



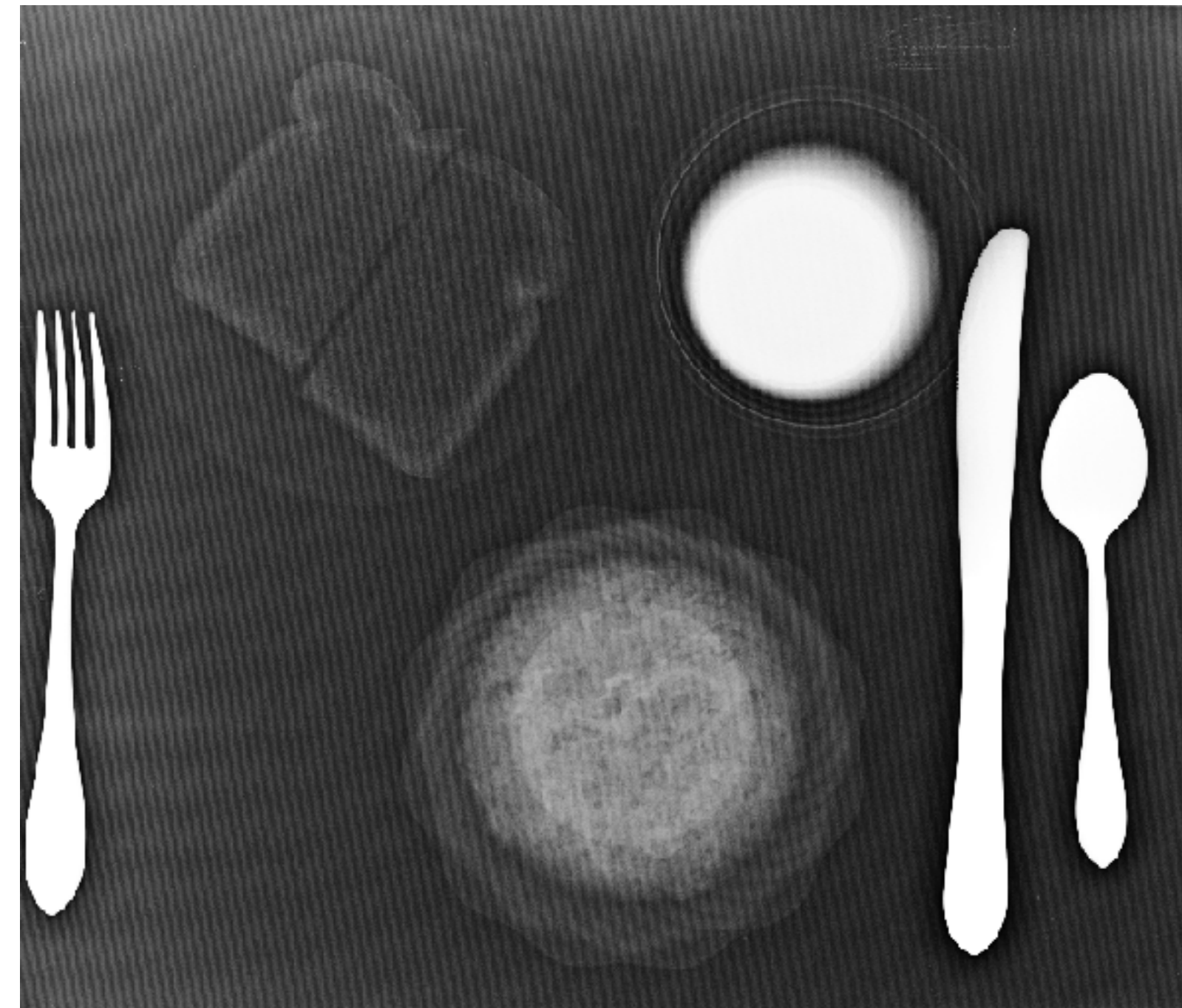
LOW CARB  
RADIOLOGY

*ENHANCING  
YOUR IMAGE*

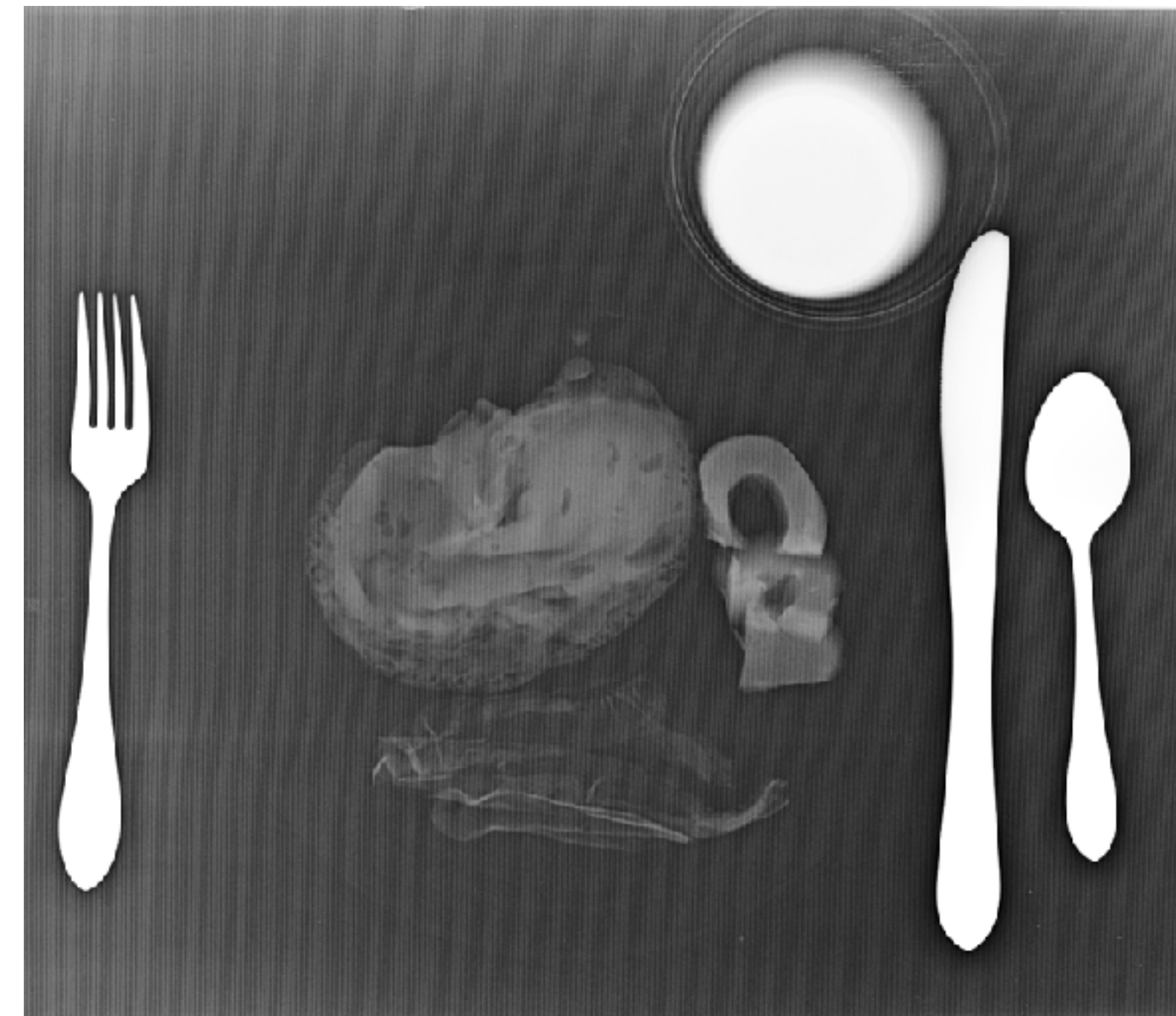
MARK W. BERGER, MD



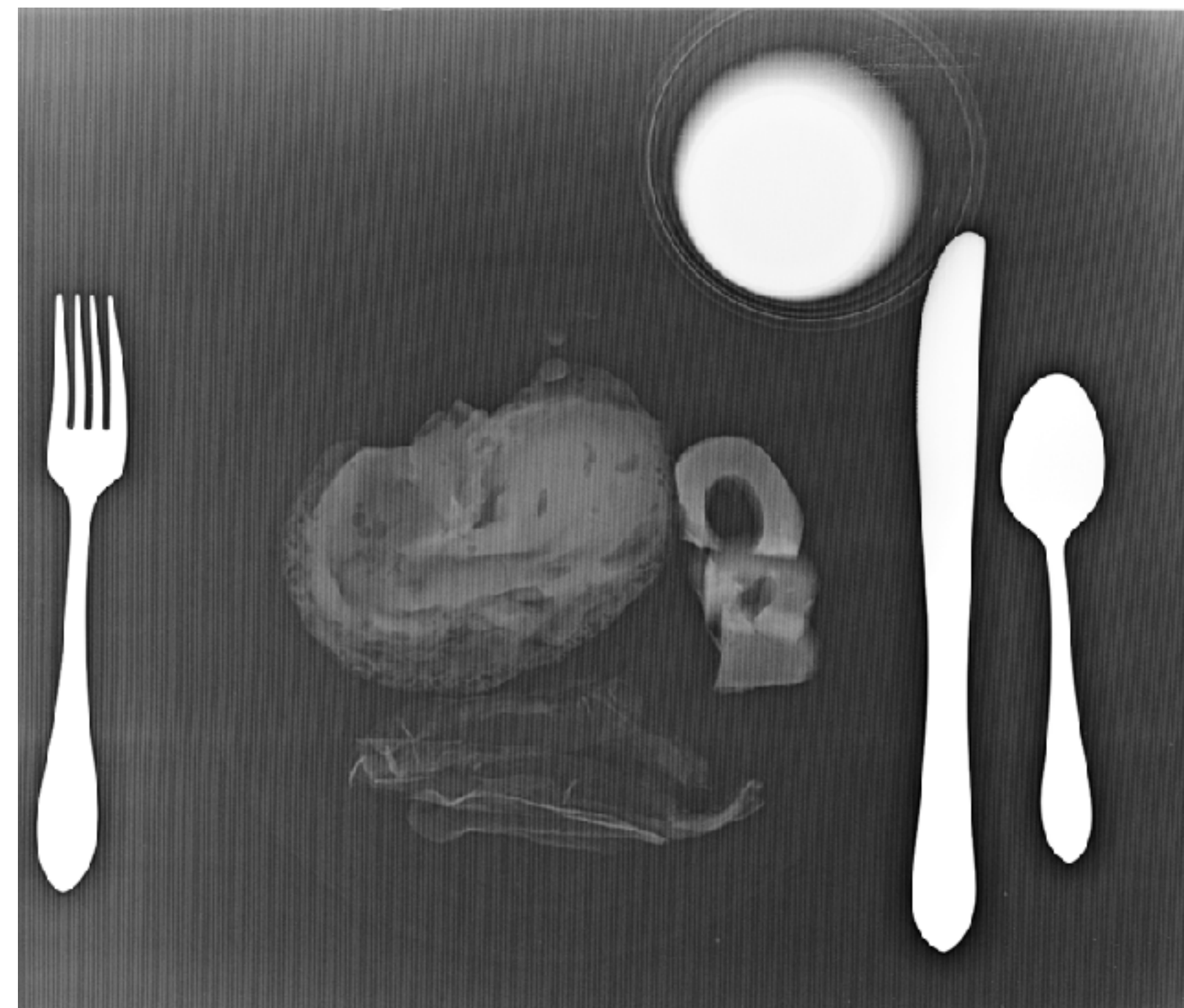
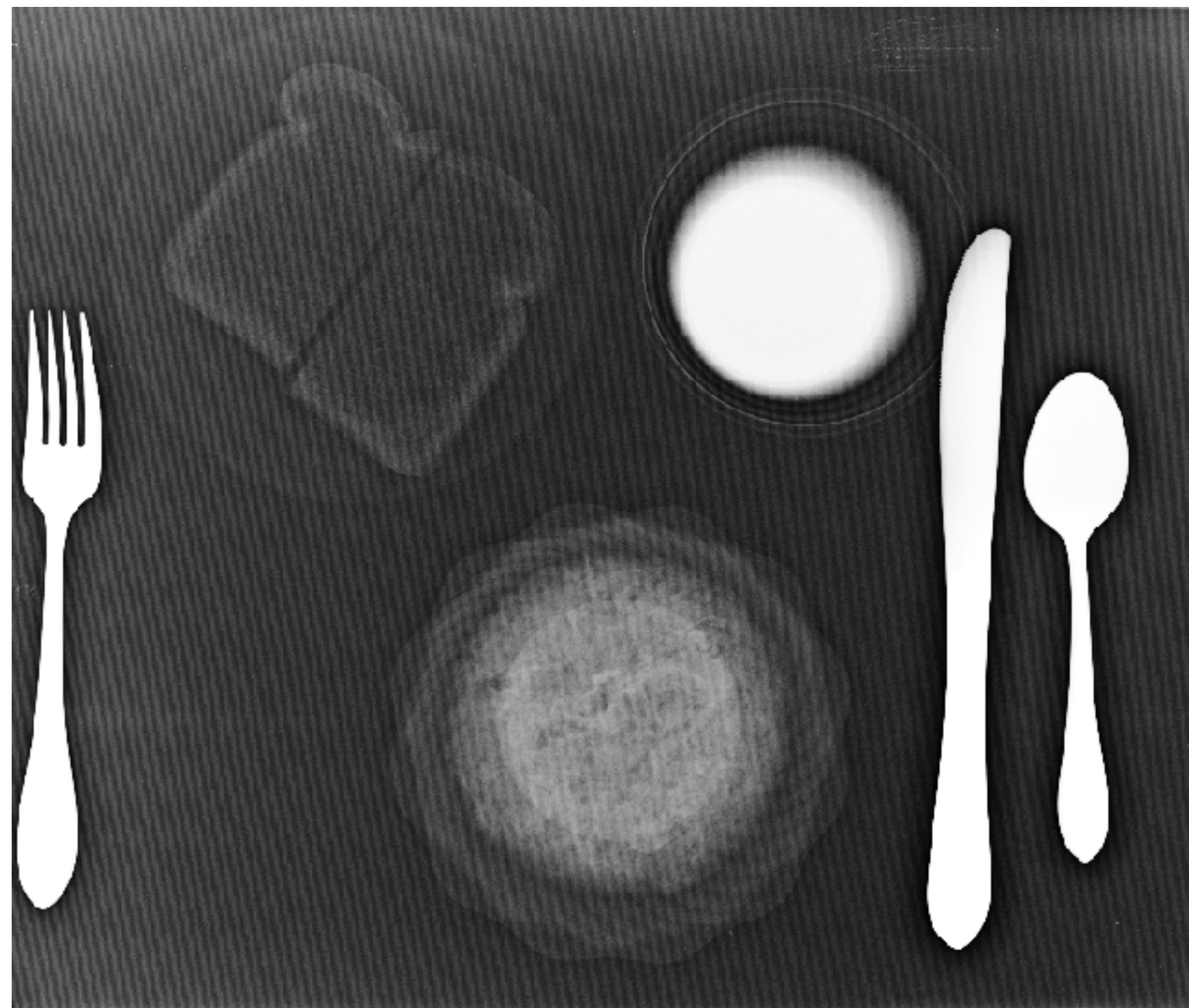
# HIGH CARB BREAKFAST



# LOW CARB BREAKFAST



# HIGH CARB VS. LOW CARB



## A LOW CARB GOD

Genesis 4:1-5

“Now Abel kept flocks, and Cain worked the soil. In the course of time Cain brought some of the fruits of the soil as an offering to the Lord. But Abel brought **fat** portions from some of the firstborn of his flock. The Lord looked with favor on Abel and his offering, but on Cain and his offering he did not look with favor.”

