

Postpartum Uterine Hemostasis is achieved by Global Uterine Intravascular Coagulation

Presented at the
Uterine Hemostasis Colloquium

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Director, Salt Creek International Women's Health Foundation
<http://saltcreekfoundation.org/>
San Clemente, CA



FOUNDATION FOR
Women & Girls
with Blood Disorders

April 5, 2017 – 4:00 to 4:25
Four Peaks Room
DoubleTree Resort
Scottsdale, AZ USA



Virchow's Triad (1856)



Rudolf Virchow
1821 - 1902

DVT & Pulmonary Emboli

Virchow R. (1856). "Thrombose und Embolie. Gefässentzündung und septische Infektion". Gesammelte Abhandlungen zur wissenschaftlichen Medicin (in German). Frankfurt am Main: Von Meidinger & Sohn. pp. 219–732.

Matzdorff AC, Bell WR (1998). Thrombosis and embolism (1846-1856). Canton, Massachusetts: Science History Publications. ISBN 0-88135-113-X.

Malone P, Colm, Agutter, Paul S. (2008). The Aetiology of Deep Venous Thrombosis: A Critical, Historical and Epistemological Survey. Berlin: Springer. p. 84. ISBN 1-4020-6649-X.



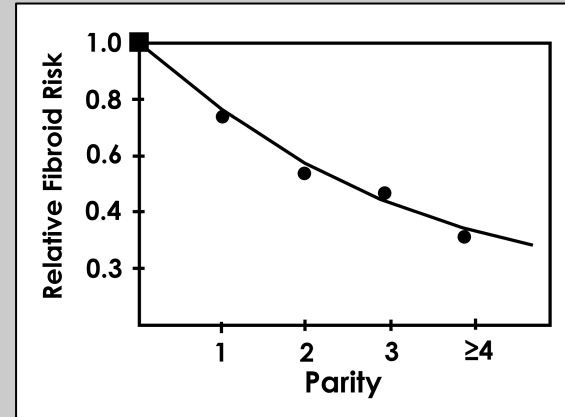
November 2000 Vol. 7, No. 4, Supplement



Uterine Artery Occlusion by Embolization
or Surgery for the Treatment of Fibroids:
A Unifying Hypothesis—Transient Uterine Ischemia

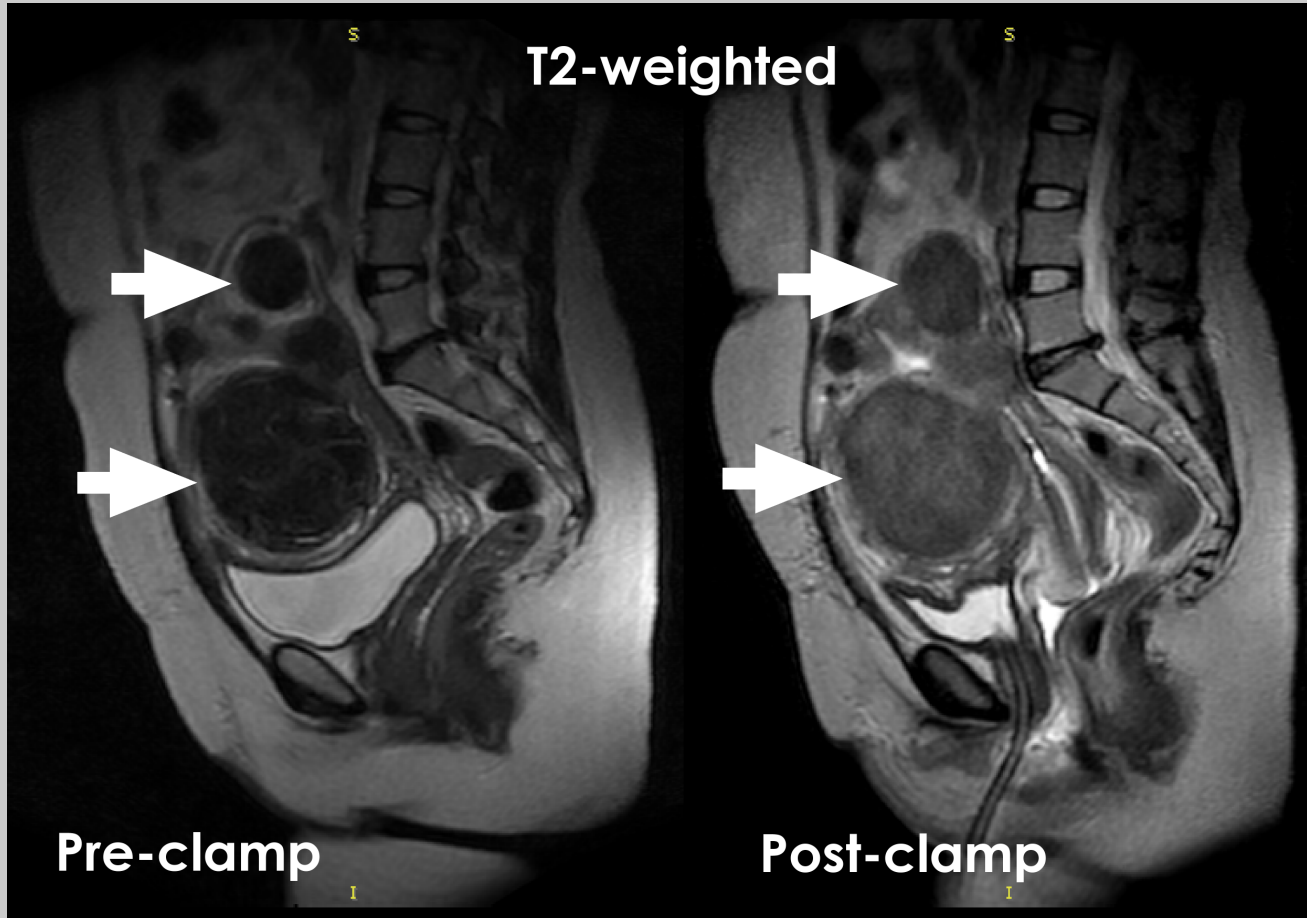
My Initial Interest: UAO and UAE Fibroid Rx

and this graph:



