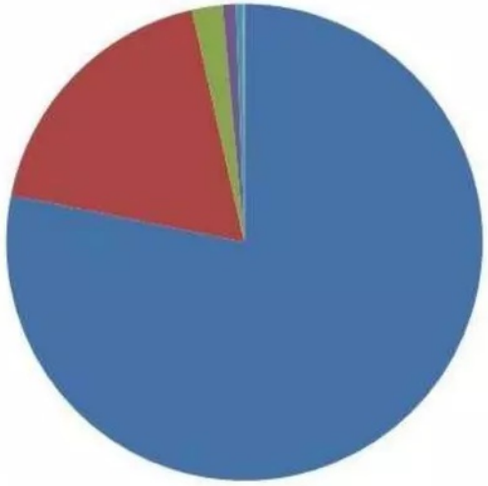
Your Microbiome is
Your "Near-Body" Environment
and its Cells
Contain 100x as Many DNA Genes
As Your Human DNA-Bearing Cells

Inclusion of the Microbiome Genomics
Will Radically Alter Medicine

We Found Major State Shifts in Microbial Ecology Phyla Between Healthy and Three Forms of IBD

Our Team Used 25 CPU-Years to Compute Comparative Gut Microbiomes Starting From 2.7 Trillion DNA Bases of My Samples and Healthy and IBD Controls

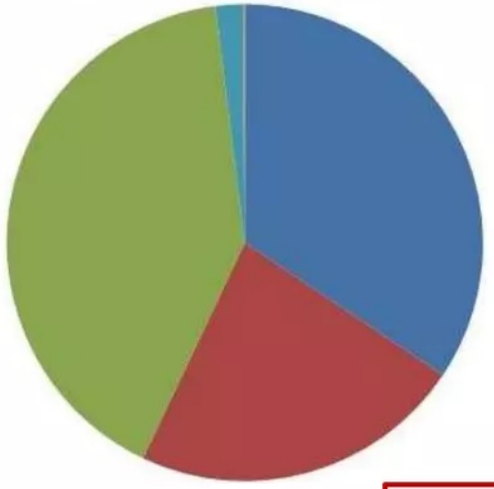
Average HE



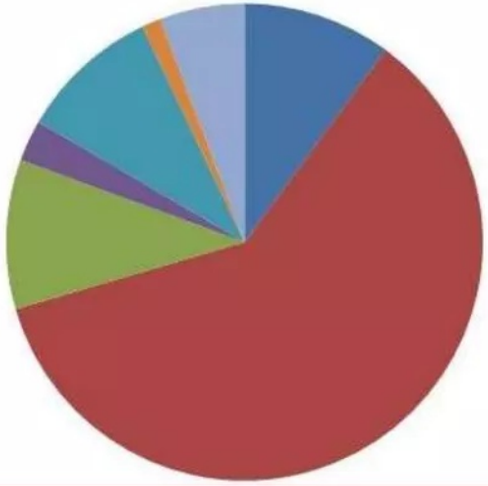
Most Common Microbial Phyla

- Bacteroidetes
- Firmicutes
- Proteobacteria
- Verrucomicrobia
- Actinobacteria
- Fusobacteria
- Euryarchaeota