# Obesity TRENDS\* AmOng U.S. ADULTS

BRFSS, 1990, 2000, 2010

(\*BMI  $\geq 30$ , or about 30 lbs. overweight for 5'4" person)

No Data



<10%



10%–14%



15%–19%



20%–24%



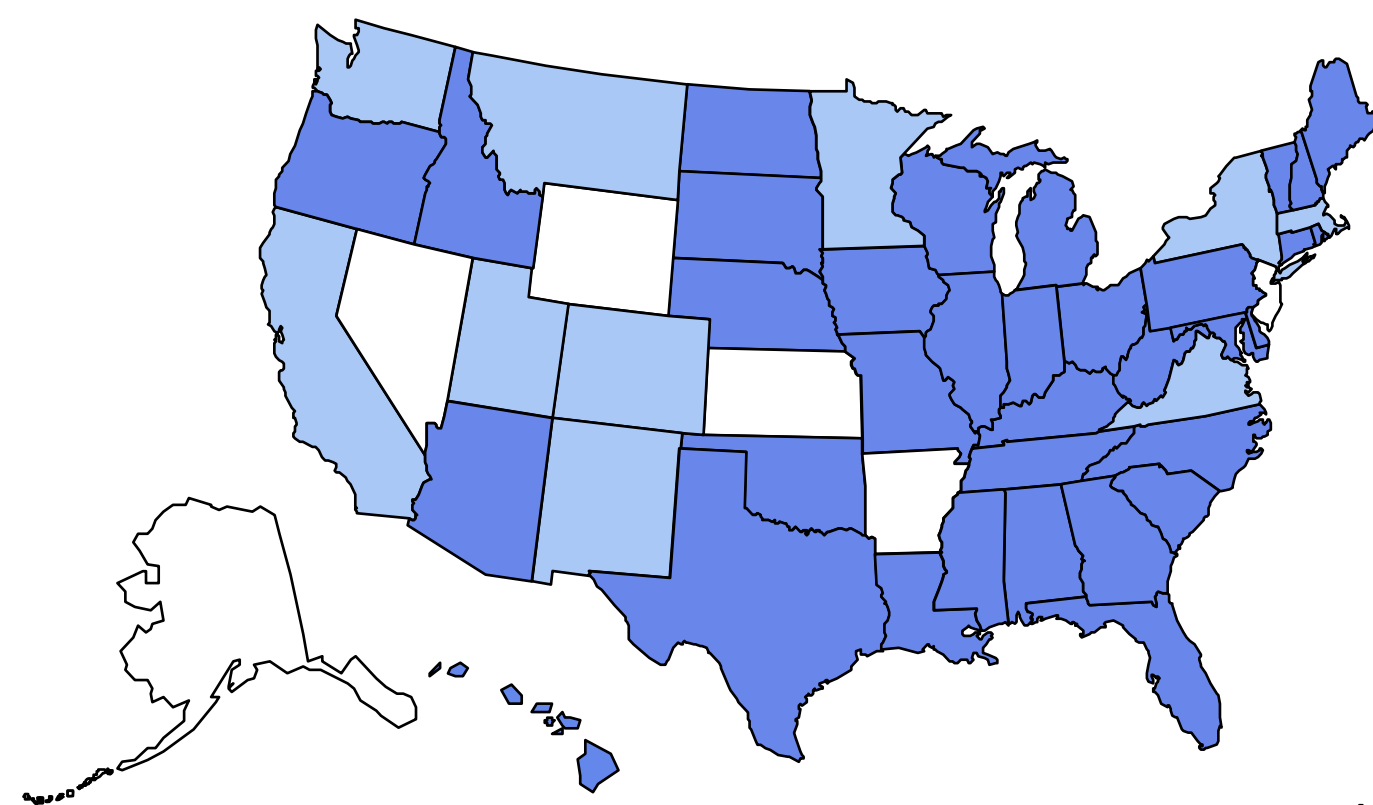
25%–29%



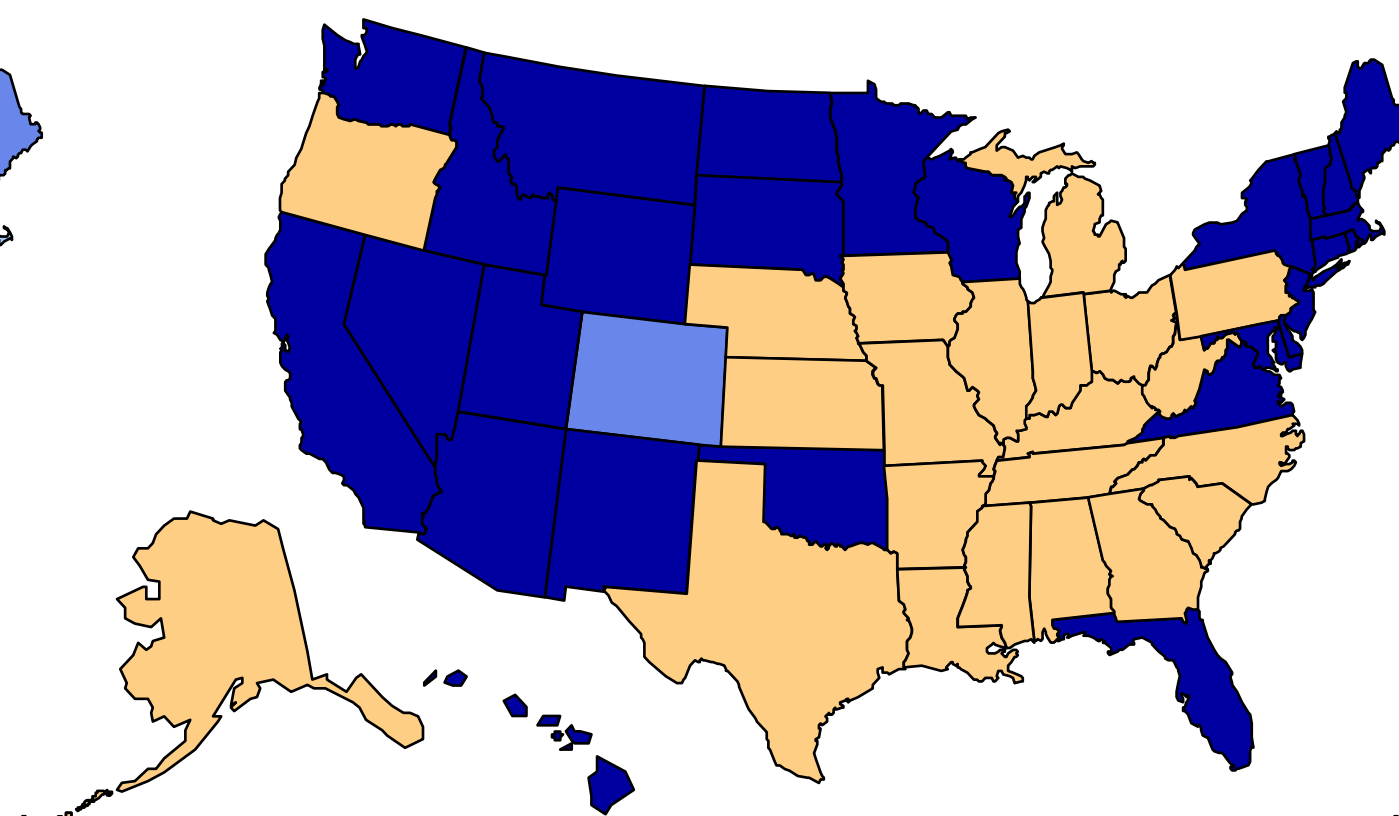
$\geq 30\%$



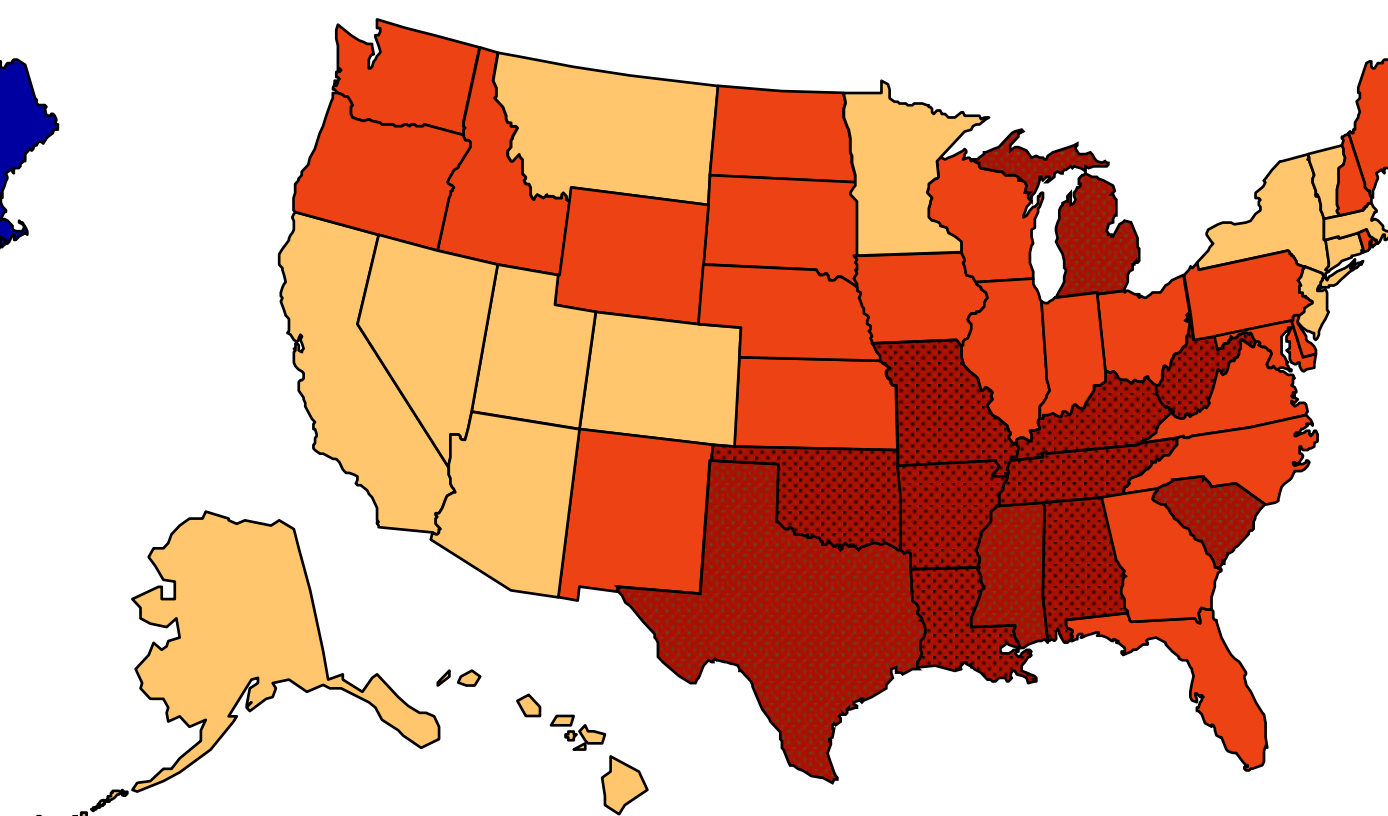
1990



2000



2010



# OBESITY IN AMERICA

- Body Mass Index is a measurement of weight related to height; mass (kg)/height (cm) squared.
- BMI >25 overweight; >30 obese
- By these criteria, 2/3 US adults overweight, 1/3 obese
- 16% of children and adolescents are obese
- Inaccurate number when looking at individuals; doesn't take into account body composition or fat distribution

According to this BMI chart... I am too short.



somee cards  
user card



## FAT DISTRIBUTION

- Subcutaneous fat: Beneath the skin, venous drainage via systemic circulation, low associated CVD risk
- Visceral fat: Deep inside the abdominal cavity, surrounds organs. Venous drainage via portal vein that empties directly into liver. Elevated risk of CVD, insulin resistance, metabolic syndrome, type 2 diabetes

# VISCERAL FAT

- In constant state of turnover, fat deposited and removed on continual basis
- Cortisol mobilizes triglycerides from fat storage and relocates them to visceral fat cells
- Visceral fat contains more cortisol receptors compared to subcutaneous fat, and greater amounts of the enzyme 11-beta hydroxysteroid dehydrogenase, which converts inactive cortisone to active cortisol
- Should be considered an endocrine organ; biologically active, produces own hormones: leptin, resistin, adiponectin
- In association with inflammatory cells also produces cytokines IL-1, IL-6, and TNF-alpha that increase cardiovascular disease risk

