

2-2021

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# The Use of Advanced Ultrasound Techniques for the Evaluation of Uterine Fibroids pre and post Uterine Artery Embolization

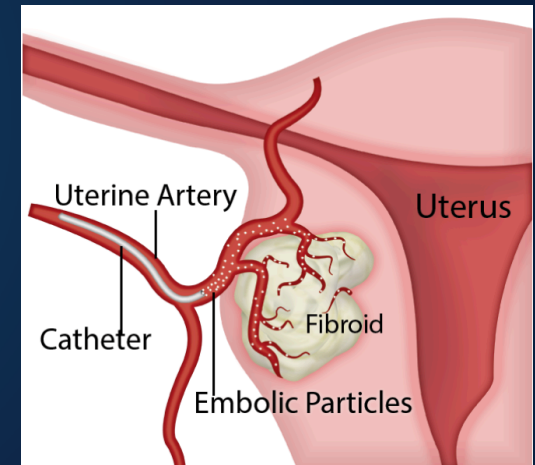
Kathleen Gillmore, Priscilla Machado, Allison Tan,  
Carin Gonsalves, Flemming Forsberg\*

# Introduction

- Uterine fibroids
  - Most common benign tumor in females of reproductive age
    - Disproportionately affect low-income populations
  - May be asymptomatic, but can lead to heavy uterine bleeding, bowel and urinary dysfunction, and pain

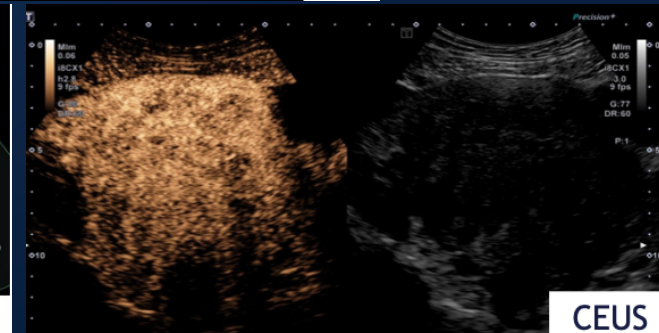
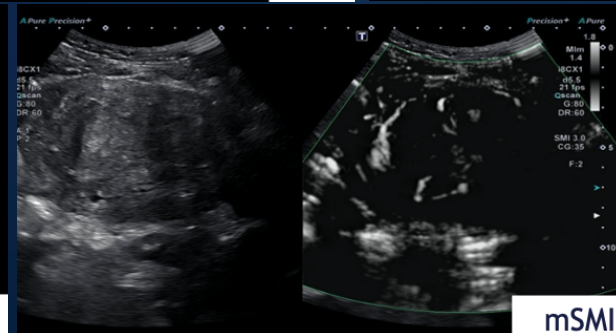
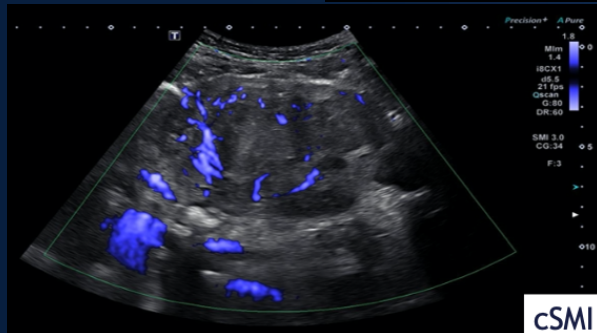
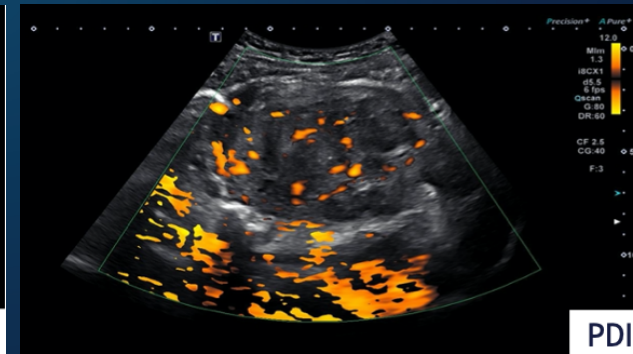
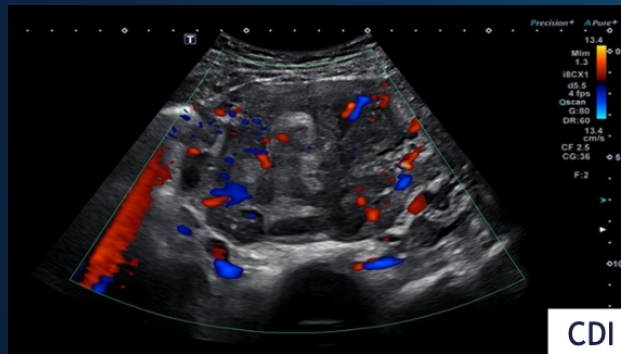
- Uterine artery embolization (UAE)
  - Minimally invasive treatment
  - Causes selective necrosis of the fibroids