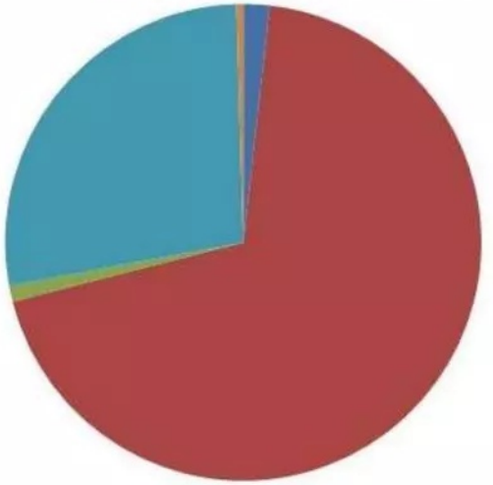
Average Ulcerative Colitis



Average LS Colonic Crohn's Disease

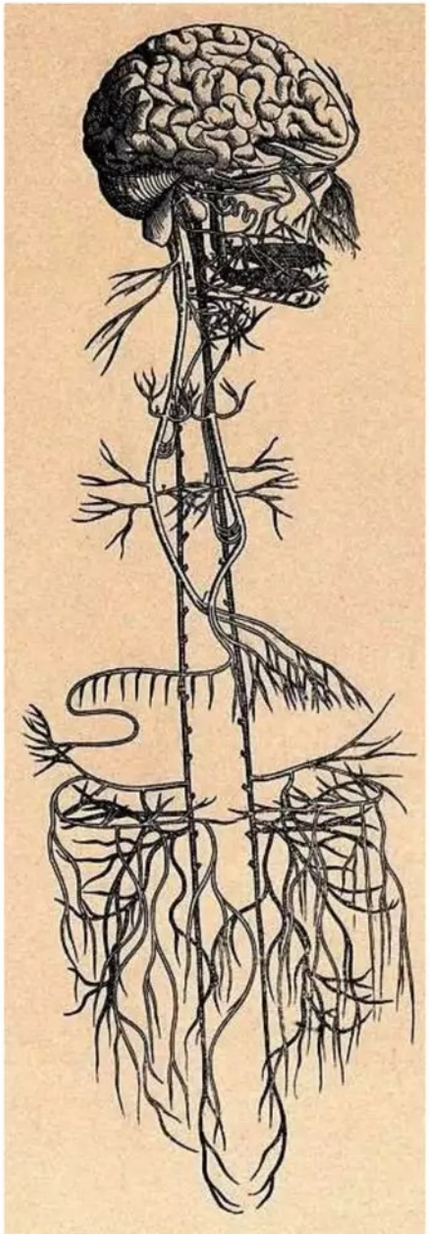


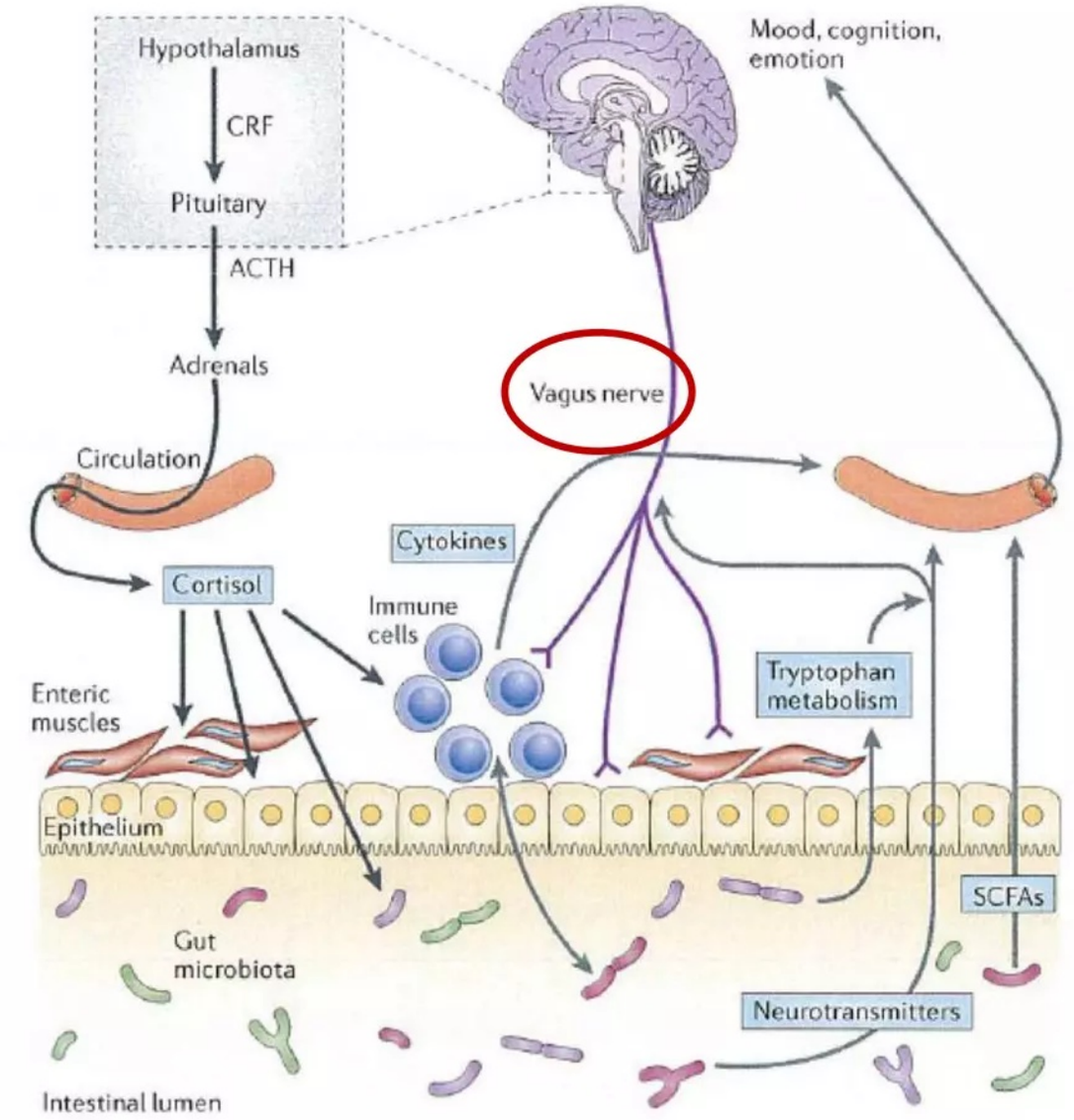
Average Ileal Crohn's Disease

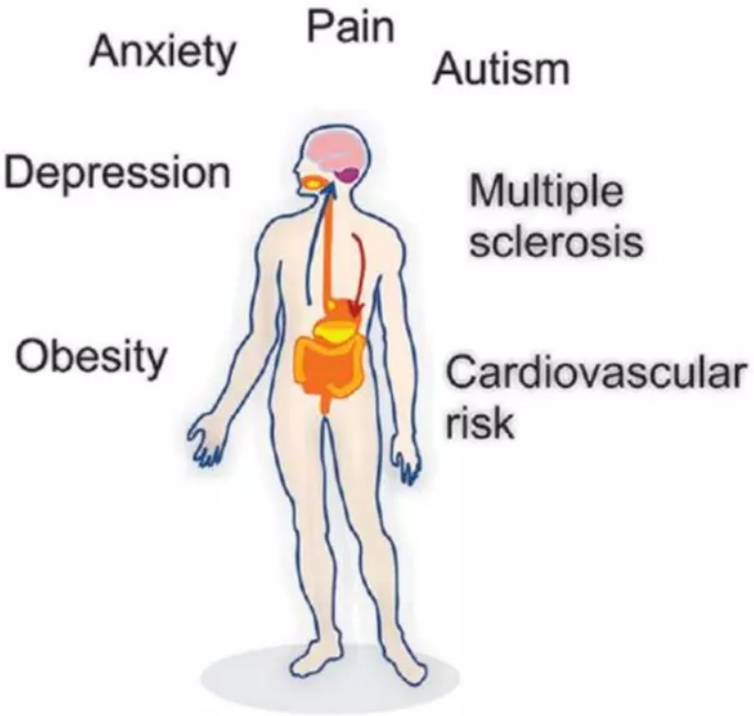


Discussion at breakout session

The Microbiome–Gut–Brain Axis Provides New Systemic Insights into Shifts in Behavior and Disease