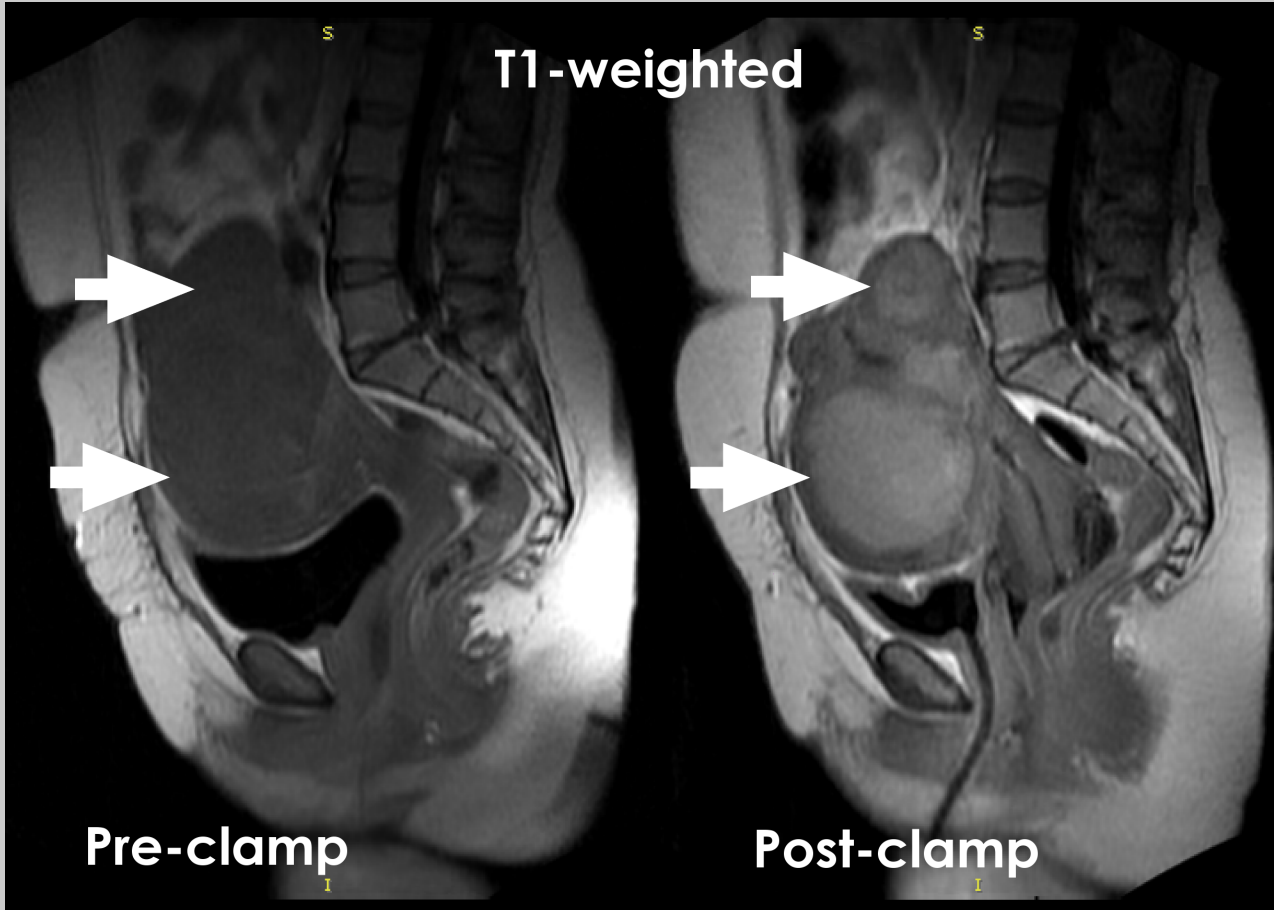


T2-weighted = Water



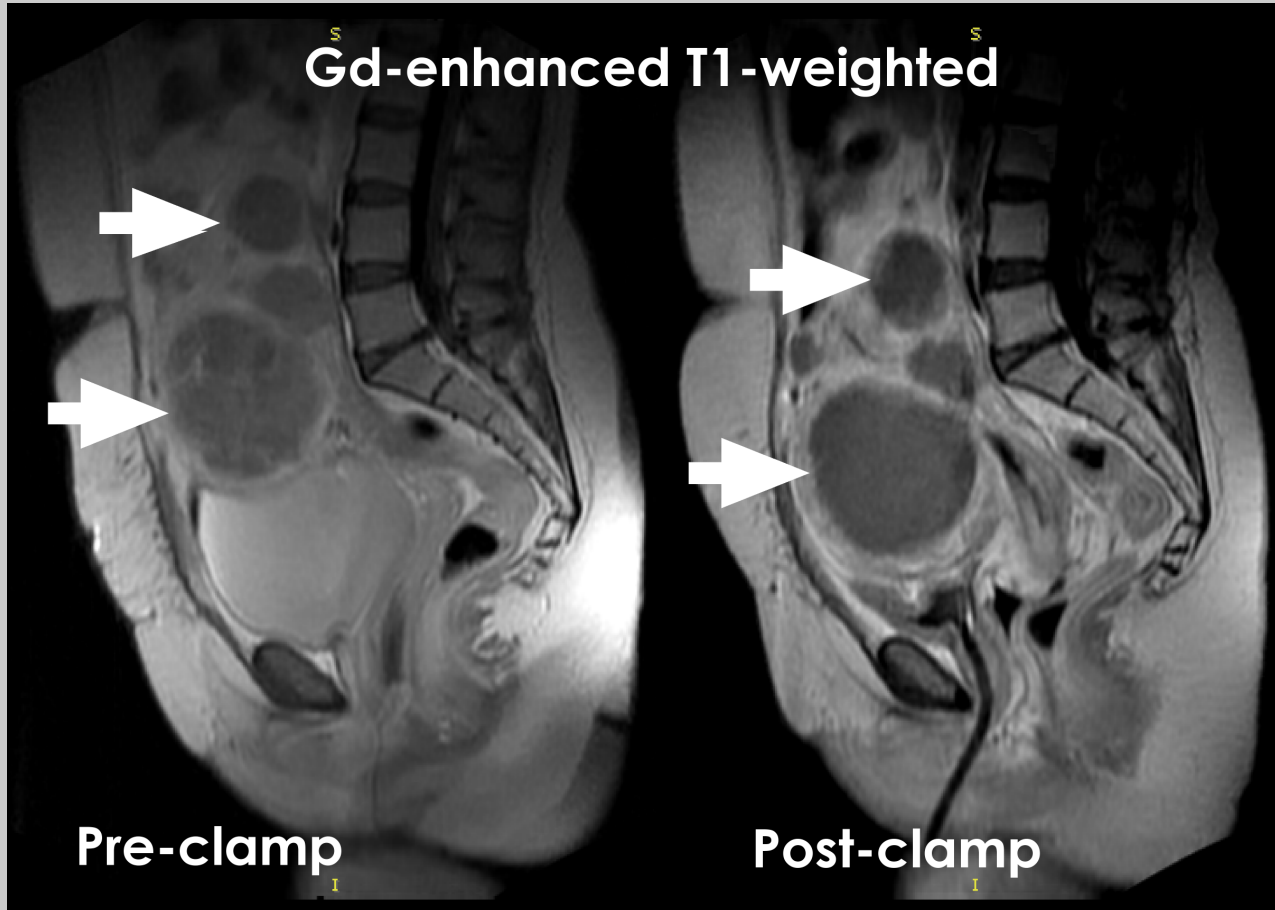


T1-weighted = Clot (Methemoglobin)