## Waist CiRCUMFERENCE

- More accurate in assessing visceral fat and abdominal obesity than BMI
- Men > 40 inches; waist/hip of >0.9
- Women > 35 inches; waist/hip of >0.85

# METABOLIC SYNDROME

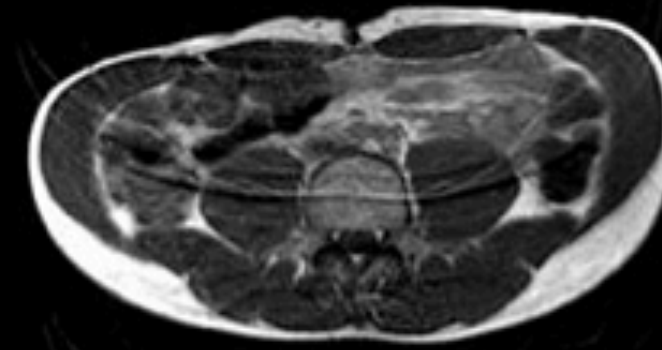
- Waist Circumference: Men > 40 inches; females >35 inches
- Hypertension (BP >130/85)
- Elevated triglycerides > 150 mg/dl
- HDL < 40 (males); <50 (females)
- Elevated fasting blood sugar >100 mg/dl

# NORMAL FAT DISTRIBUTION

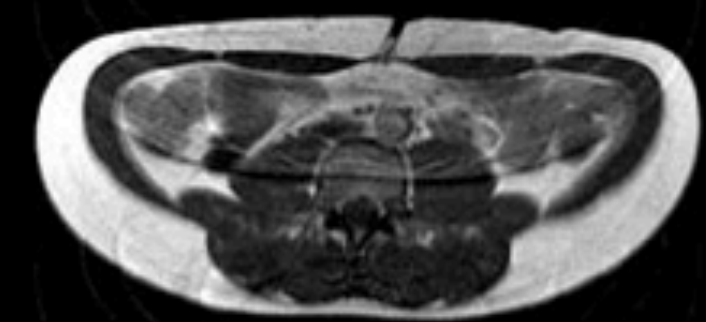


Waist  
CIRCUMFERENCE  
and VISCERAL fat

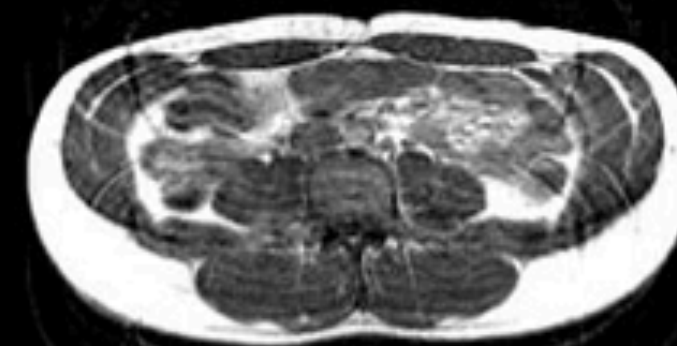
Variation in visceral fat content in men with the same waist circumference.



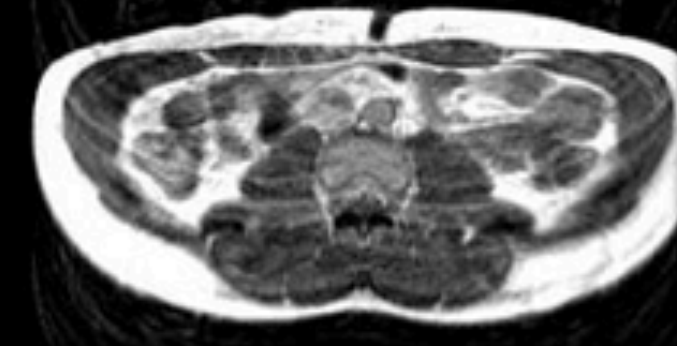
Visceral fat = 0.5 L



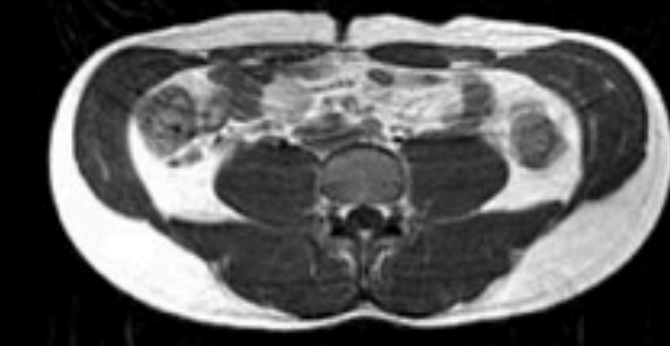
Visceral fat = 1.1 L



Visceral fat = 1.2 L



Visceral fat = 1.3 L



Visceral fat = 1.7 L



Visceral fat = 1.8 L

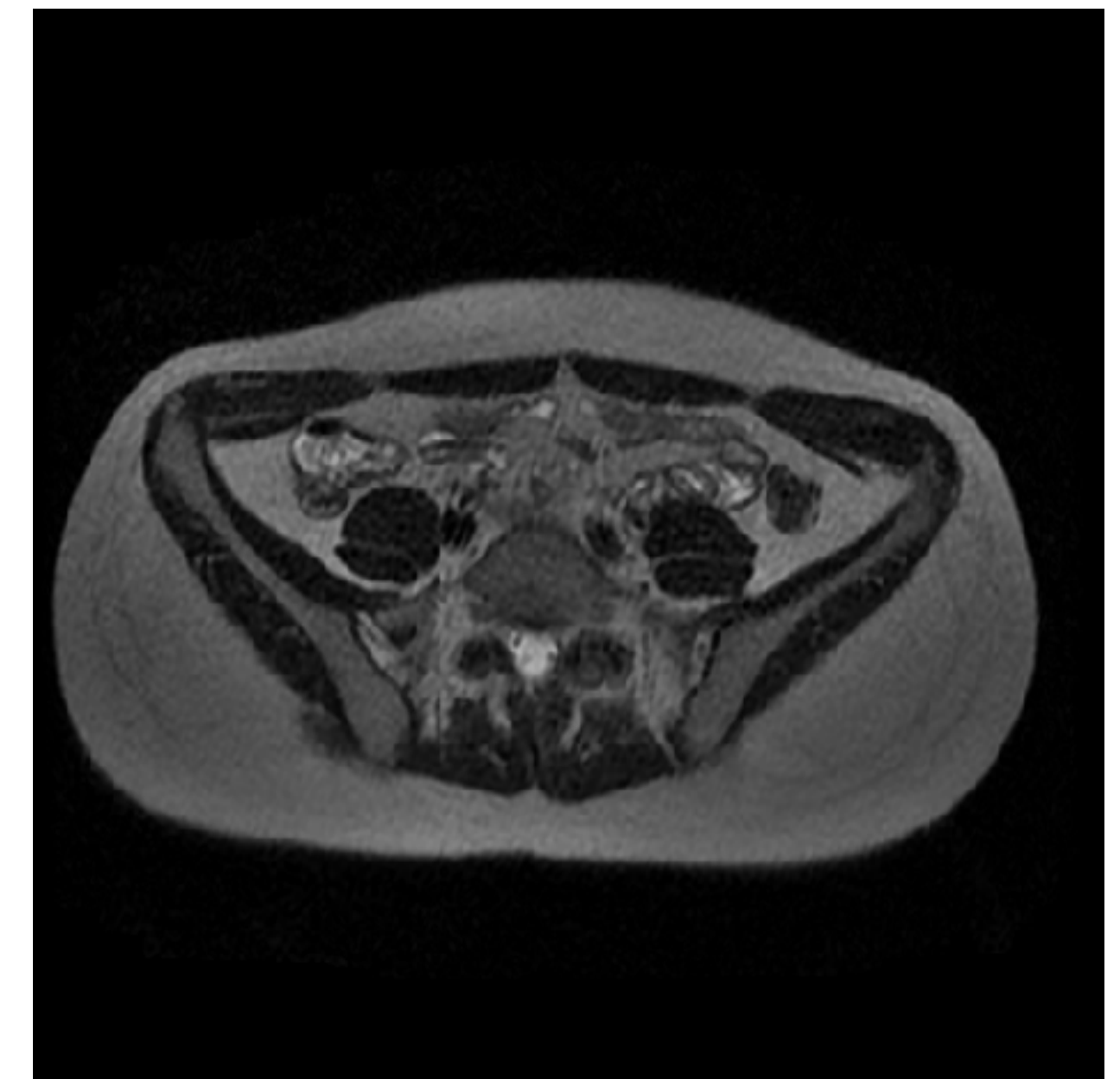
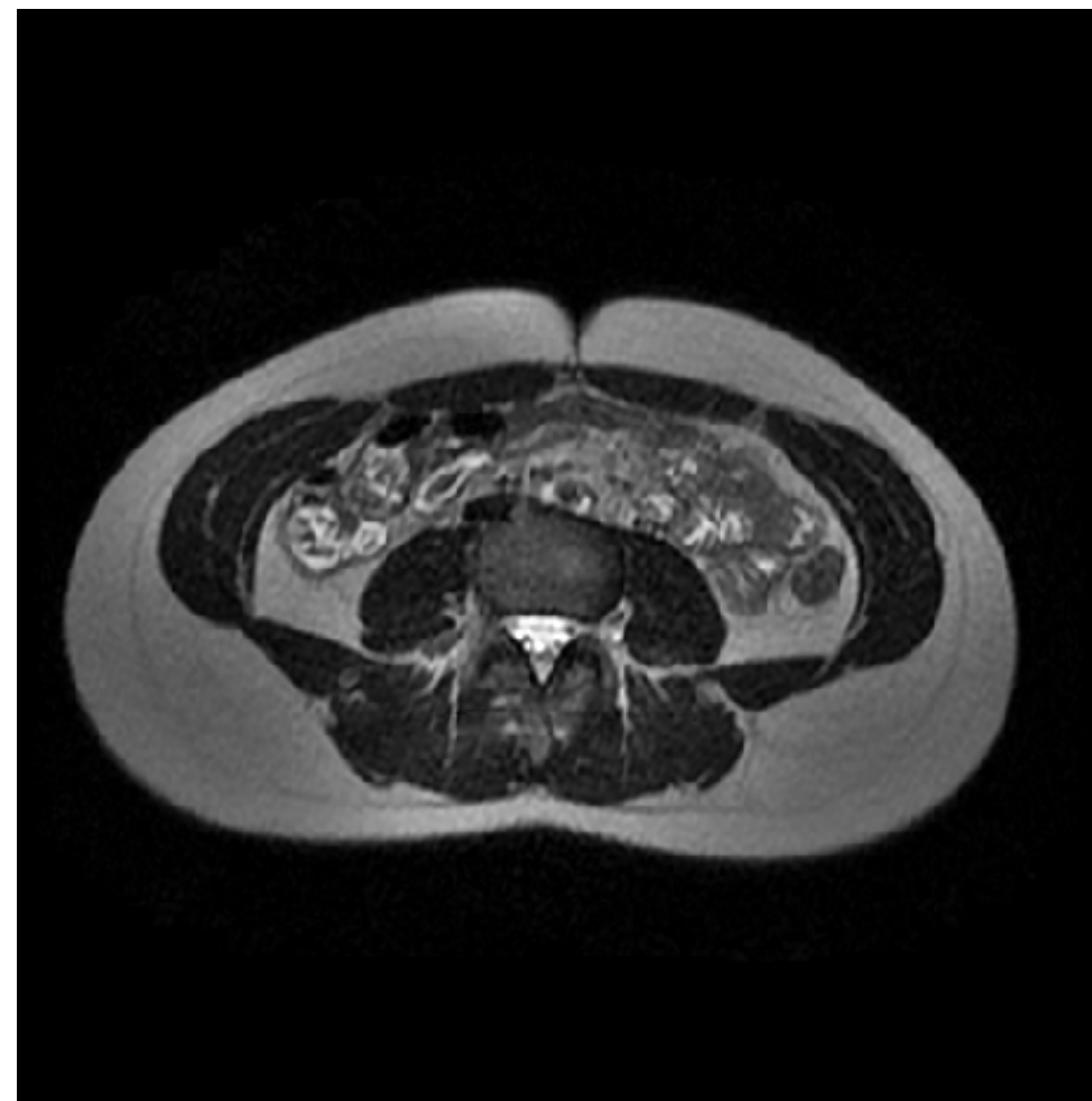
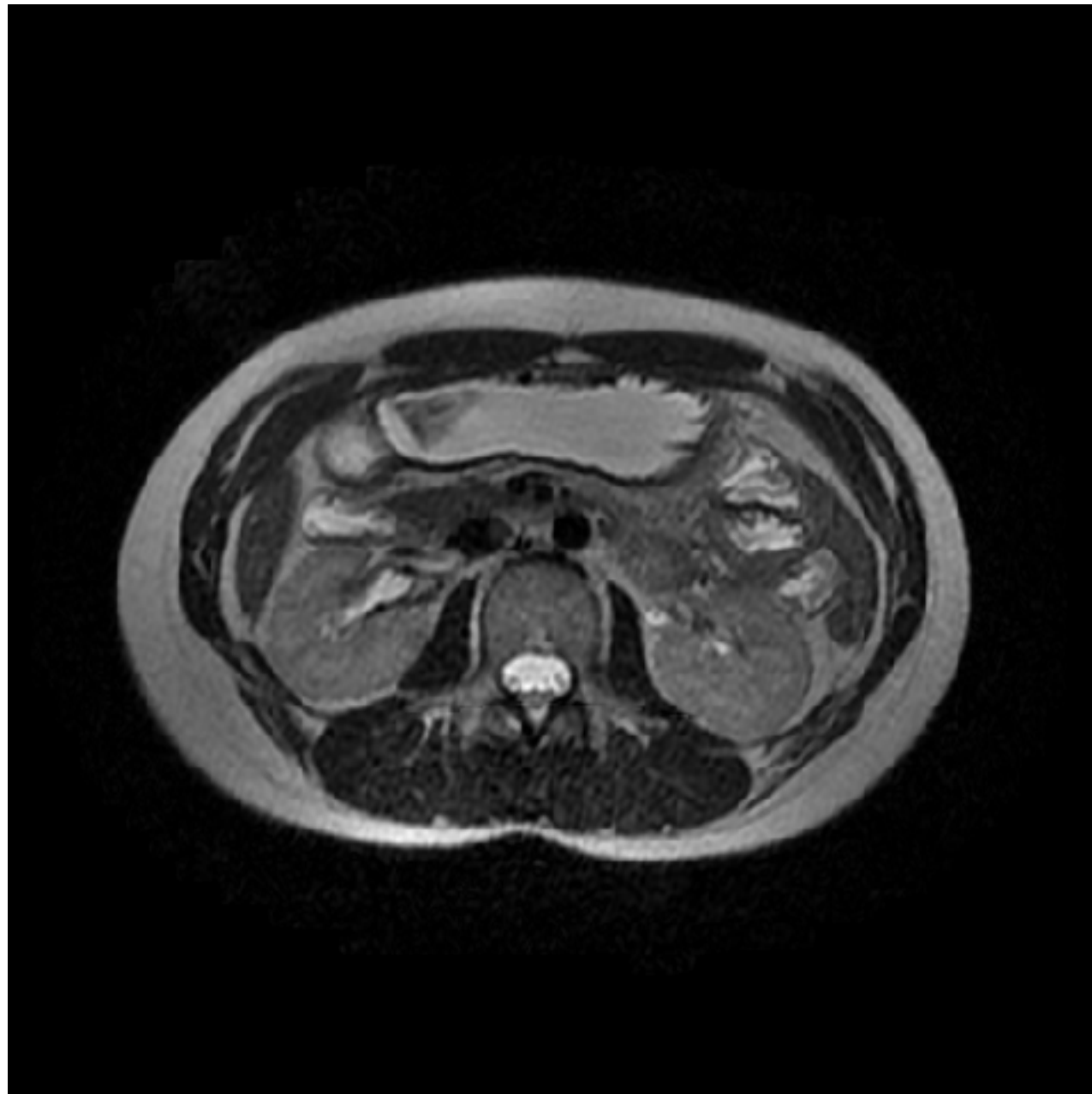