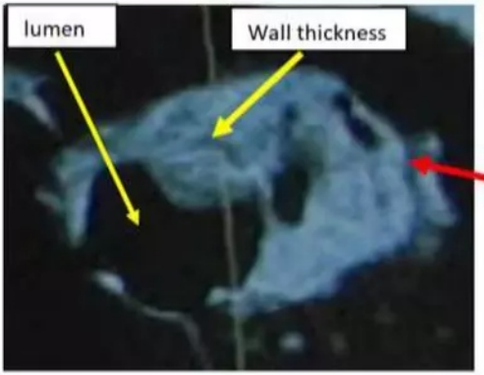


Source: Montiel-Castro, et al.
Frontiers in Integrative Neuroscience 2013

Using 3D “Visible Larry” to Guide Abdominal DO Manipulation

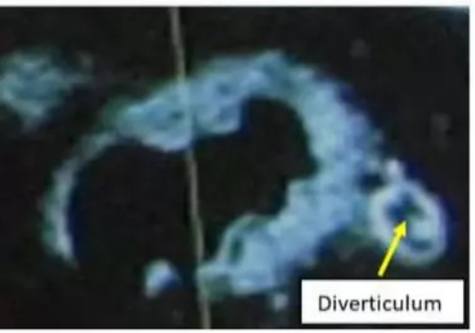


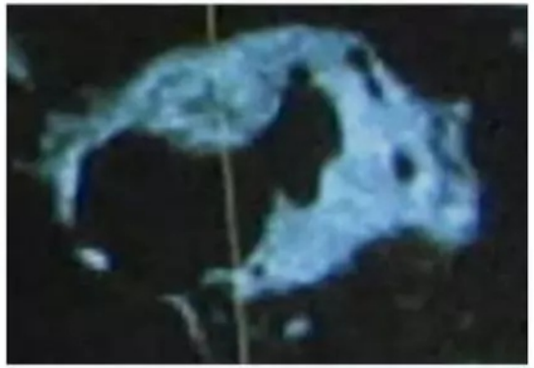
Full Body CAT Scan at mm Resolution, Including Virtual Colonoscopy June 2016 Convinced Me Time Had Come for Surgery