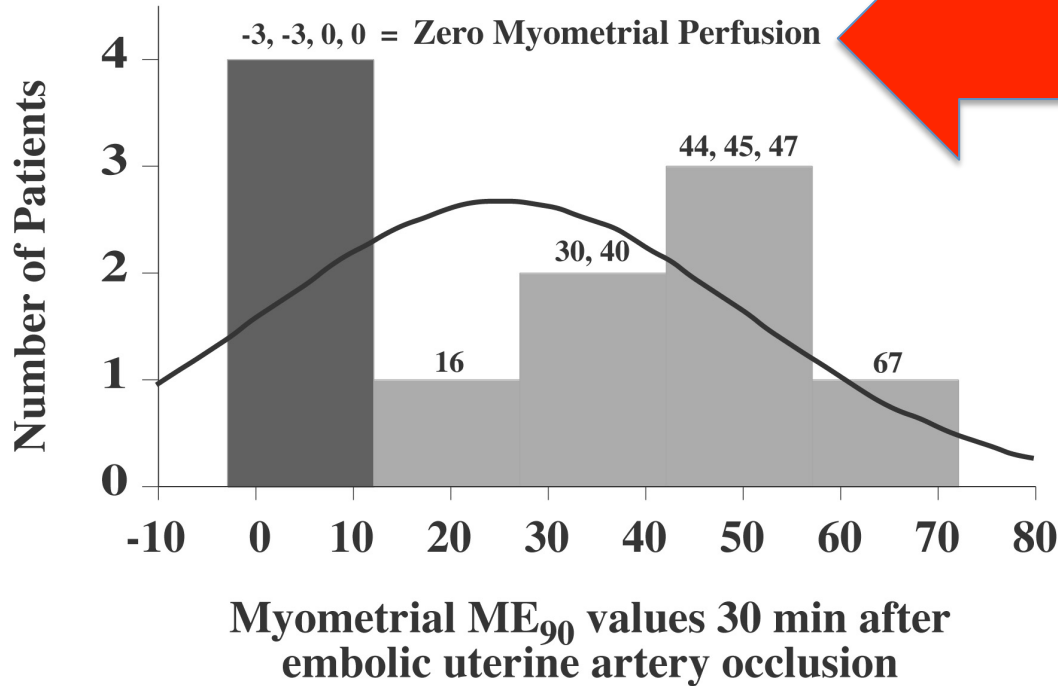


Gd-enhanced T1-weighted = Perfusion

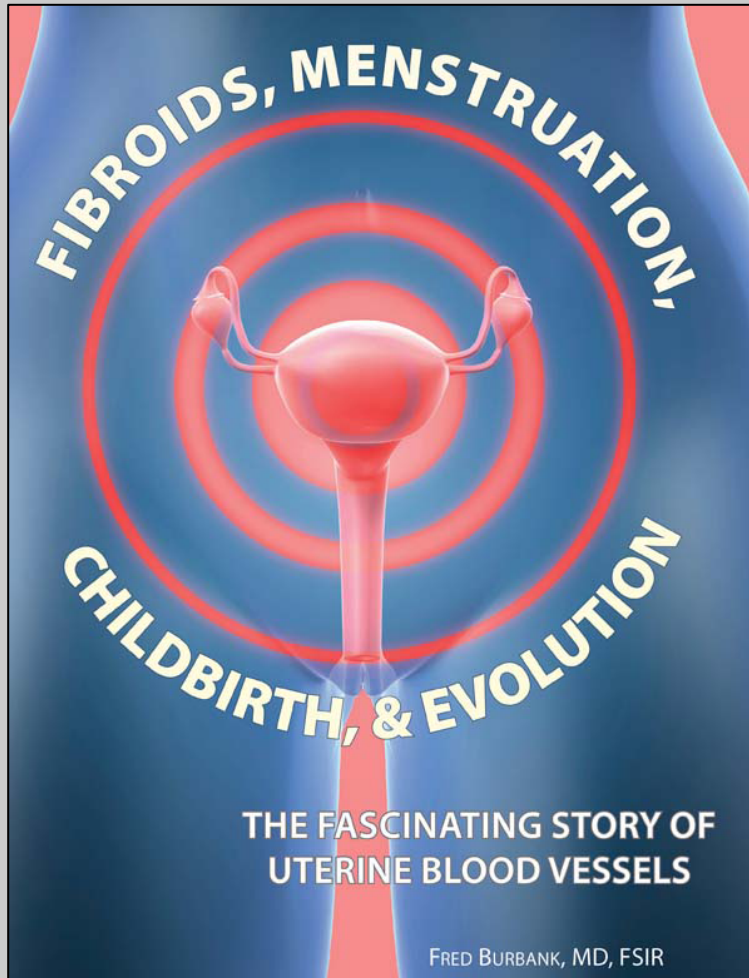




Following UAE, many had low perfusion; Some, NONE



deSouza NM, Williams AD. Uterine arterial embolization for leiomyomas: Perfusion and volume changes at MR imaging and relation to clinical outcome. *Radiology*. 2002; 222:367-374.