Visceral fat = 4.2 L

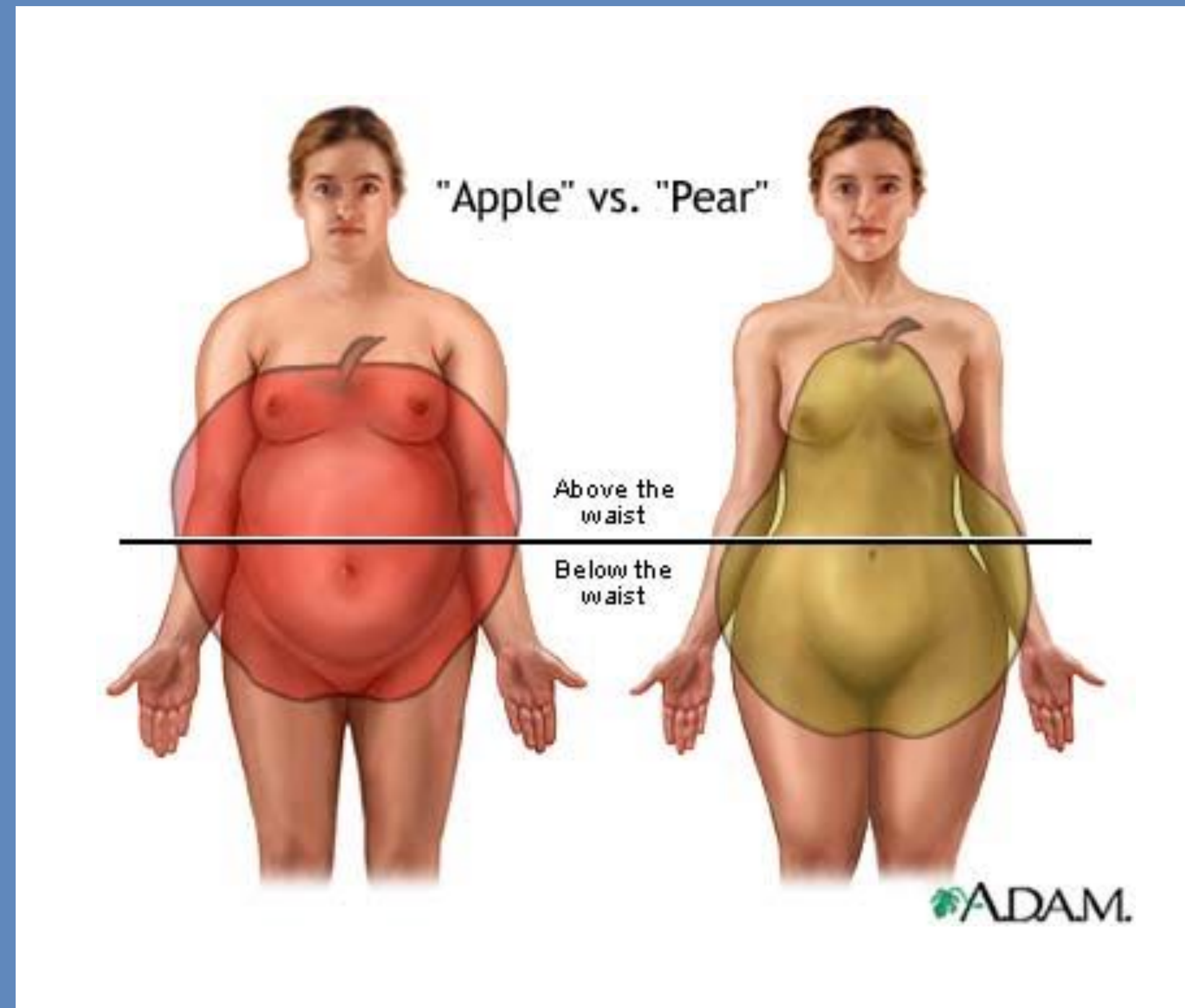


Visceral fat = 4.3 L

# NORMAL FAT DISTRIBUTION



# BODY HABITUS





# APPLE BELLY



# APPLE BELLY



# MRI APPLE BELLY



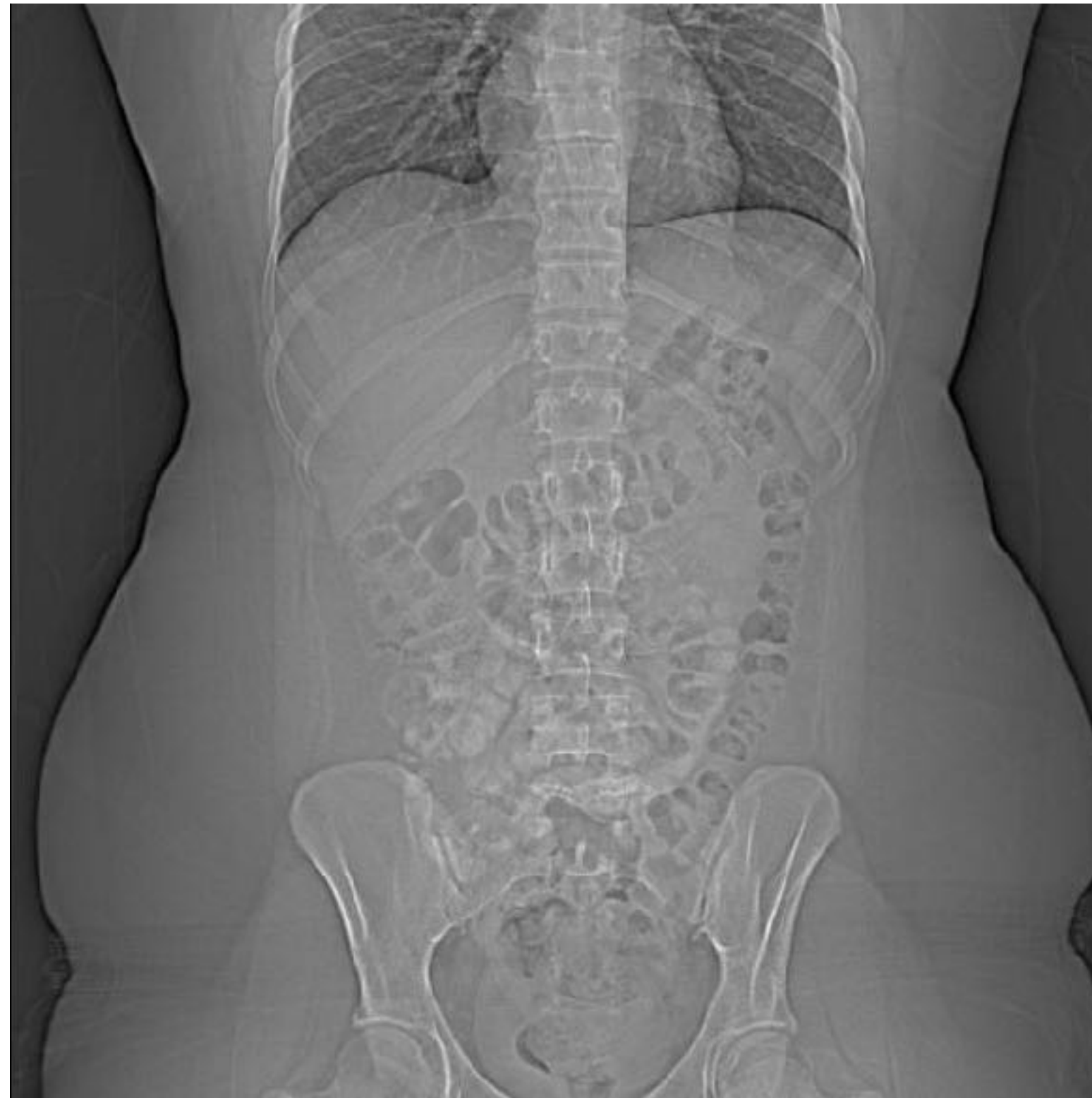
NORMAL

VISCERAL FAT

INCREASED



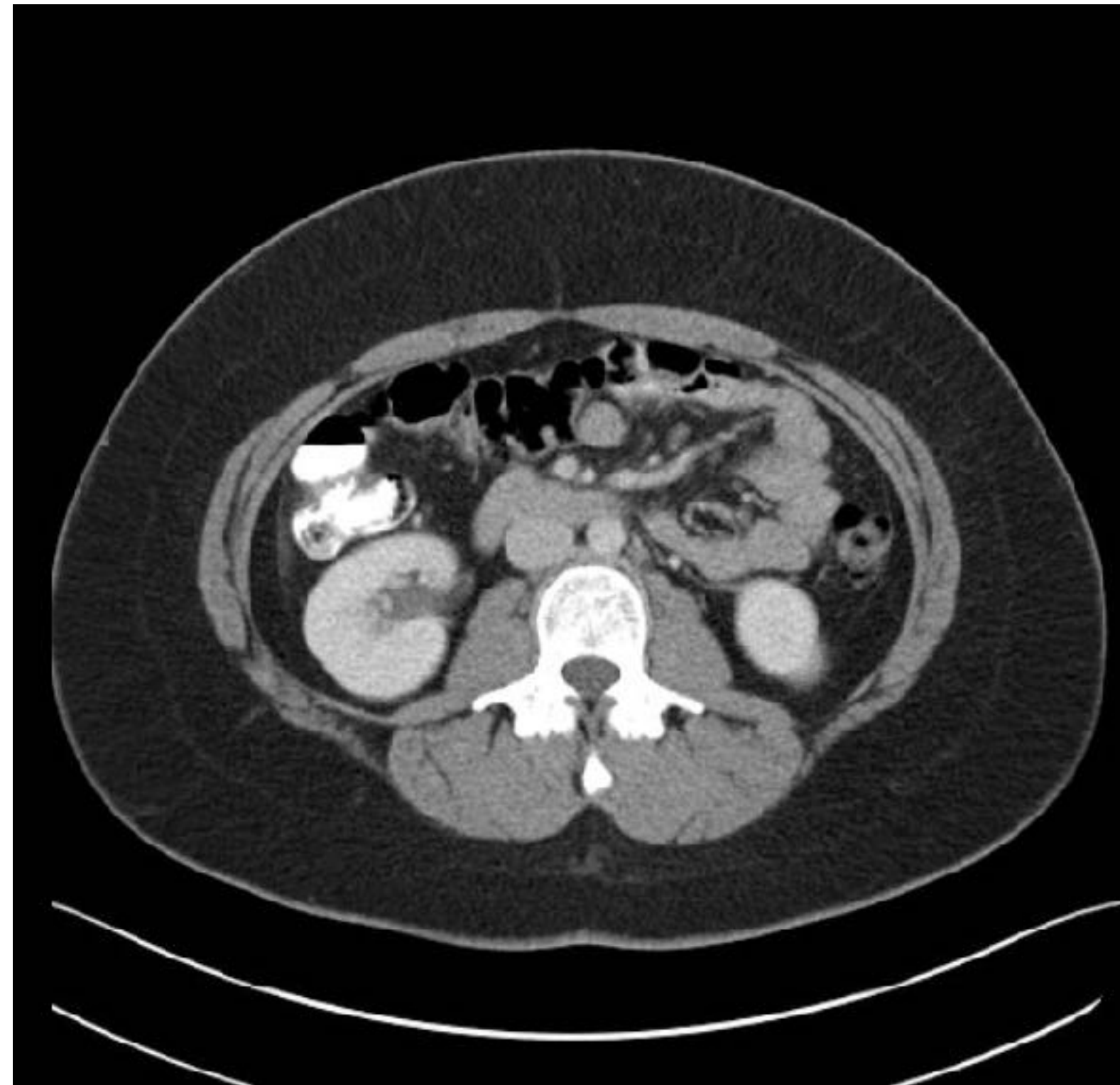
# PEAR BELLY



# PEAR BELLY



# PEAR BELLY



# APPLE & PEAR SALAD

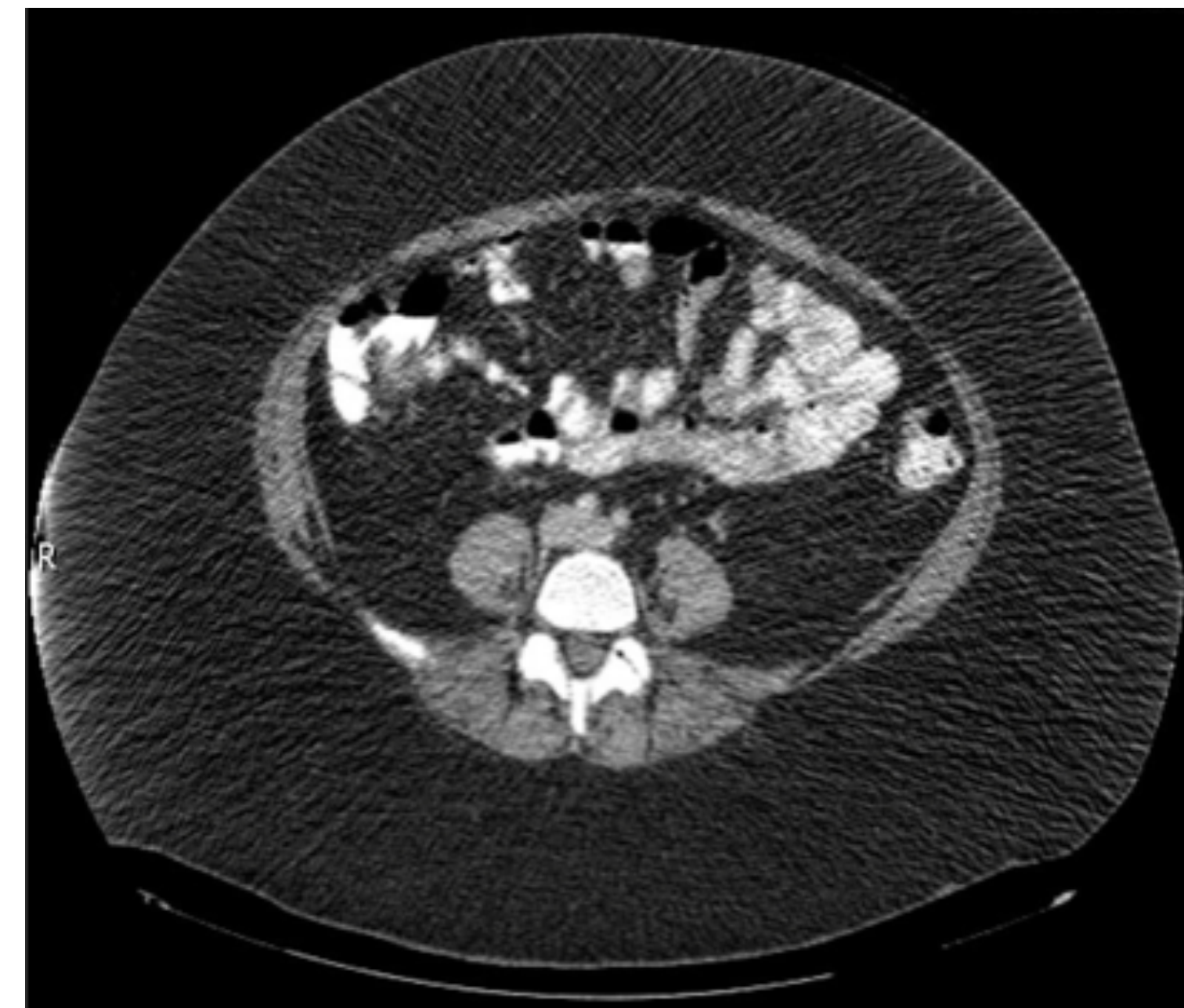




NORMAL BMI < 25



OBESE BMI > 30



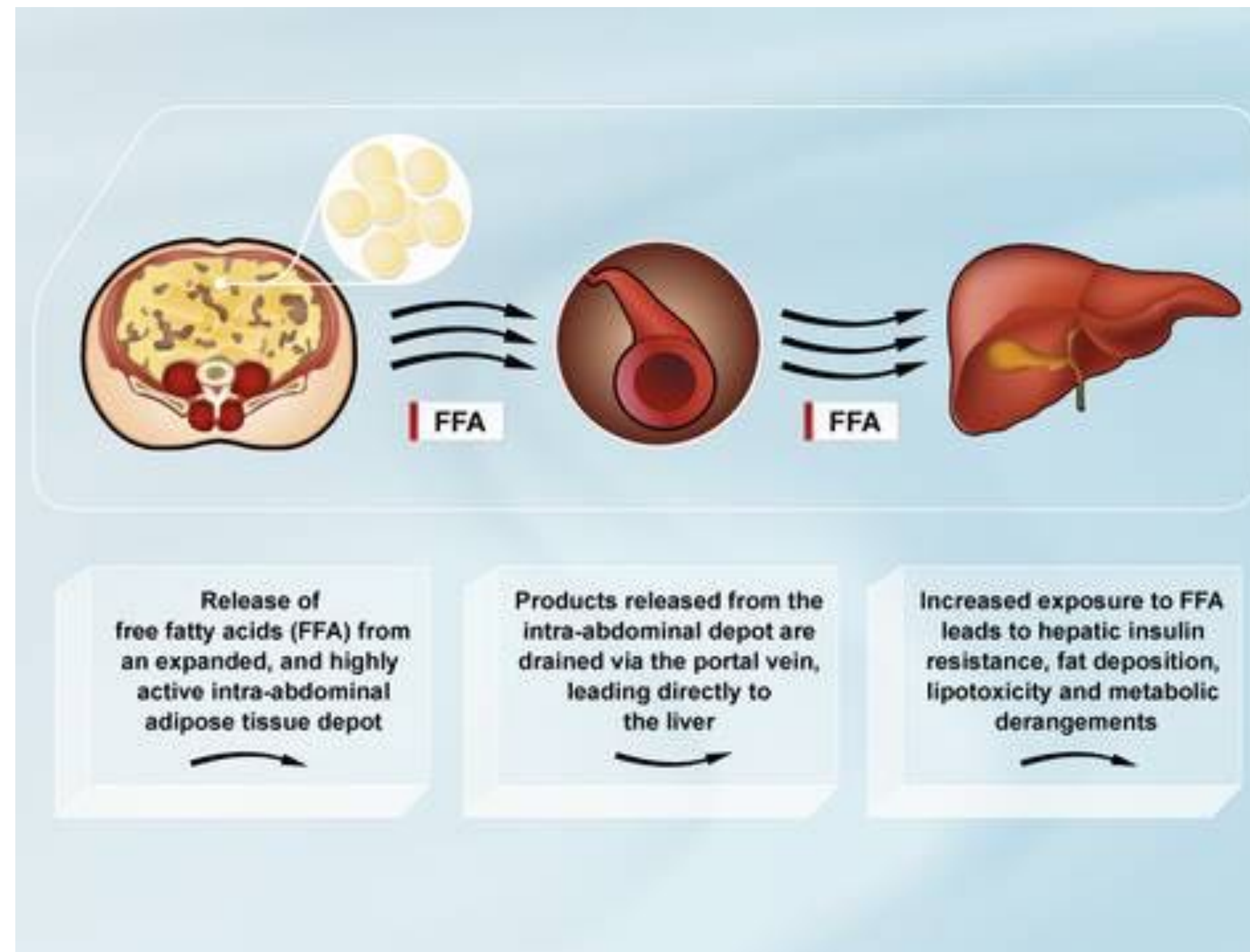
## Adipose tissue subtypes

- "TOFI" - Thin on the outside, fat on the inside; BMI <25 kg/sq m, but increased visceral fat and abnormal metabolic parameters