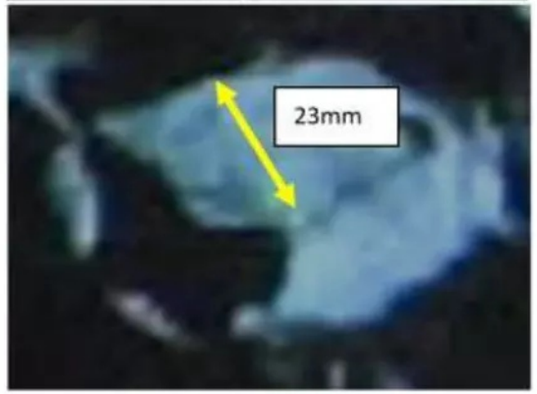




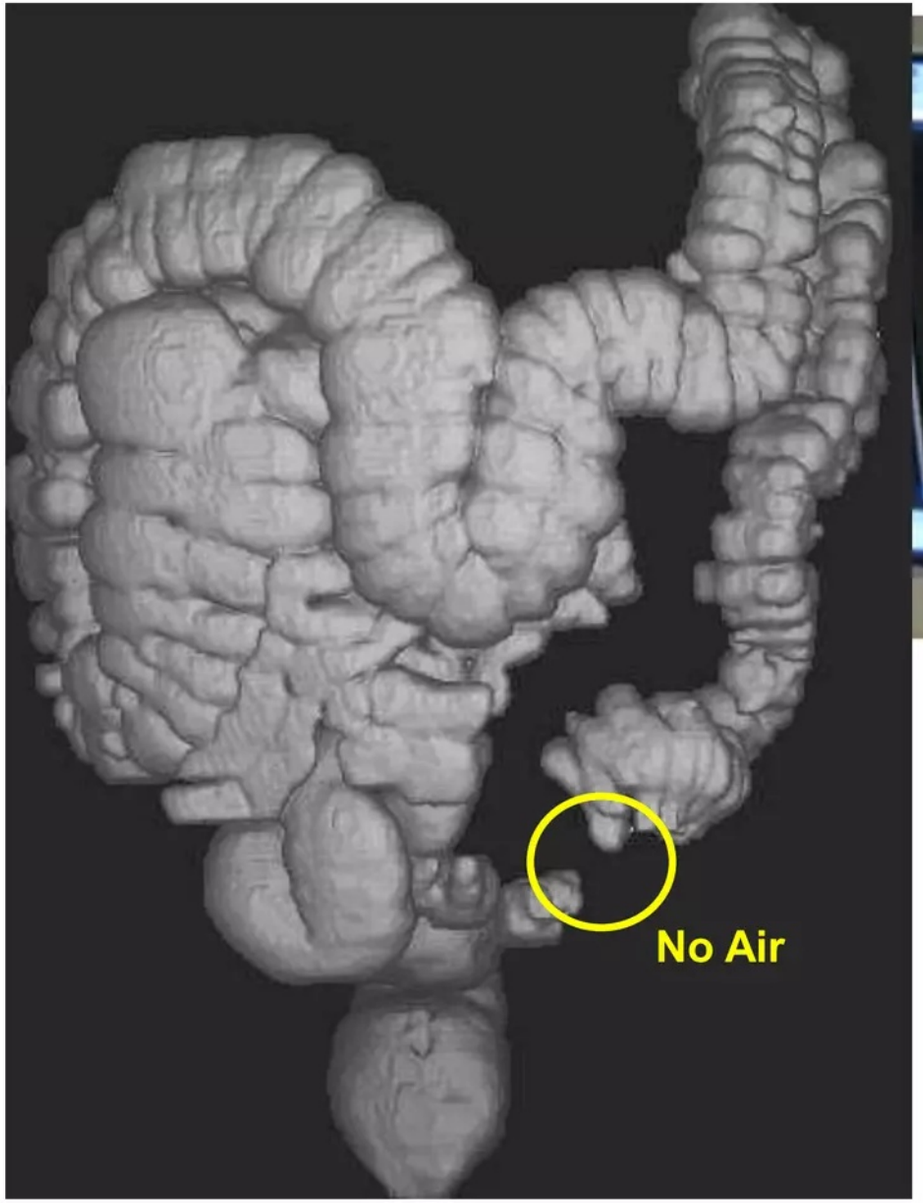








Source: June 2016
Dr. Harvey Eisenberg,
Body Scan Intl., Irvine, CA





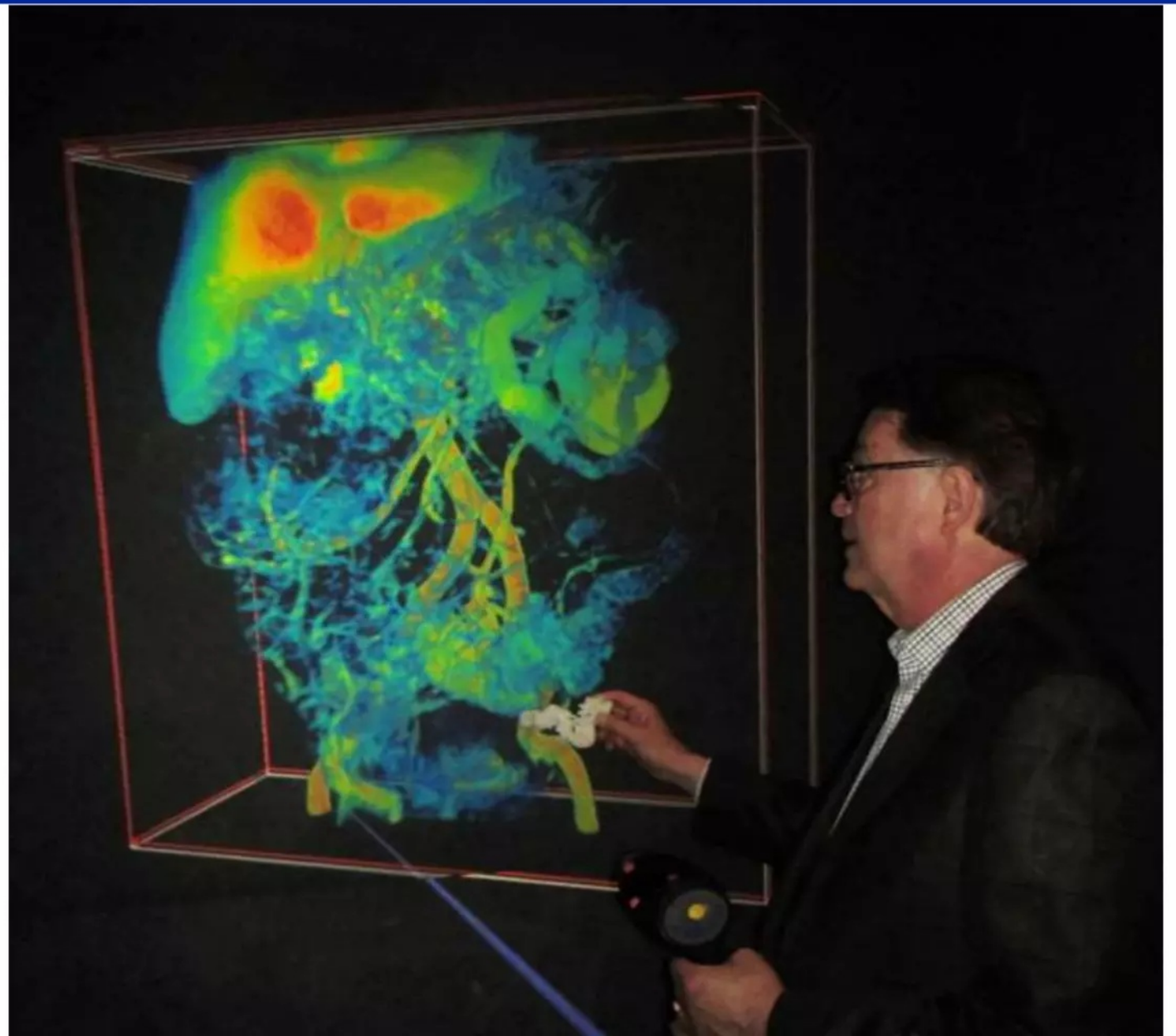
Classic Colonic Crohn's Stricture

Pre-Surgery Mental/Emotional Preparation Over Thanksgiving 2016



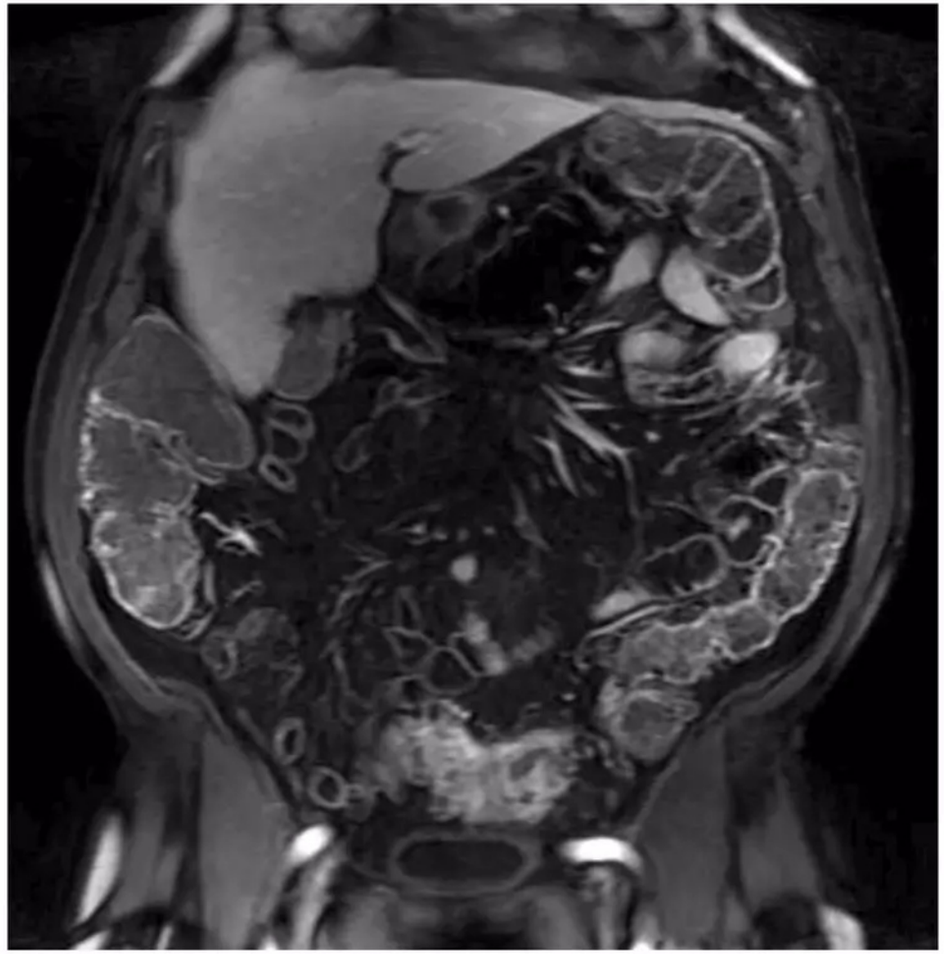
I Had Been Giving Tours of "Visible Larry" for Years: In Calit2's Virtual Reality StarCAVE