**Most materials
from this lecture
come from this
FREE (pdf) text
book**

www.saltcreekfoundation.org/education.php

**Uterine Blood Vessels
before, during,
and after
pregnancy**



A Comprehensive Textbook of POSTPARTUM HEMORRHAGE

*An Essential Clinical Reference
for Effective Management*

2nd Edition

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Me, my wife and Drs. Keith and Karoshi in London

22

Hemodynamic Changes in the Uterus and its Blood Vessels in Pregnancy*†

F. Burbank

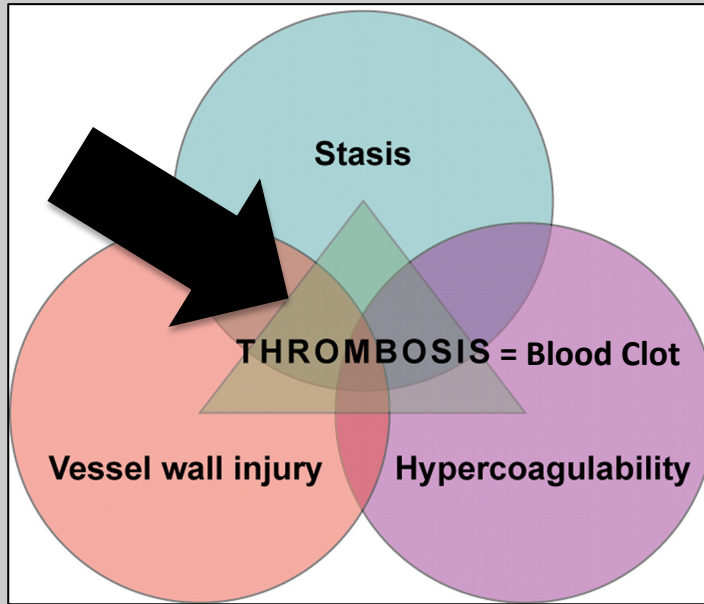
INTRODUCTION

Postpartum hemorrhage (PPH) most commonly originates from disrupted blood vessels of the uterus, a unique circulation supplied by two arterial systems and drained by two venous plexes. At term, the uterus receives one-tenth of the output of the heart.

During pregnancy fetal tissue invades the uterus and transforms a few hundred tiny arterioles into large, trumpet-shaped arteries that supply the placenta. At delivery, these huge arteries are torn apart, spilling blood into the uterine cavity.

All women do not die from hemorrhage during delivery because the potential for blood clotting and the accumulation of fibrinolytic substances build up in

14 inch image intensifier, could display all the blood vessels in the pelvis on a sequence of images beginning with arterial filling and ending with venous drainage. A contrast medium-enhanced, spiral CT can study all major arteries in the chest, abdomen and pelvis during a single injection of contrast medium within one breath-hold! Finally, imaging studies can examine blood flow during the whole cardiac cycle, providing information from systole through diastole, and they can characterize the entire vascular tree, from arteries to capillaries and veins. Vascular imaging is the foundation of modern vascular surgery, cardiac surgery, interventional cardiology and interventional radiology. Anatomic, surgical and imaging studies each have a place in developing a coherent understanding of the



Virchow's Clot-formation Triad



Rudolf Virchow
1821 - 1902

- 1. Hypercoagulability = Pregnant Blood** (Rx: Tranexamic acid, blocks plasmin & -gen)
analog aa lysine
- 2. Vessel wall injury = Placental Separation** (Rx: Active Mgt – Traction)
- 3. Stasis = Contractions** (Rx: Drugs, Massage, Balloons, Suction Direct arterial inflow control)



I am going to propose that:

$$1_{\text{(Increased Coagulation Proteins)}} + 2_{\text{(Vascular Injury)}} + 3_{\text{(Stasis)}}$$

**= Global Uterine
Intravascular Clot
Formation**

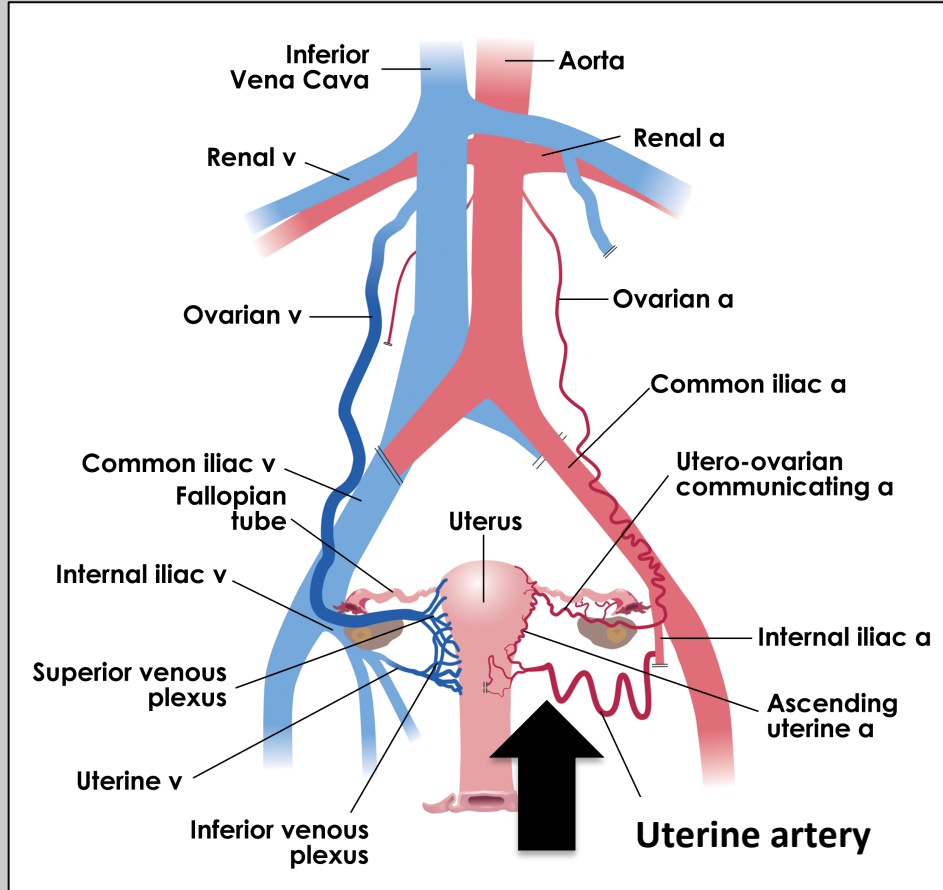


Pregnancy

Uterine Blood Vessels and Cardiac Output



Uterus has two arterial and two venous systems



Uterus is two organs:

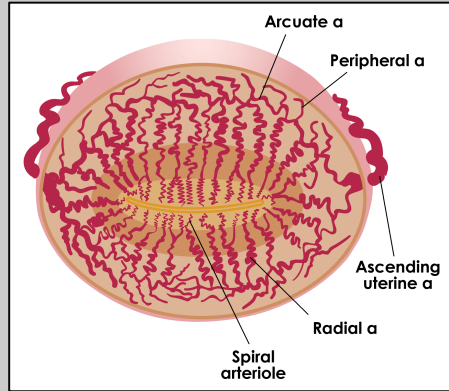
Old - Endometrium
& Junctional Zone

And

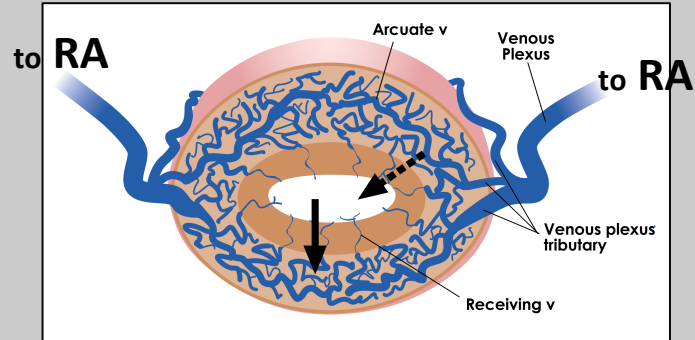
New - Outer Myometrium



The Non-pregnant Uterus is a very Vascular Organ (PG 10X more)