- Post-operative imaging has an established positive effect on long-term outcomes
  - Gadolinium-enhanced MRI is the gold standard
    - Cost and availability restrictions means these scans are typically not covered by insurance
  - Ultrasound may be a feasible alternative



Credit: IVC Northwest

- Compared to MRI, ultrasound is low-cost and accessible
  - Contrast-enhanced ultrasound (CEUS) imaging has been shown to achieve similar results to MRI in characterizing tumor microvasculature
    - A non-contrast alternative to CEUS is preferable, as contrast may be contraindicated in some patients
  - In recent years, several non-contrast ultrasound options have become available
    - We will be examining color Doppler (CDI), power Doppler (PDI), color superb microvascular imaging (cSMI), and monochrome superb microvascular imaging (mSMI)



# Objectives & Hypothesis

- Research Question
  - What is the accuracy of emerging non-contrast ultrasound modalities in assessing the success of uterine artery embolization at 2 weeks and 3 months post- operation when compared to CEUS?
- Hypothesis
  - The results found using the new ultrasound techniques will be in agreement with CEUS findings when distinguishing between successful and unsuccessful embolization



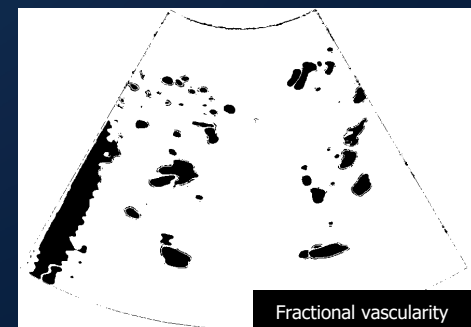
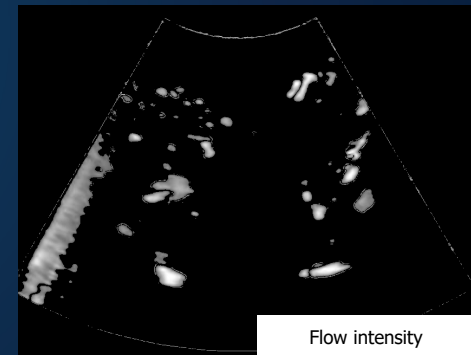
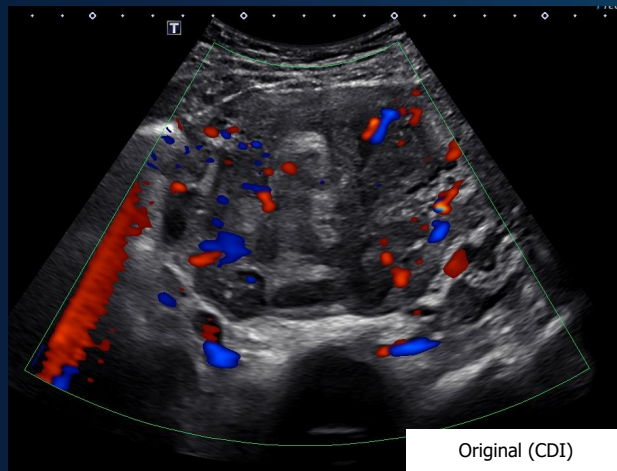
# Approach

- Open-label, non-randomized 3 year clinical trial
- Participants will be 40 adult females who have uterine fibroids and are scheduled for UAE
  - To date, 29 fibroids in 21 participants have been studied
- Participants receive 3 transabdominal ultrasounds at three different time points: pre-operative, 2 weeks post-op and 3 months post-op
  - CEUS and four non-contrast modalities (CDI, PDI, cSMI and mSMI) are used at each time point
  - The largest fibroid(s) in each participant will be studied



# Approach (cont.)

- The results of these ultrasounds are analyzed quantitatively and qualitatively
  - Assessed by two (blinded) radiologists who classify the fibroids as having internal, peripheral or no vascularity
  - ImageJ is used to measure fractional vascularity and flow intensity