3D Volumetric Visualization Created by Calit2's Jurgen Schulze from January 2012 MRI

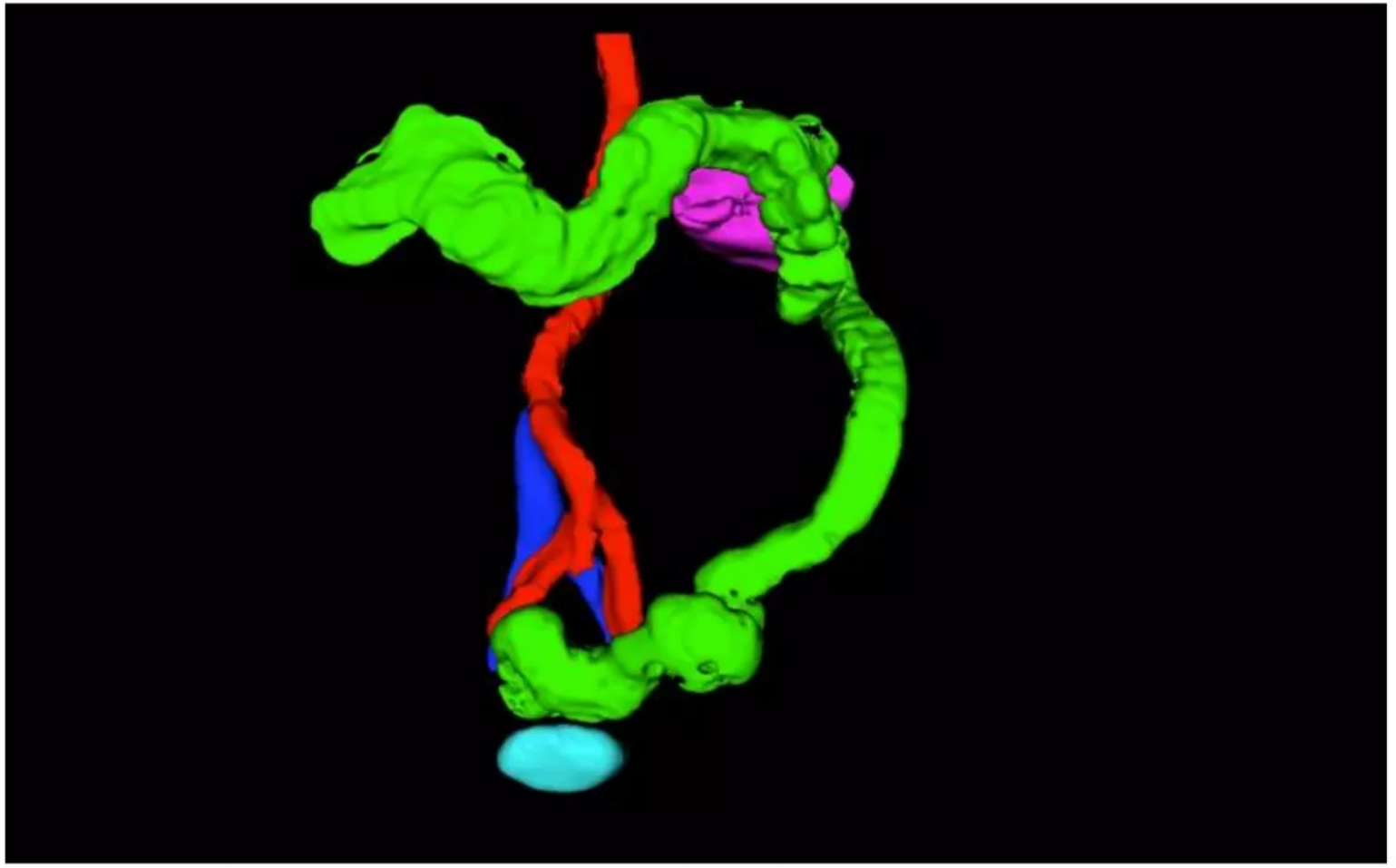


QI's Jurgen Schulze Converted Abdominal MRI Slices to 3D Organ Segmentation for Surgical Pre-Planning

Images of Dr. Smarr's Abdomen
To Support Sigmoid Colon Resection Surgery



MRI Slice from Dr. Cynthia Santillan



3D Organ Segmentation Made by Dr. Jurgen Schulze from Dr. Santillan's 150-Slice MRI