Spirals become UPs
(which have no muscles)



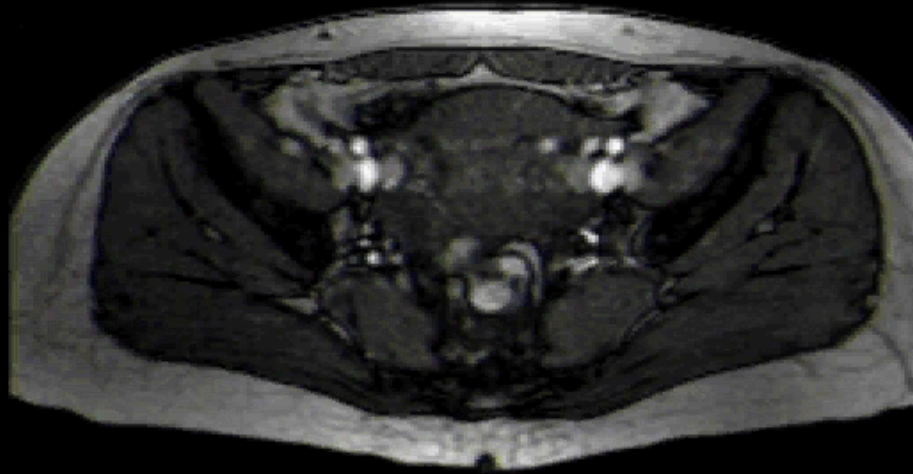
Uterine Veins have NO Valves

**Sampson JA. The blood supply of uterine myomata.
Surg Gynecol Obstet. 1912; 14: 215-234**



The Uterus is a very Vascular Organ

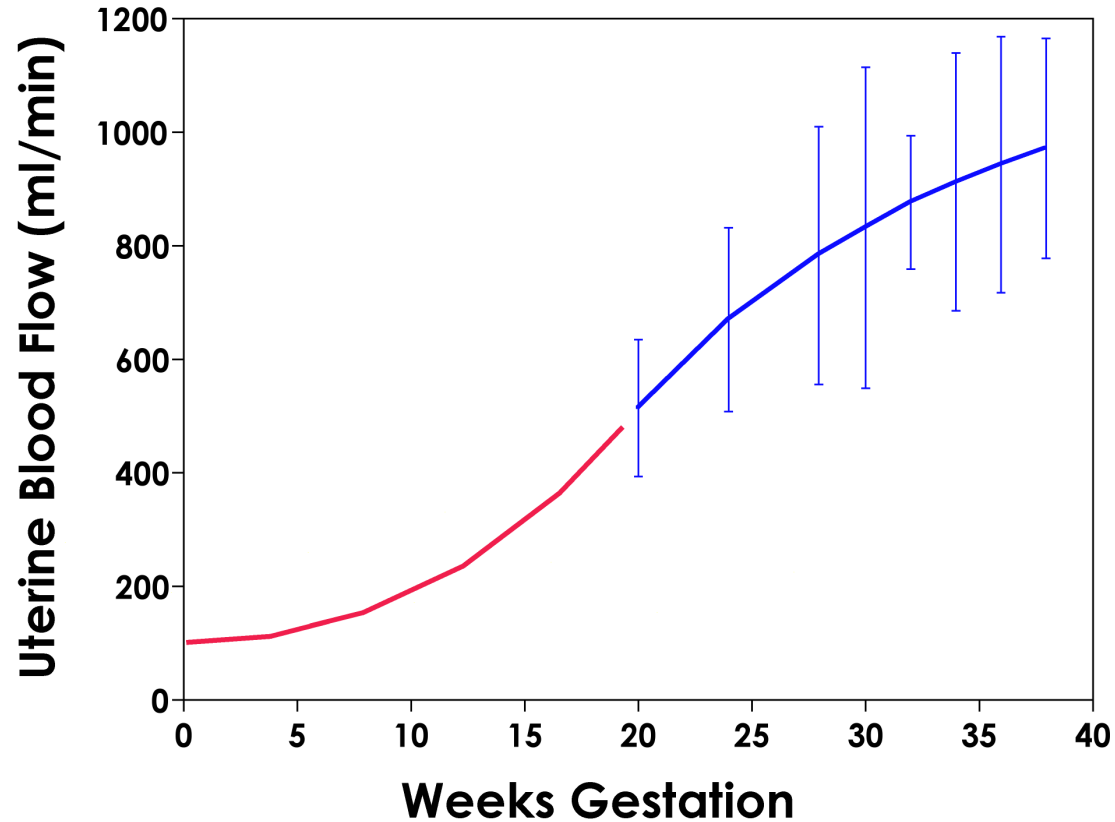