- "Fat-fit" - BMI >30 kg/sq m, but metabolically normal despite increased body adiposity
- Only way to differentiate is with cross sectional imaging or DEXA

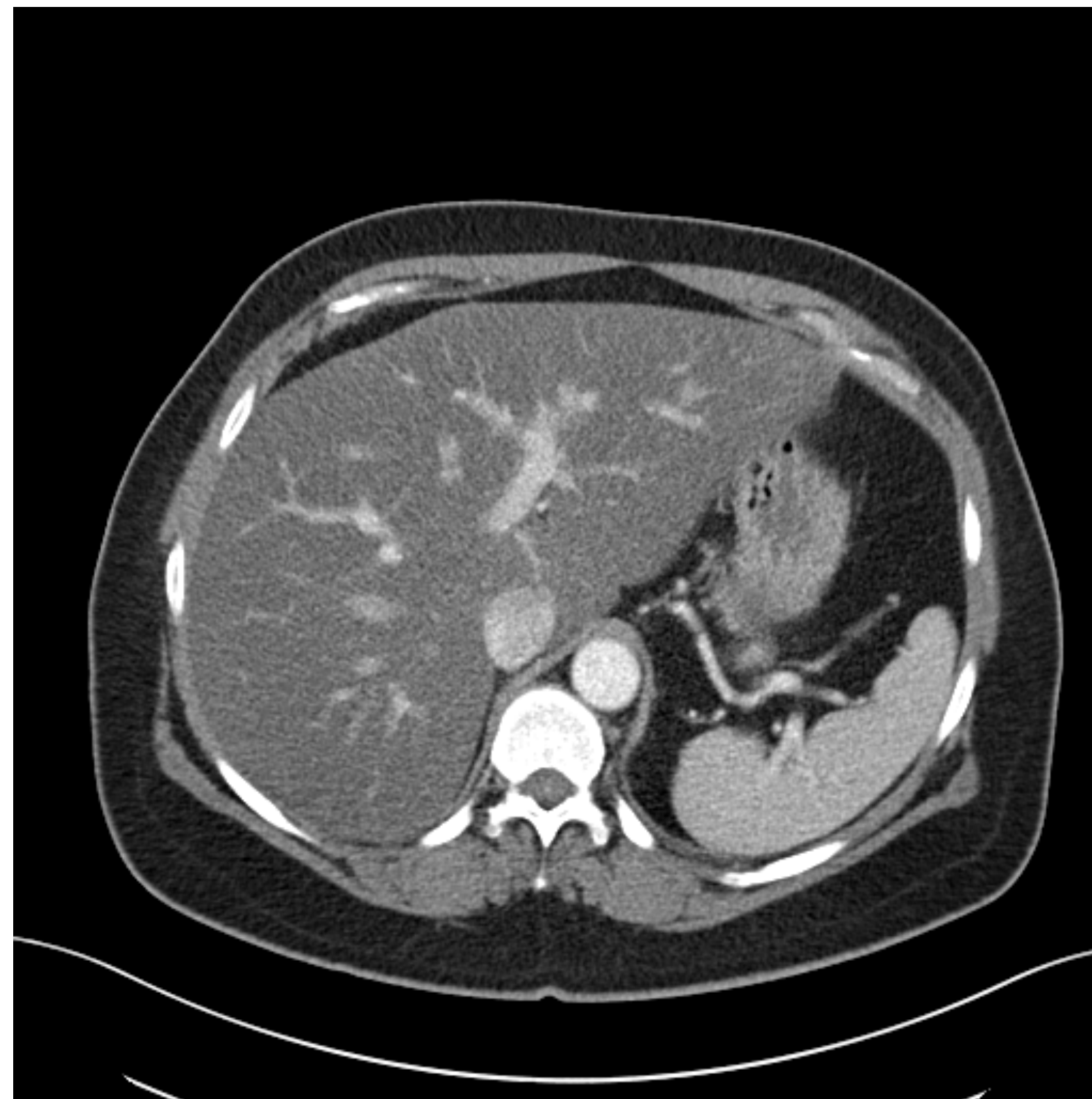
## Fatty liVeR (Hepatic steatOsis)

- Reversible condition where fatty acids in the form of triglycerides accumulate within hepatocytes, either deposited or de novo synthesis
- Associated with alcohol or steroid use, or non-alcoholic causes (NAFLD), including obesity and insulin resistance.
- Cells become inflammed resulting in non-alcoholic steatohepatitis (NASH).
- Can proceed to cirrhosis