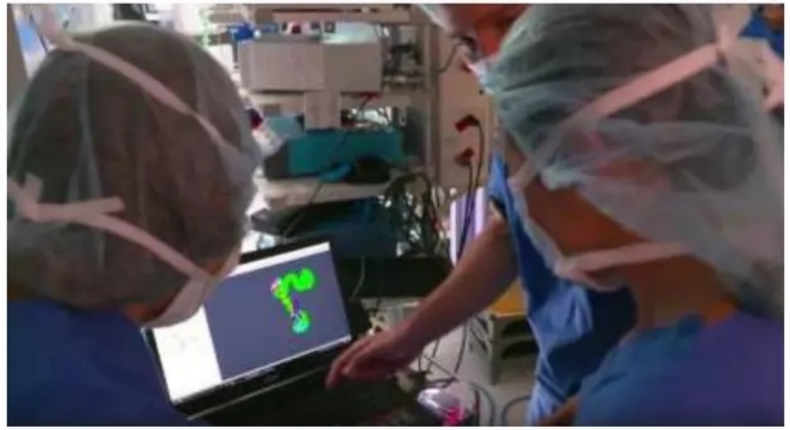
Pre-Surgical Planning in QI Virtual Reality on Friday November 25, 2016

Dr. Ramamoorthy in QI Virtual Reality CAVE Exploring Dr. Smarr's Colon With Dr. Schulze's Software



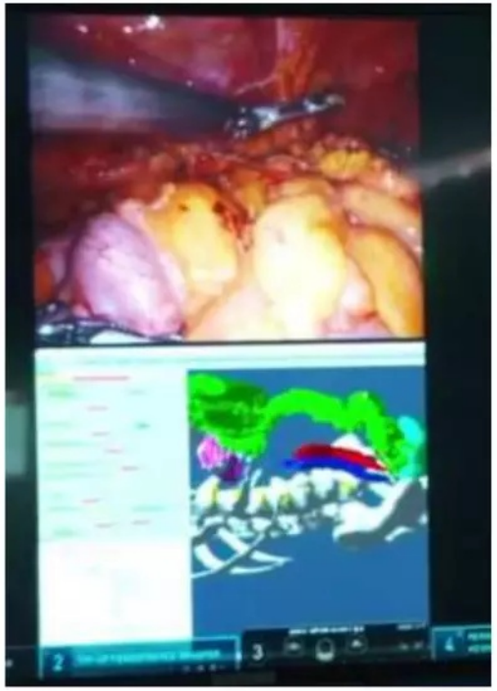
Using QI Organ Segmentation in Jacobs OR on Tuesday November 29, 2016

Dr. Schulze Rotating 3D Organs To Match Up With da Vinci Arms and Internal Camera





Dr. Smarr
With da Vinci Robot
Arms Inside Him





Dr. Ramamoorthy Operating
Da Vinci Xi Robot During Surgery



OR Team Using Large Screens
To Watch Dr. Schulze's da Vinci Images

Dr. Ramamoorthy's Use of 3D Interactive Anatomy To Guide Surgical Team on Site For Bowel Division



Surgery Day:
Worlds Apart Yet Connected



Dr. Smarr



Dr. Kurisu

Dr. Kurisu Using Oculus Rift Virtual Reality to Watch 360 Degree Time Lapse of Dr. Smarr's Surgery