Contrast-Enhanced MRI



Movie

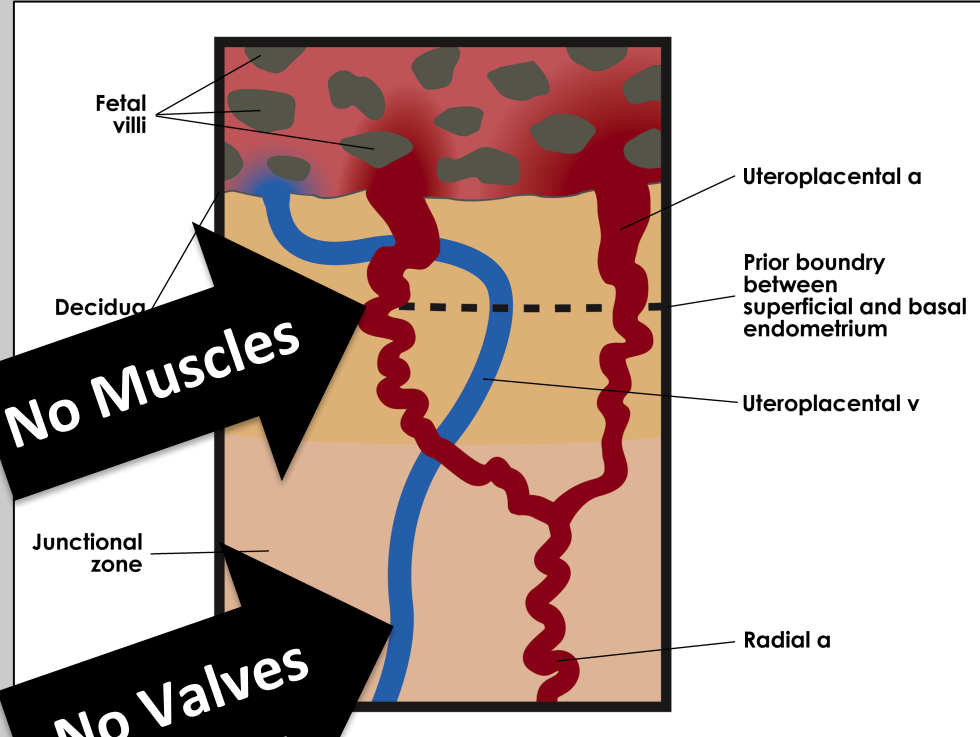
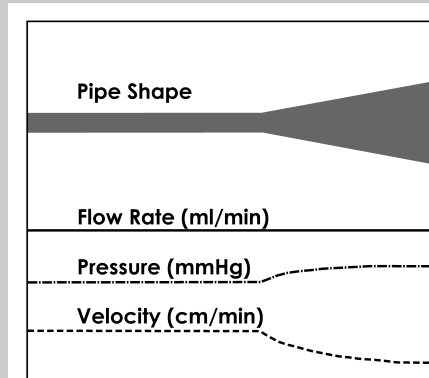
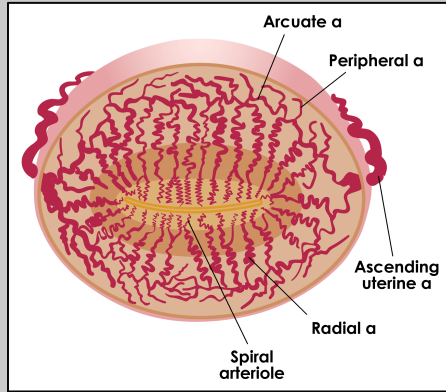


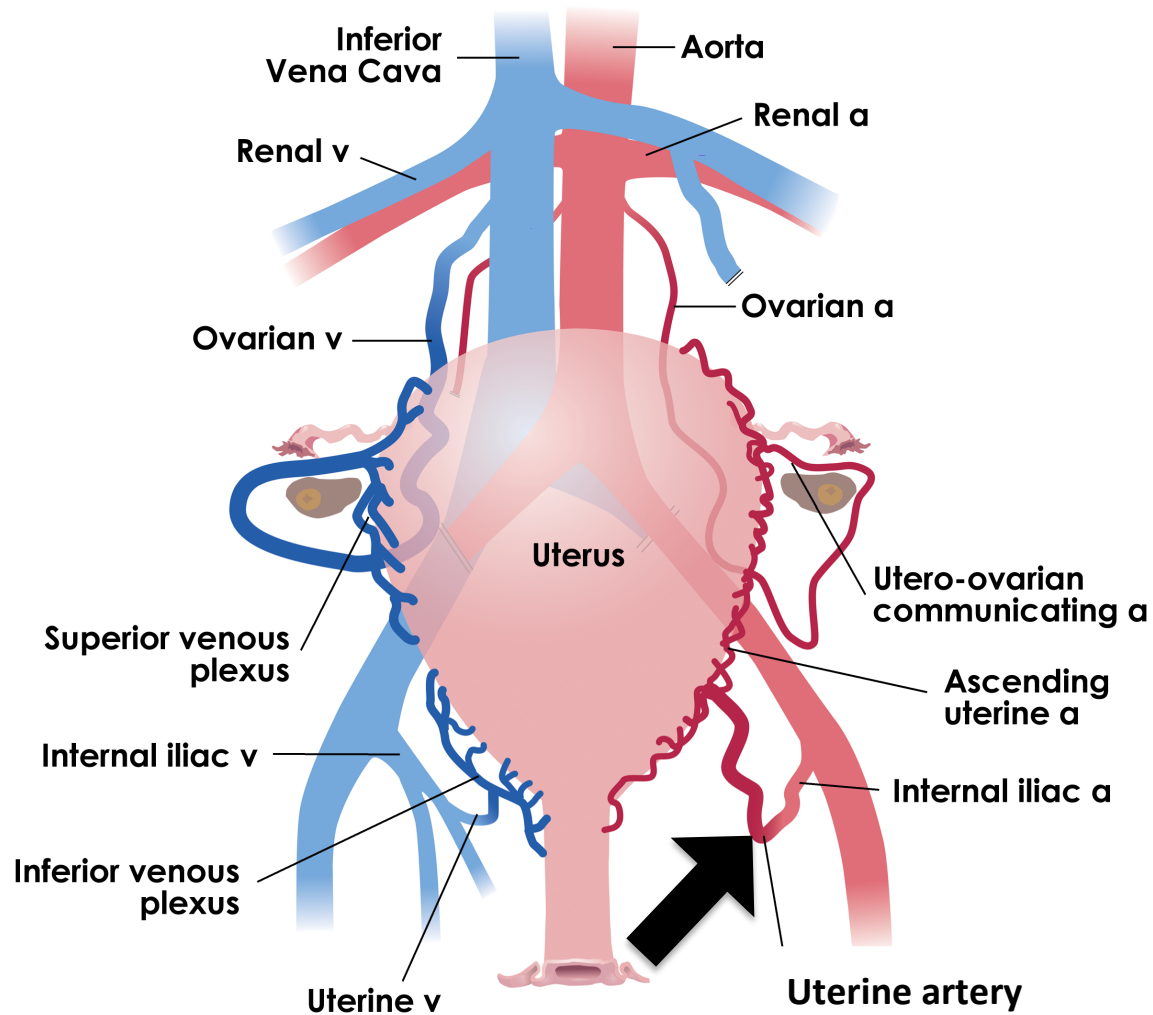
100 ml/min to 1000 ml/min or 10 % cardiac output