# VISCERAL FAT AND PORTAL VENOUS DRAINAGE



# FATTY LIVER



NORMAL

LIVER CT

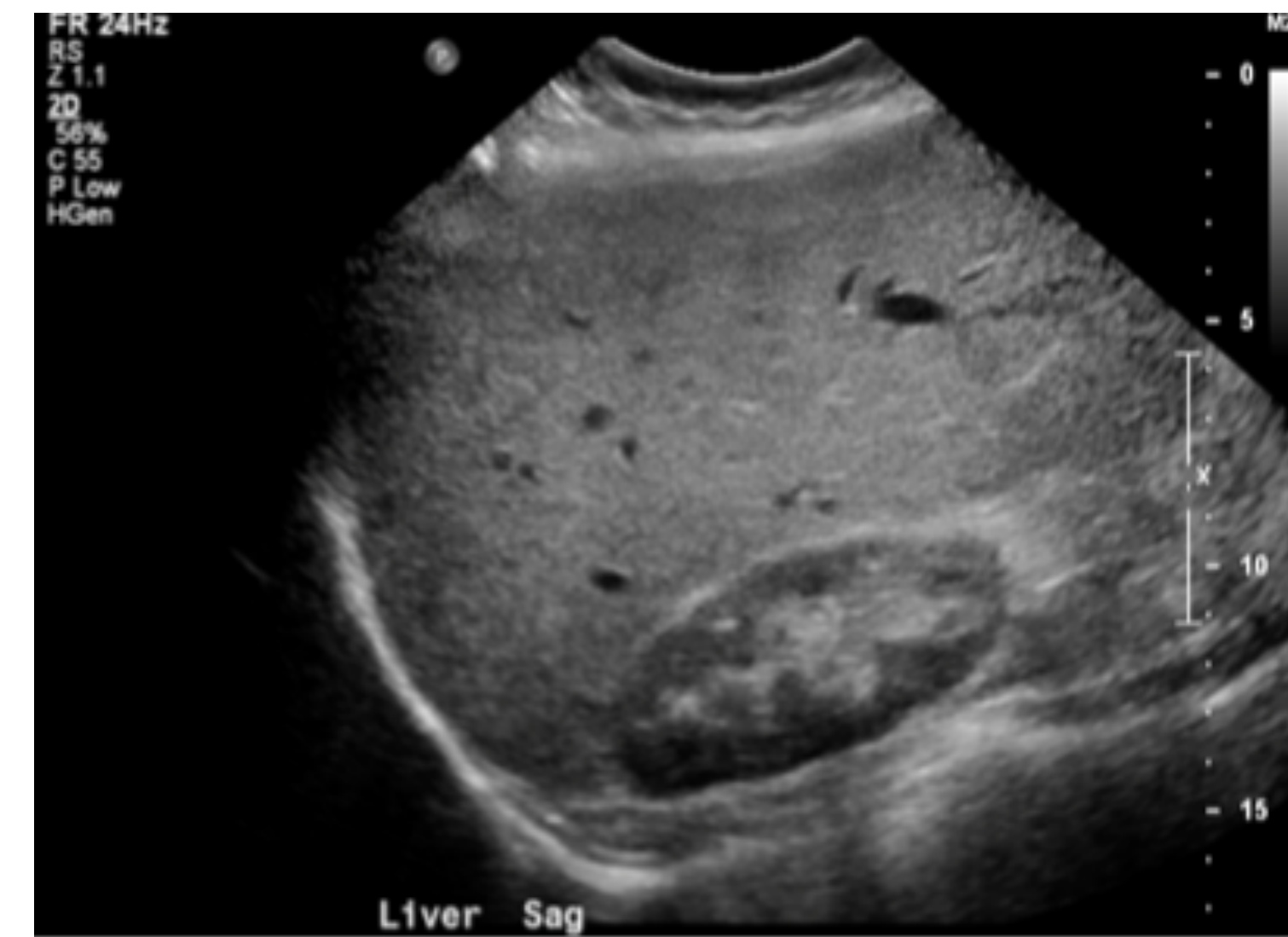
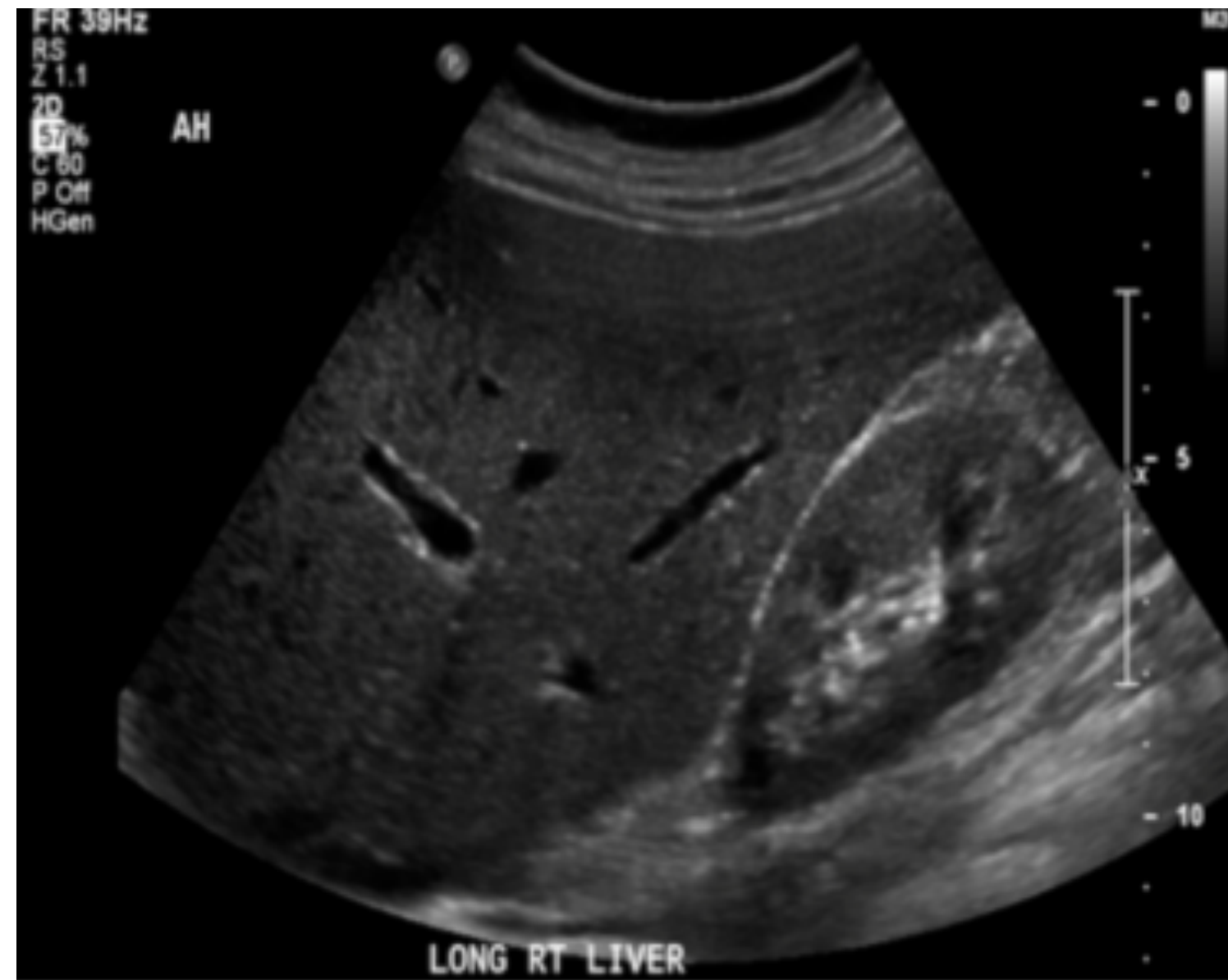
FATTY



NORMAL

LIVER ULTRASOUND

FATTY



## MEDIVAT STUDY

- Evaluated the effects of a Mediterranean diet on visceral fat volume and hepatic steatosis detected by MRI and metabolic parameters
- 30 overweight or obese participants; 17 male, 13 female
- MRI and blood testing at baseline and at 3, 6 and 12 months with review of images with participants
- Nutritional consultation with dietician at baseline and monthly
- Maintained food journal
- Pedometer, with goal of 10,000 steps/day



# MEDIVAT STUDY

- Mediterranean style diet
- Emphasis on vegetables and fruit
- Higher fat; predominantly monounsaturated olive oil, but included saturated fat/occasional red meat and seafood
- Whole grains
- Legumes, nuts and seeds
- Goal of 30% carbohydrate, 30% protein, 40% fat

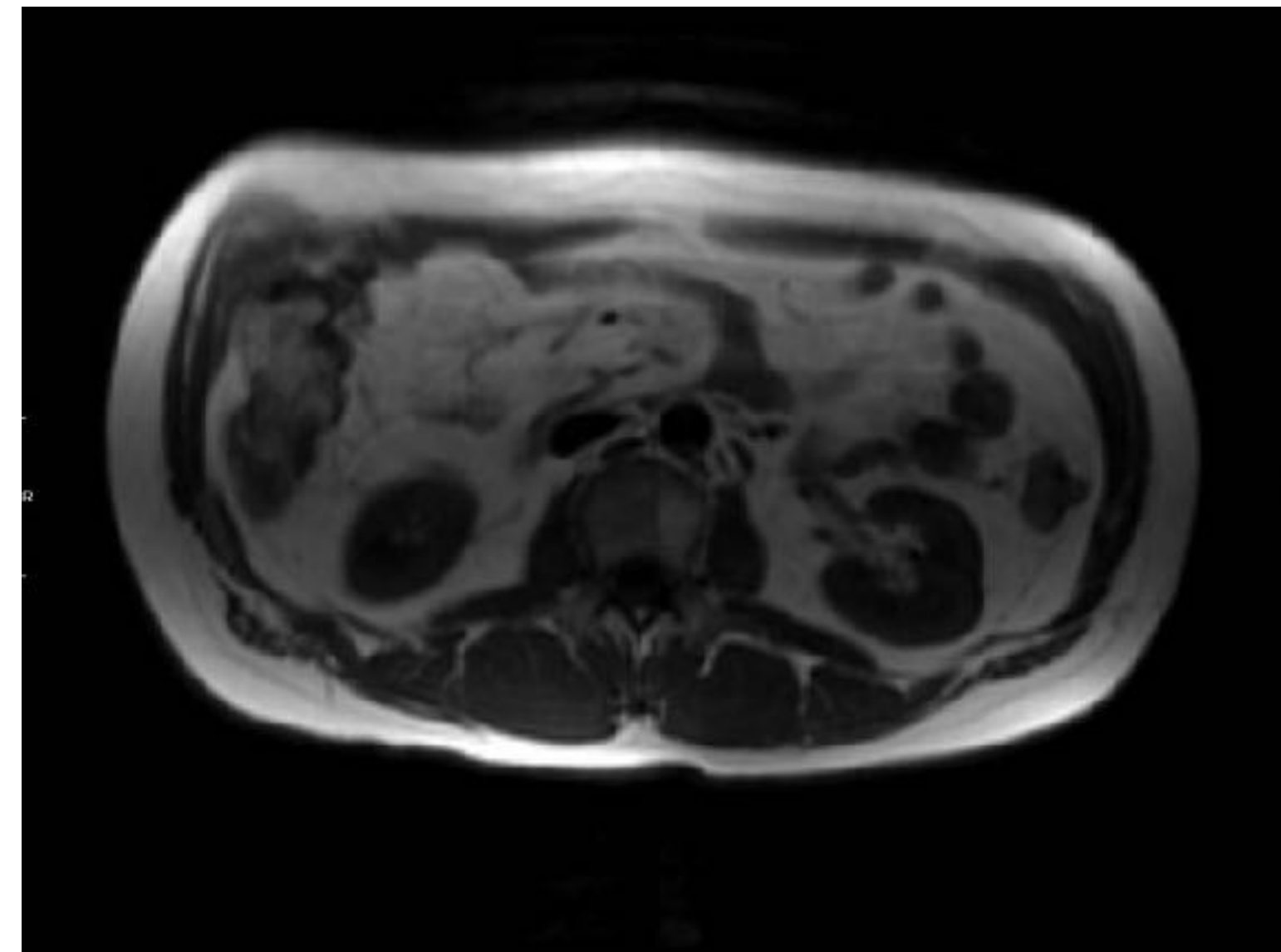
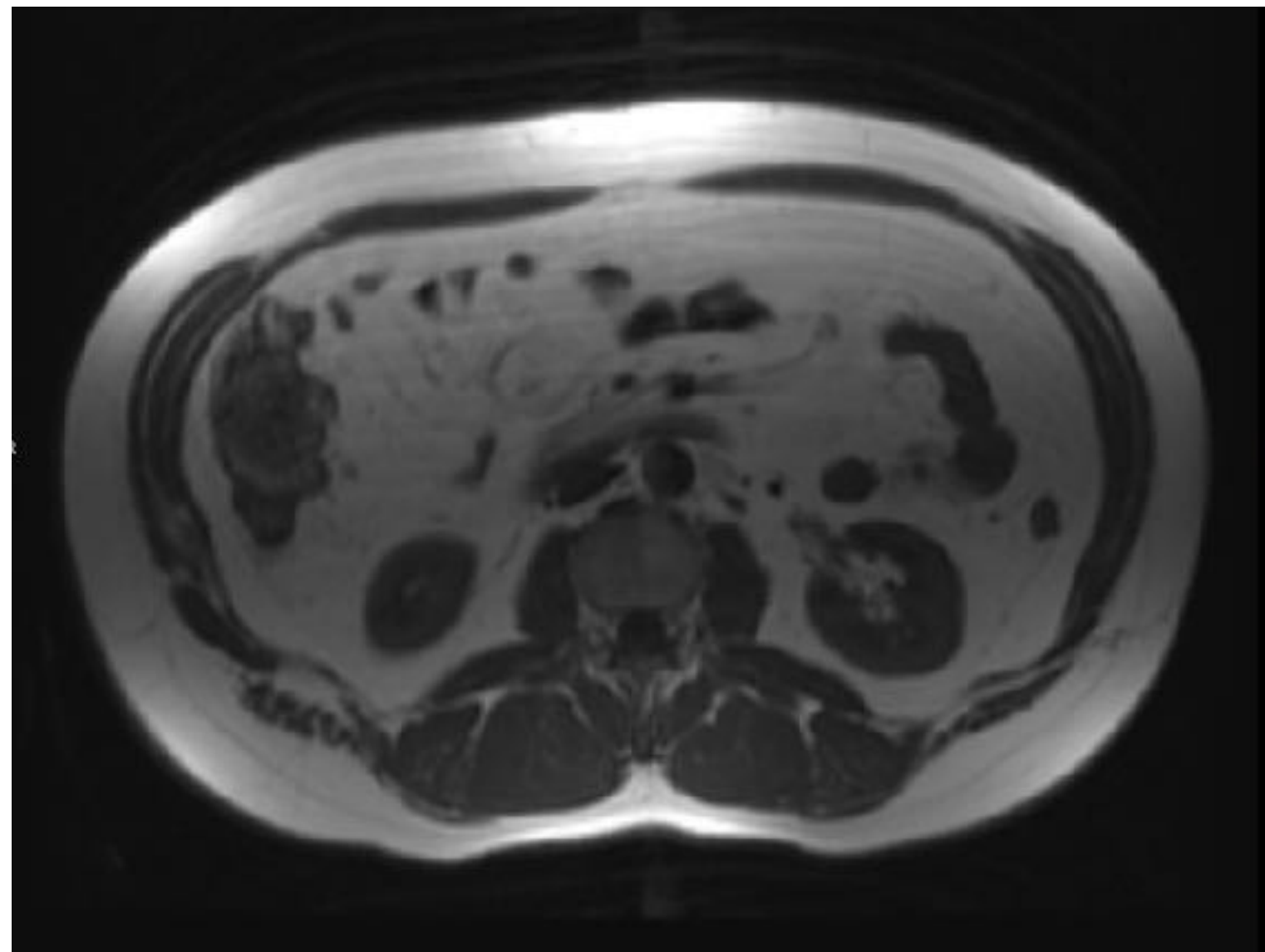
## MEDIVAT STUDY

- 9 of 30 participants completed 1 year study period
- 5 of 9 experienced significant visceral fat reduction (>5%). Of these, 4 of 5 improved hepatic steatosis
- 3 experienced no change in visceral fat, but improved metabolic markers
- 1 increased visceral fat by 4%

8 /20 /14

SHANNON DURING  
AND AFTER MOUNTAIN DEW.