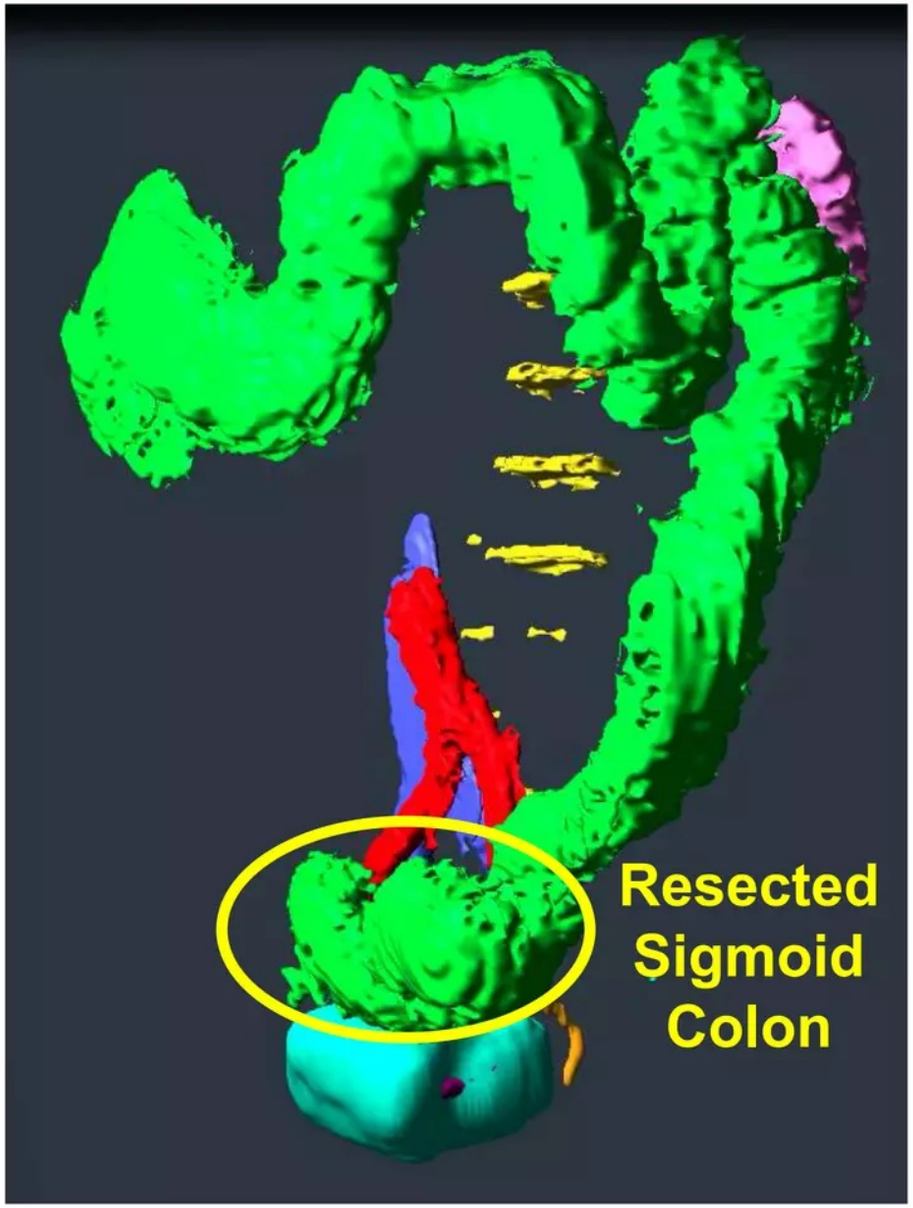


Jurgen Schulze Showing Mike Kurisu
How to Use
an Oculus Rift Virtual Reality Headset



Jurgen Schulze Used 360 Degree Camera
To Record Time Lapse Movie of Surgery

3D View of Colon
Before and After Surgery





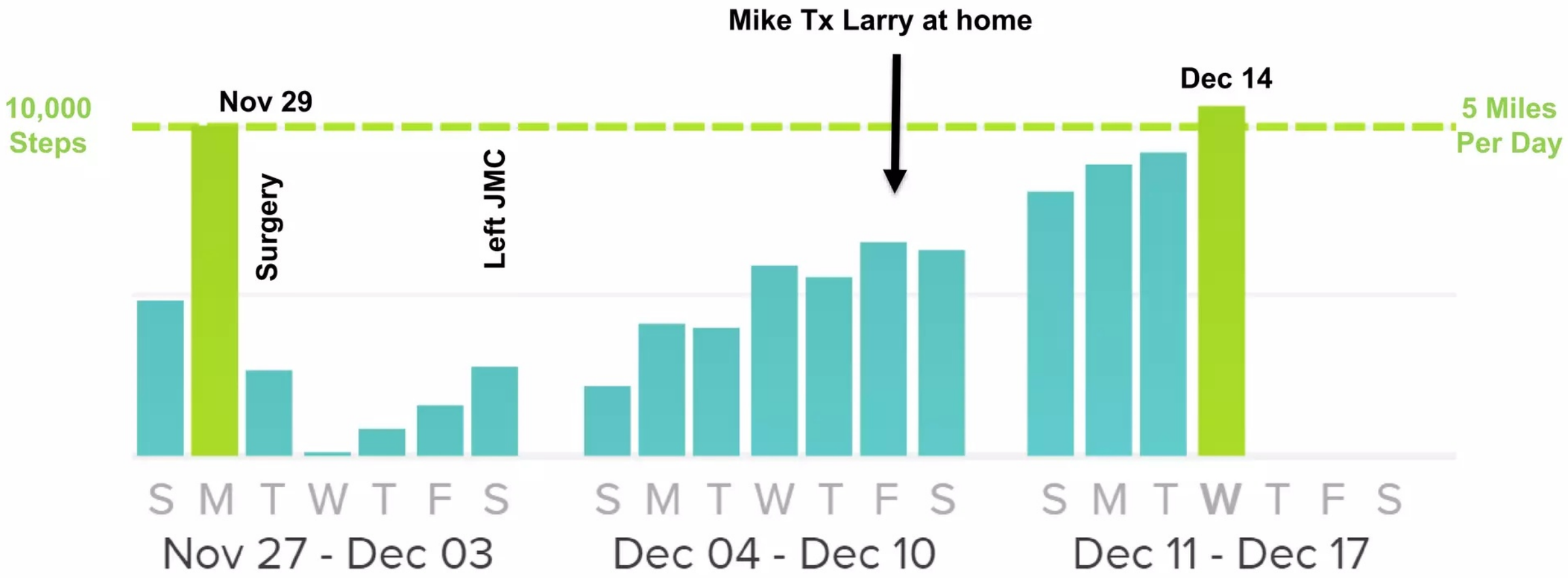
Blood hs-CRP on Log Scale: Use as Post-Surgery Biomarker of Success?



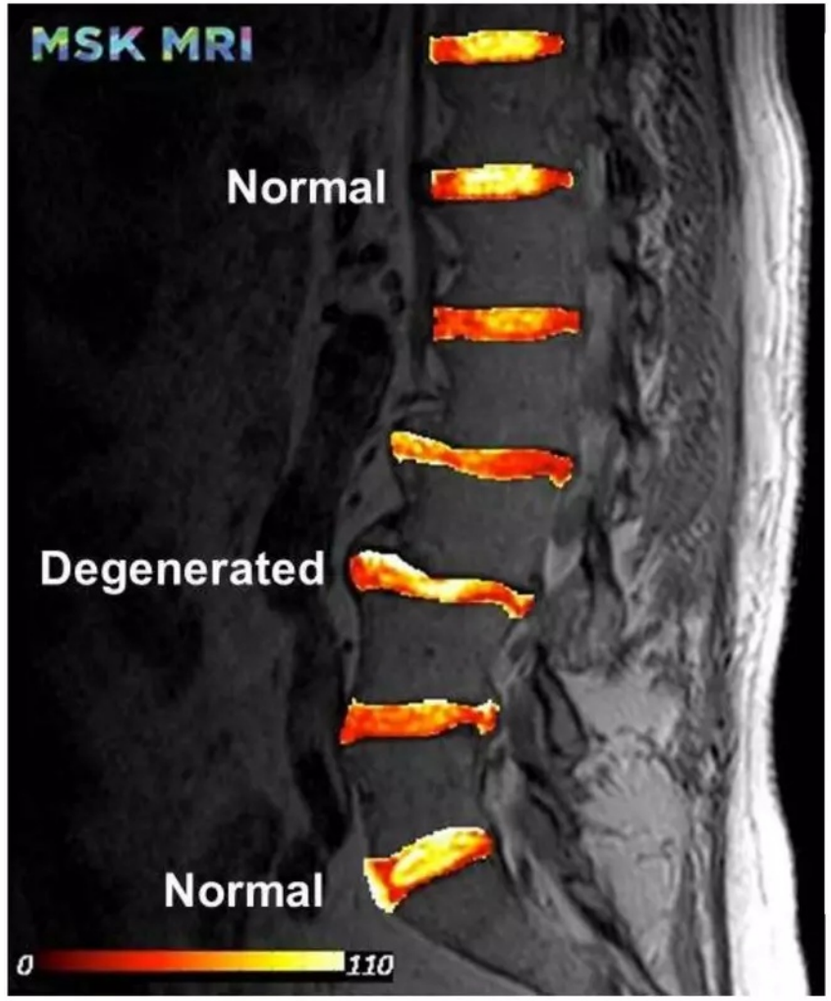
Stool Lactoferrin on Log Scale: Dramatic Drop After Surgery