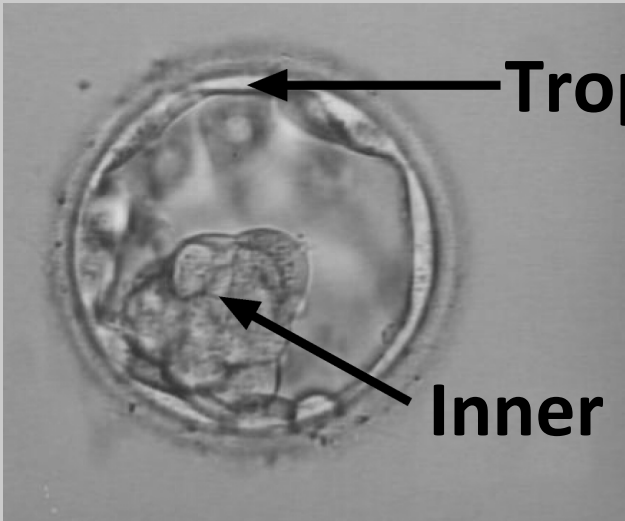
Tiny spiral arterioles become Large uteroplacental arteries







Baby's first organ: The Placenta

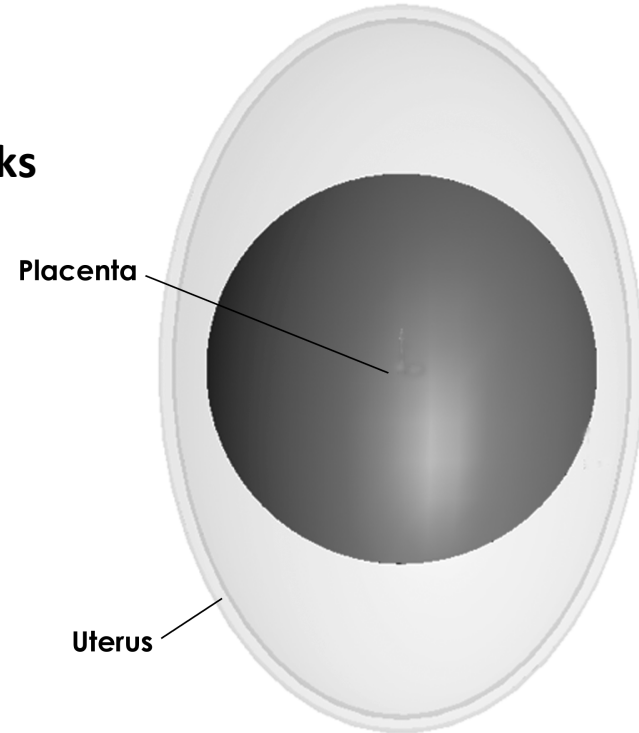
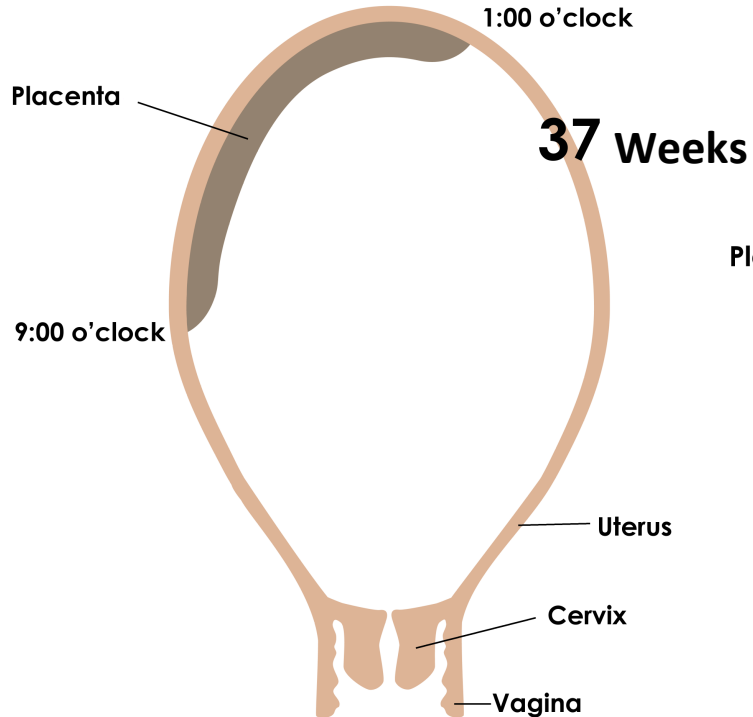


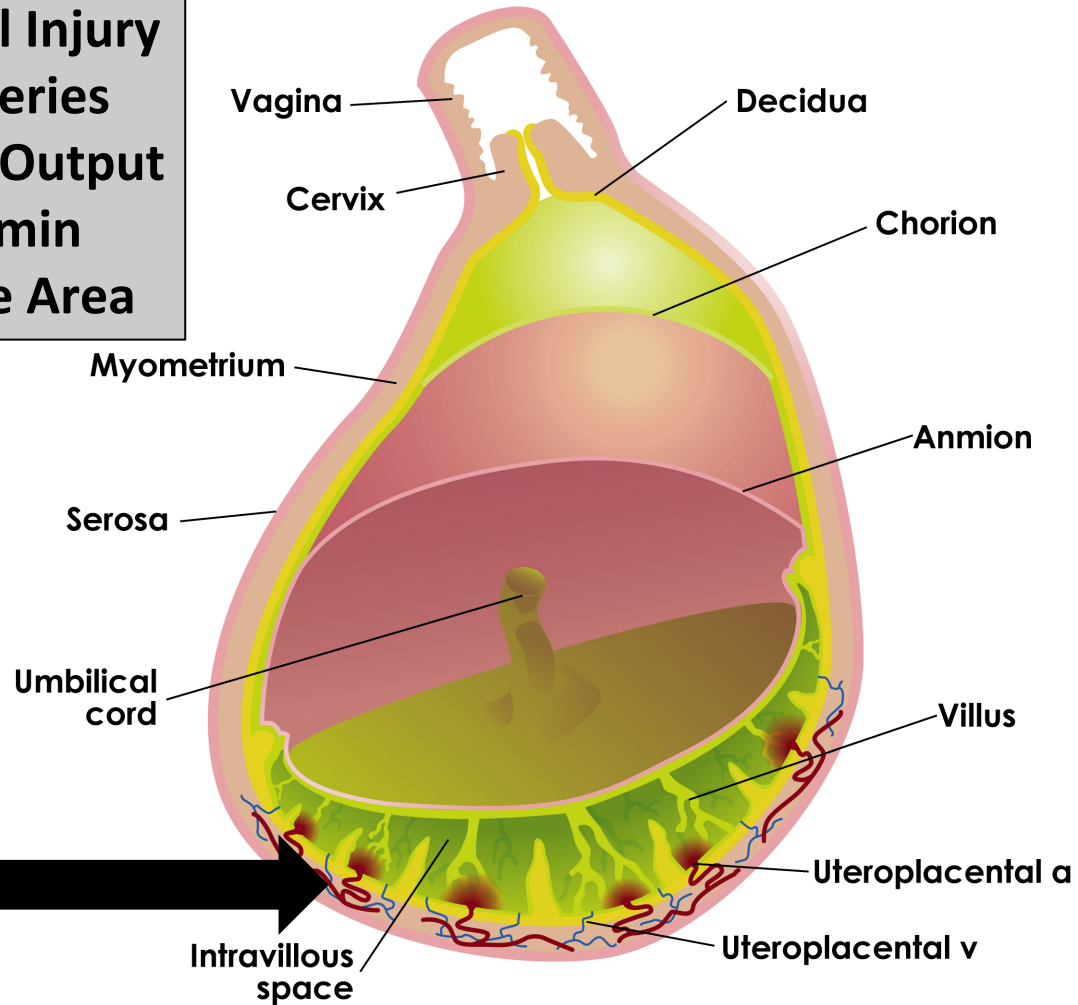
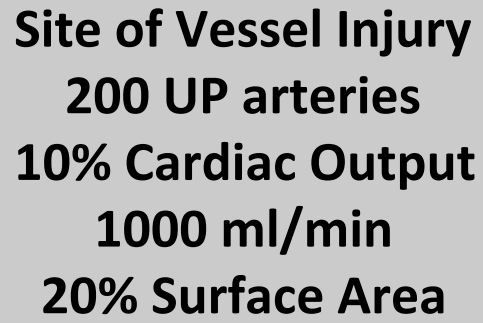
← Trophoblasts = Placenta