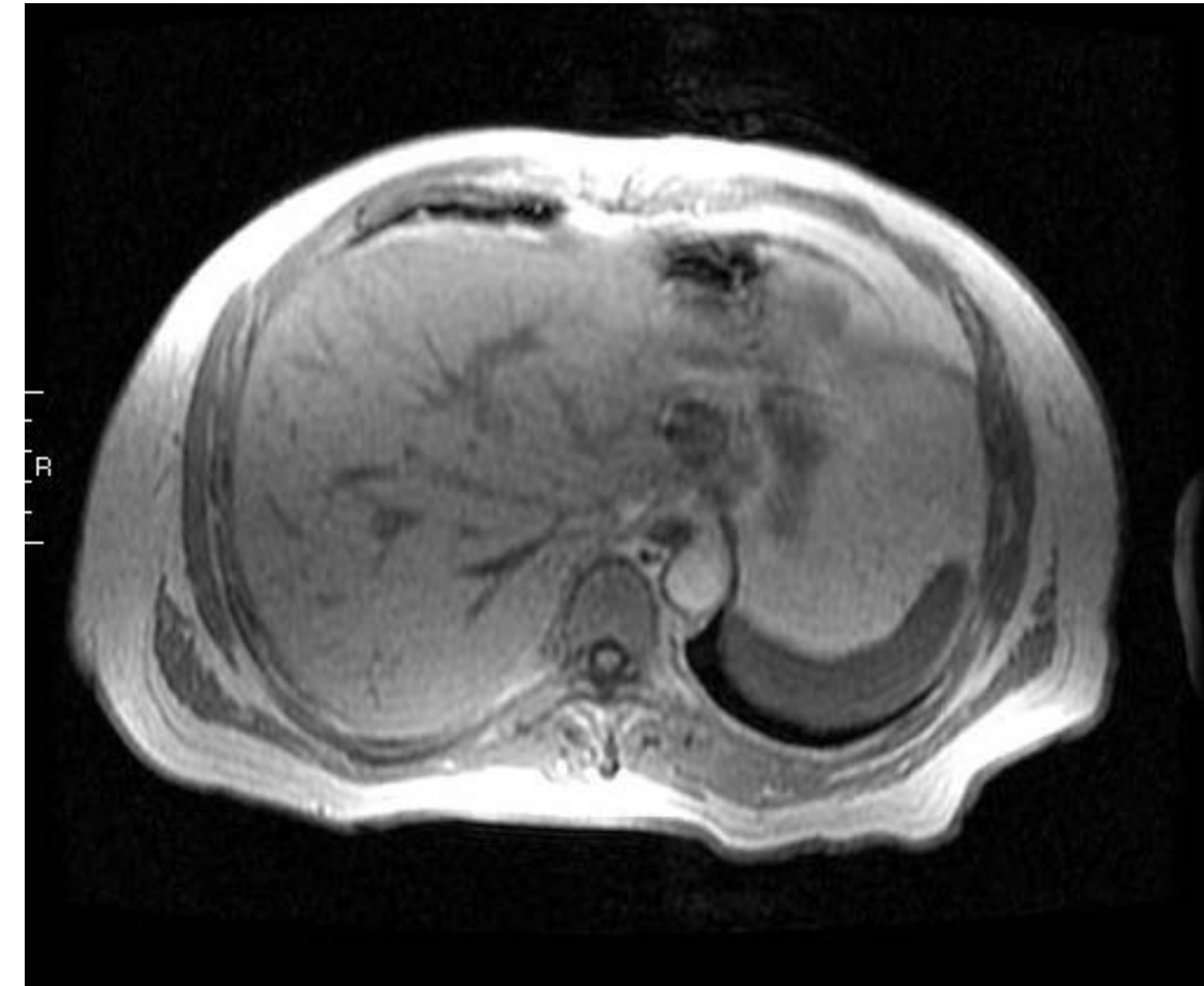
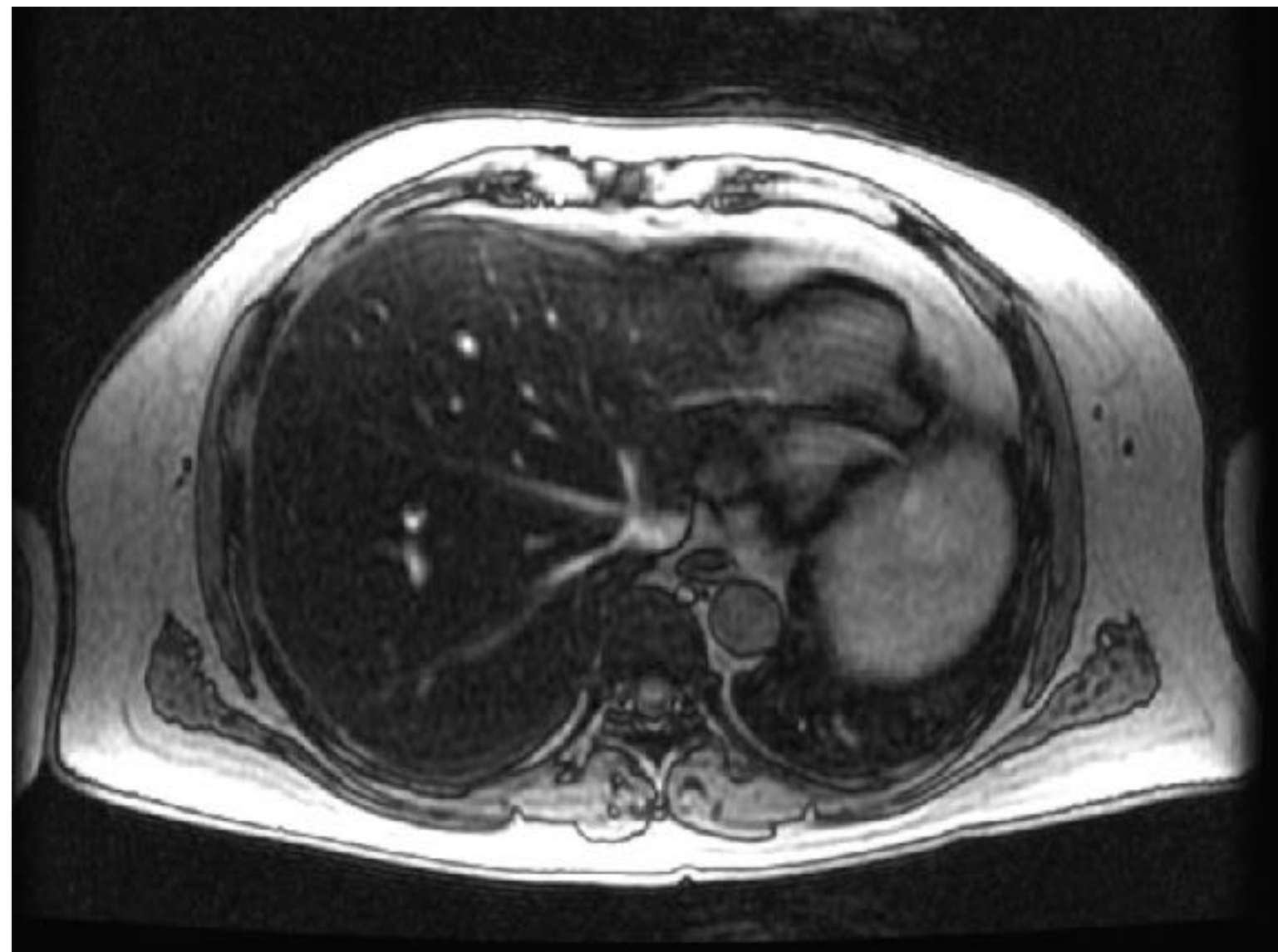
10 /29 /14



8 /20 /14

SHANNON DURING  
AND AFTER MOUNTAIN DEW

10 /29 /14



## EXPECTED METABOLIC PROFILE ON HIGHER FAT DIET

- Increased HDL
- LDL variable; may increase, but type A non-atherogenic particles
- Lower triglycerides
- Lower fasting blood sugar
- Lower HbA1C
- Lower inflammatory markers (CRP, homocysteine, fibrinogen)

# SHANNON'S LABS

	8/20/14	10/29/14	08/29/15
Cholesterol	199	147	199
LDL	132	76	117
HDL	44	45	57
Triglycerides	113	105	107
CRP	2.3	1.3	1.3
Homocysteine	12.3	12.0	10.3
AST	33	17	17
ALT	65	23	14
Fasting glucose	88	78	84
HbA1C	5.8	5.1	5.3

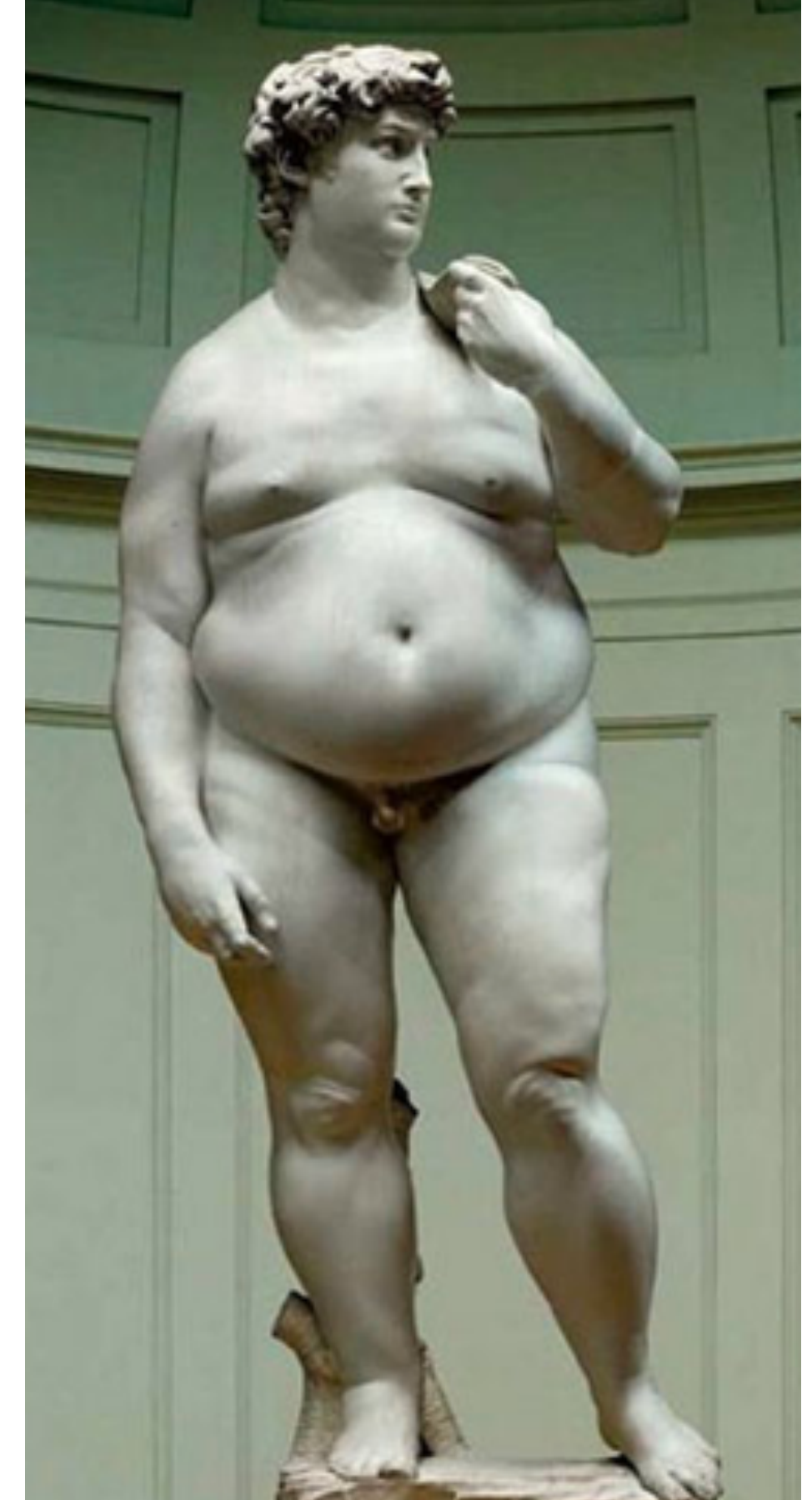
## WHAT HAVE WE LEARNED?

“It may be stated categorically that the storage of fat and therefore the production and maintenance of obesity cannot take place unless glucose is being metabolized. Since glucose cannot be used by most tissues without the presence of insulin, it also may be stated categorically that obesity is impossible in the absence of adequate concentrations of insulin.”

-“A New Concept in the Treatment of Obesity,”  
Edgar Gordon, JAMA, 1963



DAVID GOES  
HIGH CARB





# KETONE CONSERVATION



# BODY COMPOSITION ANALYSIS

- Skin fold caliper
- Bioelectrical impedance
- Water displacement/Hydrostatic weighing
- DEXA imaging
- CT
- MRI

# SKIN FOLD CALIPER

- Long track record
- Generally an accurate measure of subcutaneous body fat
- Taken at strategic locations: biceps, triceps, mid and lower back, waist, and calf. Results used to calculate total percent body fat
- User dependent



# BIOELECTRICAL IMPEDANCE

- Based on principle that lean tissue is more electrically conductive than fat
- Mild painless electrical current passed through body, usually from wrist to foot
- Can be performed with individual fully clothed
- Accurate, minimal skill required by examiner
- Favored form of analysis in health clubs, but more expensive than skin caliper measurements



# HYDROSTATIC WEIGHING

- Based on principle that fat is less dense than water
- Compares individuals weight on dry land to their underwater weight, and uses results to calculate the proportion of fat to lean tissue
- Due to equipment requirements and operator expertise, not readily available.