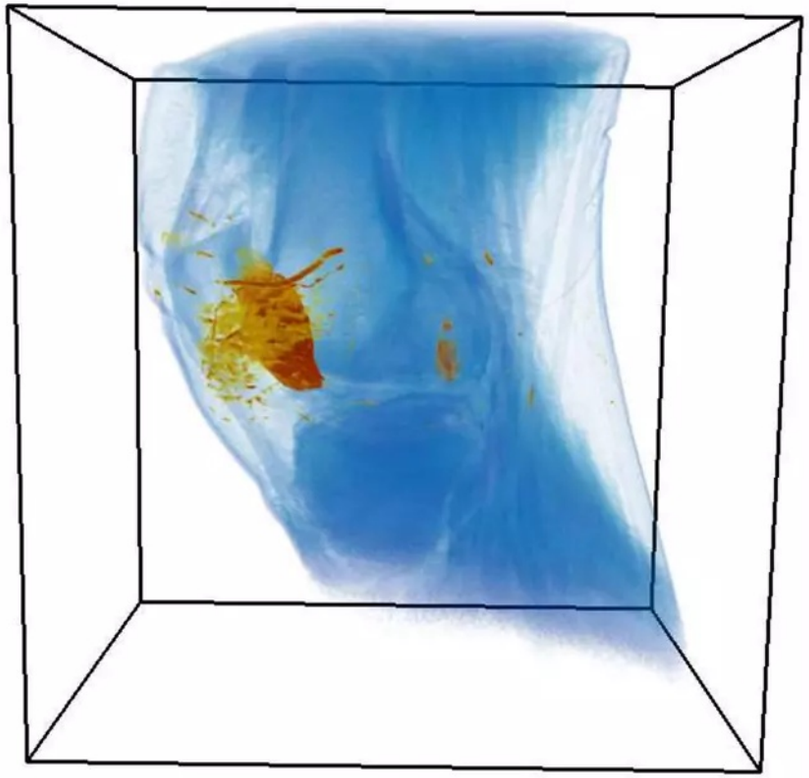


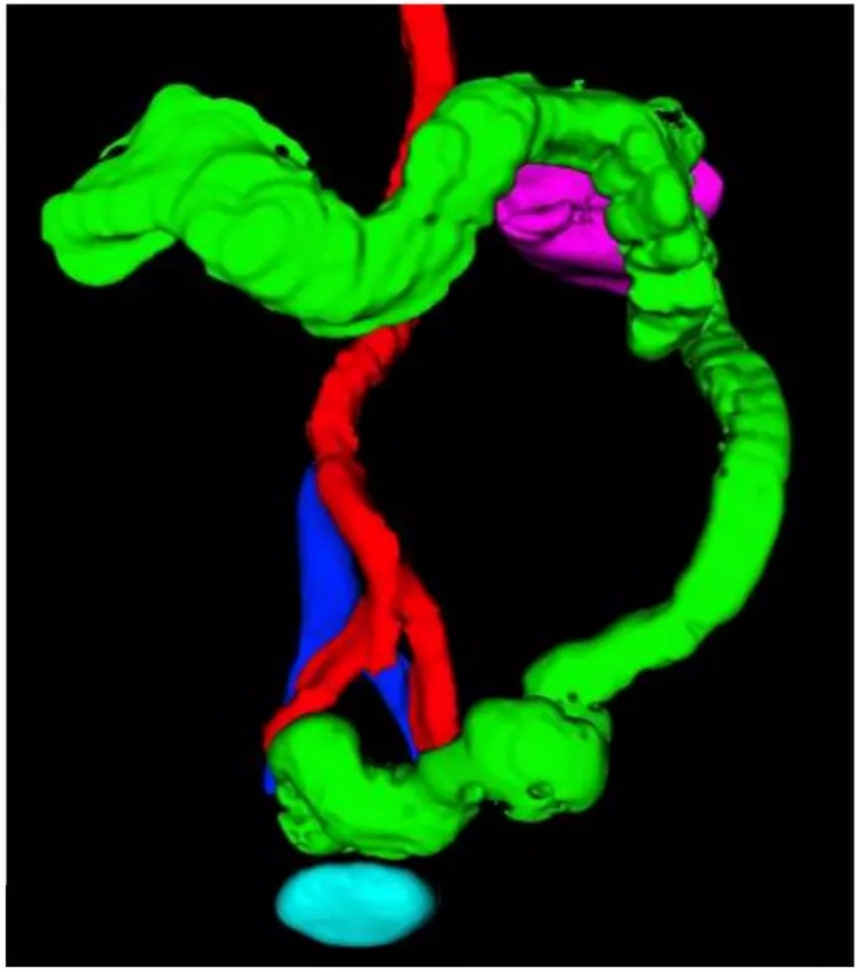
Quantified Recovery (Steps Walked Per Day) - Recovered to Pre-Surgery Level in Two Weeks



Spine, Knee, Abdomen, Aorta, Colon:
They Are All Part of a Connected Body System







Discussion at breakout session

From Digitally-Enabled Future Patient to Digitally-Enabled Future Doctor