# Qualitative Results

Table 1: Qualitative assessment of each fibroid across modes and time points

Pt #	Fibroid #	0 days								14 days								90 days							
		CDI		PDI		cSMI		mSMI		CDI		PDI		cSMI		mSMI		CDI		PDI		cSMI		mSMI	
		R1	R2	R1	R2	R1	R2	R1	R2	R1	R2	R1	R2	R1	R2	R1	R2	R1	R2	R1	R2	R1	R2	R1	R2
1		P	P	P	NV	I	I	I	I	P	I	P	NV	P	P	P	I	NV	NV	NV	NV	NV	NV	NV	NV
2	1	I	P	I	P	I	P	I	I	I	P	I	NV	I	P	I	I	NV	NV	NV	NV	NV	NV	NV	NV
	2	I	P	I	P	I	P	I	I	NV	P	NV	NV	I	P	I	I	NV	NV	NV	NV	NV	NV	NV	NV
3	1	I	I	I	I	I	I	I	I	NV	NV	NV	NV	NV	NV	NV	I	NV	P	NV	P	NV	P	NV	NV
	2	P	I	P	I	I	I	I	I	NV	NV	NV	NV	NV	NV	NV	I	NV	P	NV	P	NV	P	NV	NV
4		P	NV	P	P	I	I	I	I	NV	NV	NV	NV	NV	NV	NV	I	NV	NV	NV	P	NV	P	NV	P
5		I	I	I	I	I	I	I	I	NV	NV	NV	P	NV	P	NV	I	NV	NV	NV	NV	NV	NV	NV	NV
6		I	I	I	I	I	I	I	I	P	P	P	I	I	I	I	I								
7		I	I	I	I	I	I	I	I	NV	P	NV	P	NV	P	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV
8		I	P	I	I	I	P	I	P	NV	NV	NV	I	NV	P	NV	I	NV	NV	NV	NV	NV	NV	NV	NV
9	1	I	I	I	I	I	I	I	I	NV	NV	NV	P	P	I	P	P	NV	P	NV	P	NV	P	NV	P
	2	I	I	I	I	I	I	I	I	NV	NV	NV	P	P	I	P	P	NV	P	NV	P	NV	P	NV	P
	3	I	I	I	I	I	I	I	I	NV	NV	NV	P	P	I	P	P	NV	P	NV	P	NV	P	NV	P
	4	I	I	I	I	I	I	I	I	NV	NV	NV	P	P	I	P	P	NV	P	NV	P	NV	P	NV	P
10		I	I	I	I	I	I	I	I	NV	I	NV	P	NV	I	NV	I	NV	P	NV	P	NV	NV	NV	NV
11	1	P	P	P	P	P	NV	P	NV	P	P	P	P	NV	P	P	NV								
	2	P	P	P	P	P	NV	P	NV	P	P	P	P	NV	P	P	NV								
13		I	I	I	I	I	I	I	I	NV	NV	NV	NV	NV	P	NV	NV	NV	NV	NV	NV	P	NV	P	P
15		I	I	I	I	I	I	I	I	NV	NV	NV	NV	NV	I	NV	I	I	P	I	I	I	P	I	P
16		I	I	I	I	I	P	I	I									NV	NV	NV	NV	NV	NV	NV	P
17		P	I	P	I	P	I	I	I	NV	P	NV	P	NV	P	NV	P								
18		P	P	P	P	NV	P	I	NV	NV	NV	NV	P	NV	P	NV	P								
19		I	I	P	I	P	P	I	I	NV	NV	NV	NV	NV	NV	NV	NV								
20		P	NV	P	NV	NV	P	NV	P	NV	P	NV	P	NV	P	NV	P								
21	1	I	I	I	I	I	I	I	I	NV	P	NV	P	NV	P	NV	P								
	2	I	I	I	I	I	I	I	I	NV	P	NV	P	NV	P	NV	P								
22		P	P	P	P	P	P	P	P	NV	NV	NV	NV	NV	NV	NV	NV								
23	1	I	I	I	I	I	I	I	I																
	2	NV	I	NV	I	NV	I	NV	I																

I = internal

P = peripheral

NV = non-vascular



# Quantitative Results

Table 2: Average FV and signal intensity across modes and time for 29 fibroids

	CDI		PDI		cSMI		mSMI	
	FV	SI	FV	SI	FV	SI	FV	SI
0 days	8.39	11.11	6.38	9.20	4.88	7.06	9.02	5.47
14 days	0.95	1.10	0.77	1.15	1.51	2.24	5.93	4.46
90 days	0.40	0.48	1.04	2.02	0.13	0.19	1.90	0.99

FV = fractional vascularity    SI = signal intensity

- To date, 29 fibroids in 21 participants have been studied
- Preliminary results:
  - Qualitative analysis
    - There was an overall agreement between the 2 readers for all imaging modalities (CDI, PDI, cSMI, mSMI) and examinations times ( $p=0.2$ )
  - Quantitative analysis
    - All four modalities showed statistically significant pre- and post-operative differences in fractional vascularity, in agreement with the CEUS readings ( $p < 0.001$ )
    - Signal intensity did not show a statistically significant difference for any of the four modalities ( $p = 0.96$ )
- Preliminary results indicate that non-contrast ultrasound modalities show promise in evaluating fibroid microvasculature and have the potential to improve patient care and outcomes
  - These findings may allow for the implementation of inexpensive, accessible post-operative imaging methods that could improve patient outcomes



# Future Directions

- Over the next year, we will continue to collect data to finalize our results
- We hope that this work will not only affect guidelines for fibroid imaging, but other highly vascular tumors as well



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# Acknowledgements

A special thank you to Dr. Forsberg and Dr. Machado for their ongoing support and mentorship