# CT AND MRI

- Gold standards for assessing visceral fat
- Can directly measure and quantify both subcutaneous and visceral compartments
- Software programs can automatically measure visceral fat, but expensive and typically limited to academic setting. Manual measurements accurate, but time consuming and operator dependent
- Much more expensive than other modalities
- CT utilizes radiation; no radiation with MRI

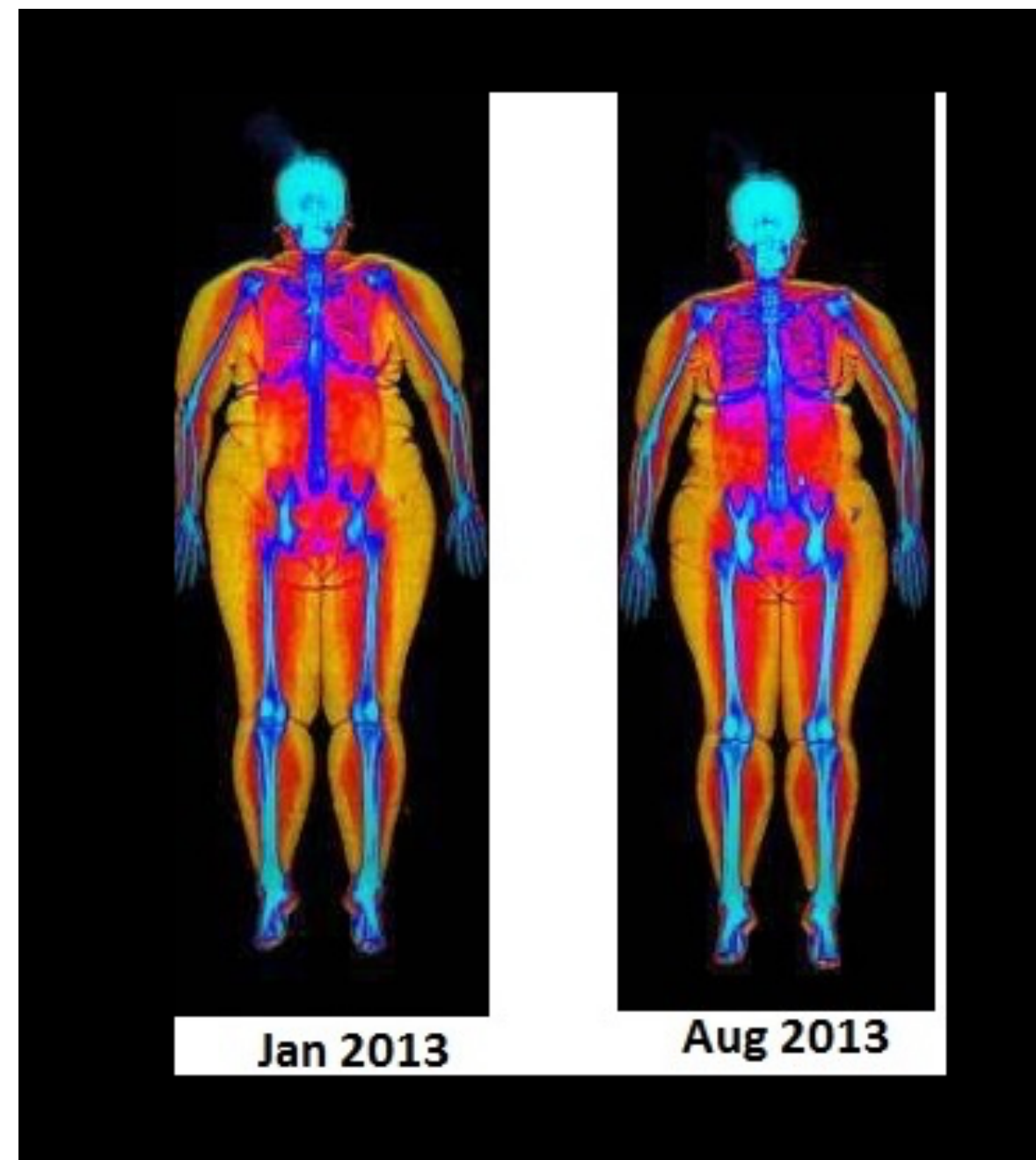


# DEXA

- Dual Energy X-ray Absorptiometry
- 2 low dose X-ray beams of different energy levels. Differential attenuation of the 2 beams used to estimate bone mineral density and soft tissue composition.
- Subtracts directly measured lean body tissue to determine fat mass.
- Similar accuracy to CT
- Very quick, 10 minutes for whole body scan
- Much less expensive than MRI and more available

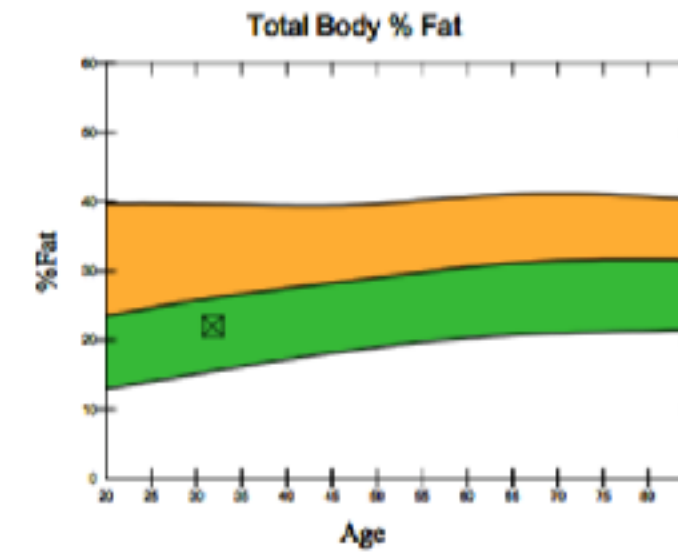
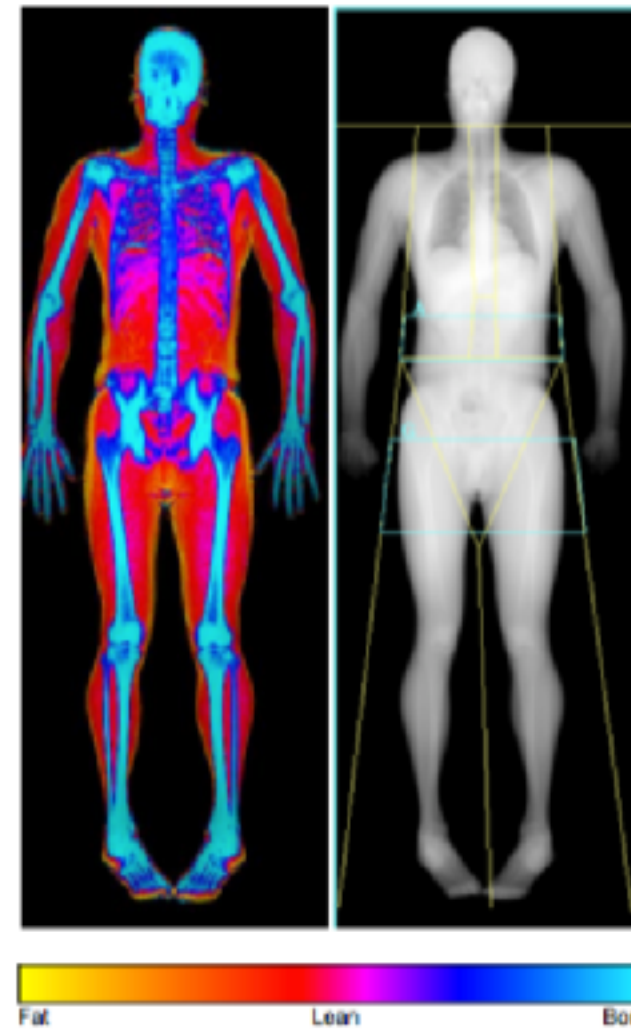


# DEXA



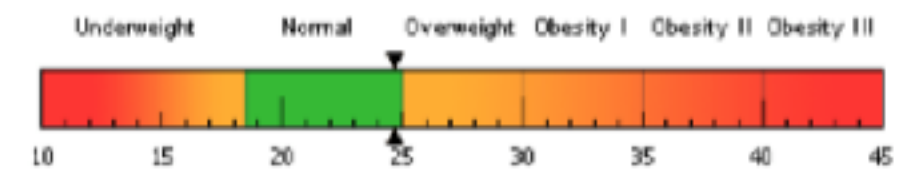


# DEXA REPORT



Source: 2008 NHANES White Male

World Health Organization Body Mass Index Classification  
BMI = 24.7 WHO Classification Normal



BMI has some limitations and an actual diagnosis of overweight or obesity should be made by a health professional. Obesity is associated with heart disease, certain types of cancer, type 2 diabetes, and other health risks. The higher a person's BMI is above 25, the greater their weight-related risks.

## Body Composition Results

Region	Fat Mass (g)	Lean+ BMC (g)	Total Mass (g)	% Fat	T-score	% Fat Z-score
L Arm	939	3873	4812	19.5		
R Arm	949	3805	4754	20.0		
Trunk	8244	28068	36312	22.7		
L Leg	2561	9775	12335	20.8		
R Leg	2752	9605	12357	22.3		
Subtotal	15445	55126	70571	21.9		
Head	1221	3853	5074	24.1		
<b>Total</b>	<b>16666</b>	<b>58979</b>	<b>75645</b>	<b>22.0</b>	<b>-0.4</b>	<b>-0.7</b>
Android	1258	4133	5390	23.3		
Gynoid	3041	9256	12297	24.7		

Scan Date: 18 March 2014 ID: A03181408  
 Scan Type: Whole Body  
 Analysis: 18 March 2014 15:56 Version 13.0  
 Operator: Auto Whole Body  
 Operator: GJ  
 Model: Explorer (S/N 91075)  
 Comment:

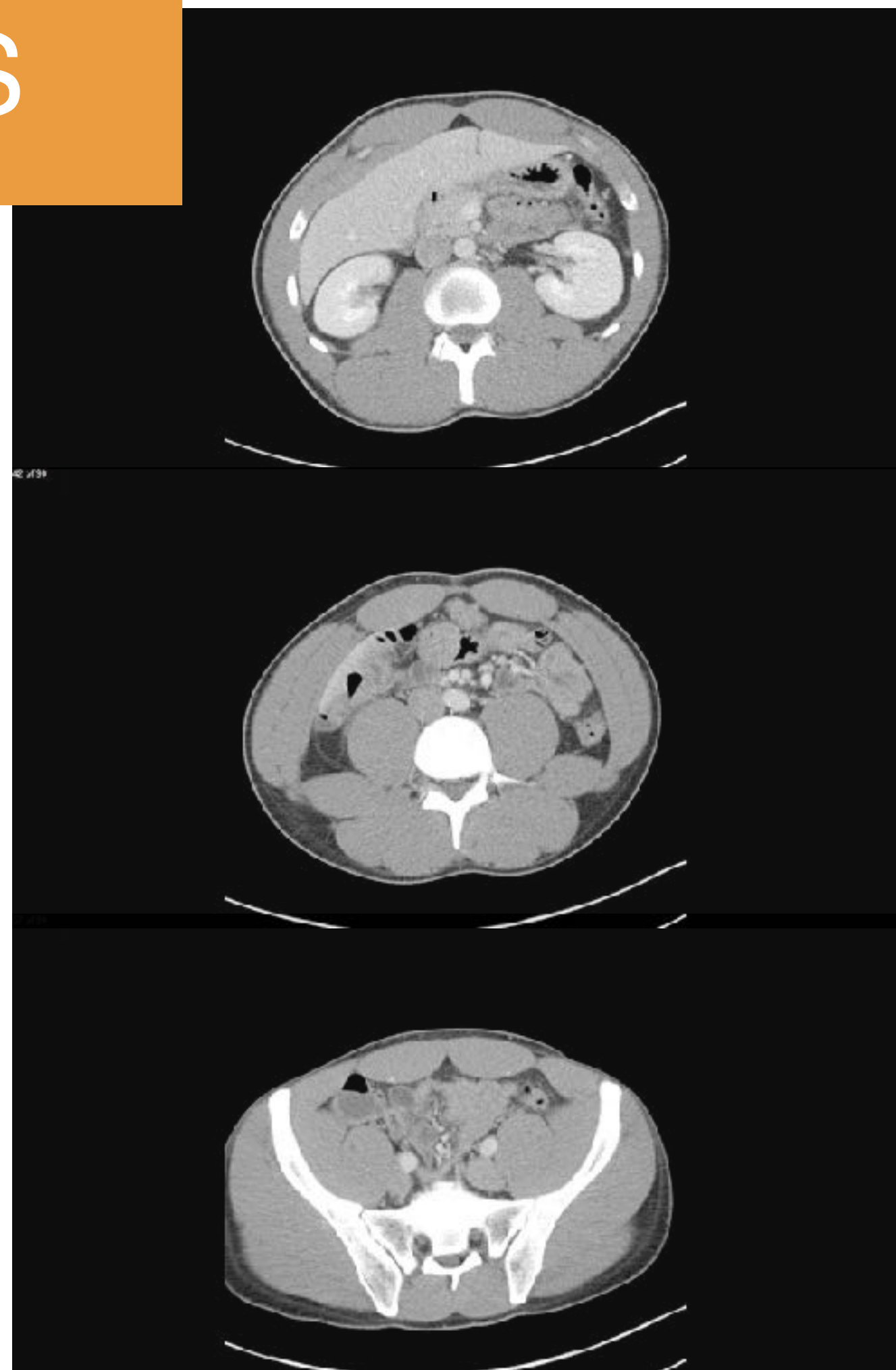
## Adipose Indices

Measure	Result	T-score	Z-score
Total Body % Fat	22.0	-0.4	-0.7
Fat Mass/Height (kg/m <sup>3</sup> )	5.41	-0.4	-0.6
Android/Gynoid Ratio	0.94		
% Fat Trunk/% Fat Legs	1.06	0.8	0.4
Trunk/Limb Fat Mass Ratio	1.14	0.8	0.3

## Lean Mass Indices

Measure	Result	T-score	Z-score
Lean Mass/Height (kg/m <sup>3</sup> )	19.1	-0.1	-0.2
Appen. Lean Mass/Height (kg/m <sup>3</sup> )	8.78	-0.1	-0.2

# LOW CARB 6-PACK ABS





LOW CARB  
RADIOLOGY

*ENHANCING  
YOUR IMAGE*

*MARK W. BERGER, MD*