← Inner Cell Mass = Baby



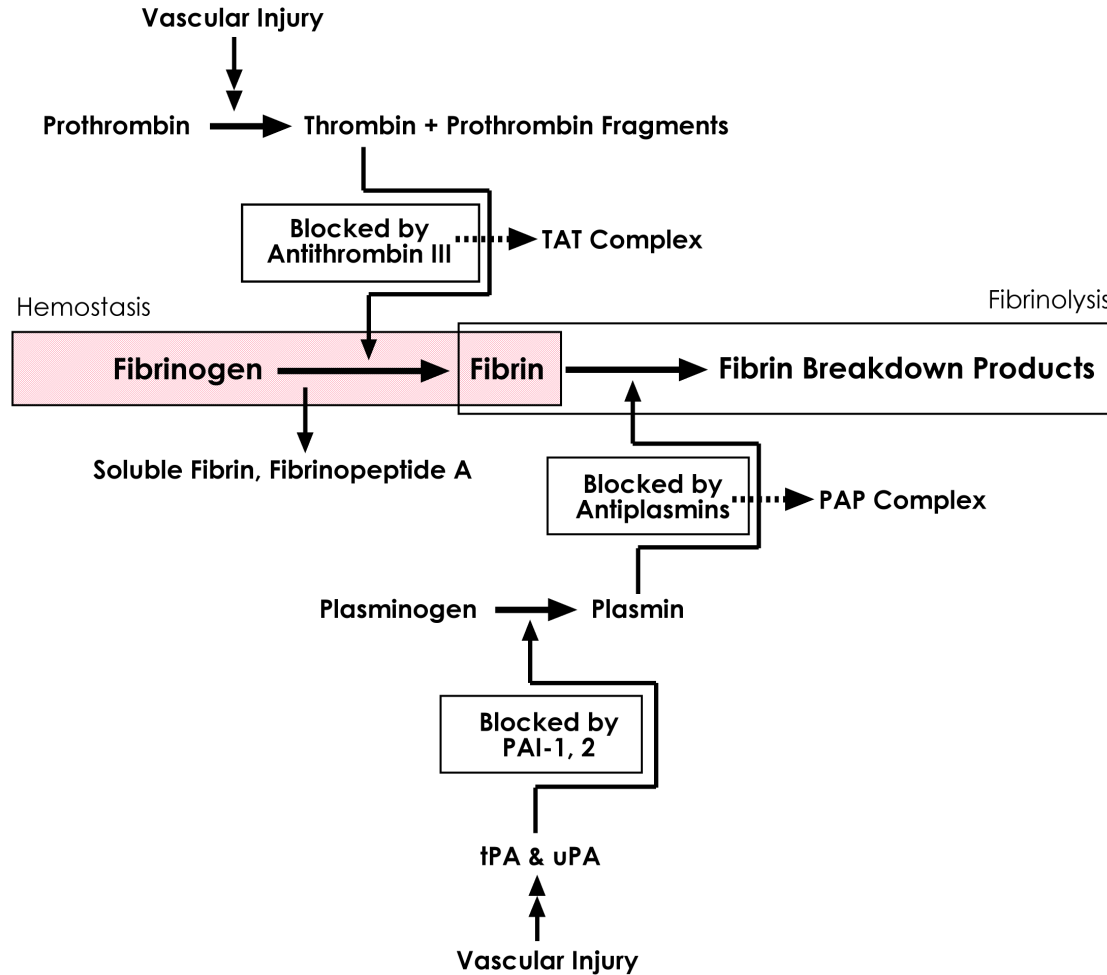
20% Surface Area of the Uterus 200 non-muscular uteroplacental arteries





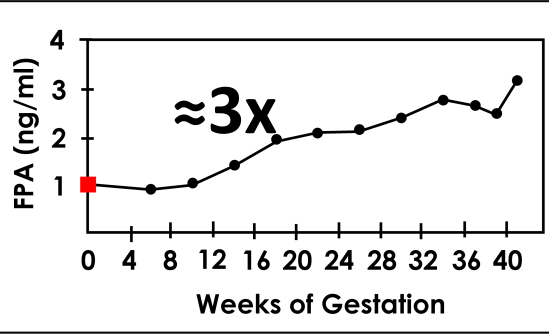


1. Pregnancy - Clotting & Fibrinolysis Proteins



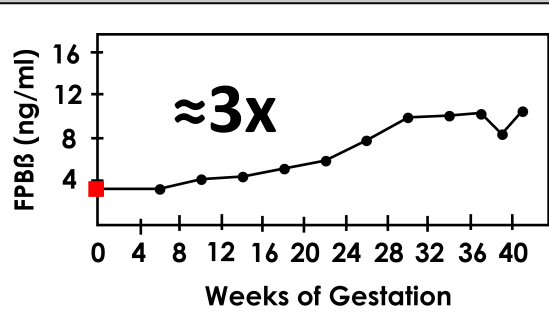


Fibrinopeptide A



Clotting Factors

Fibrinopeptide B beta



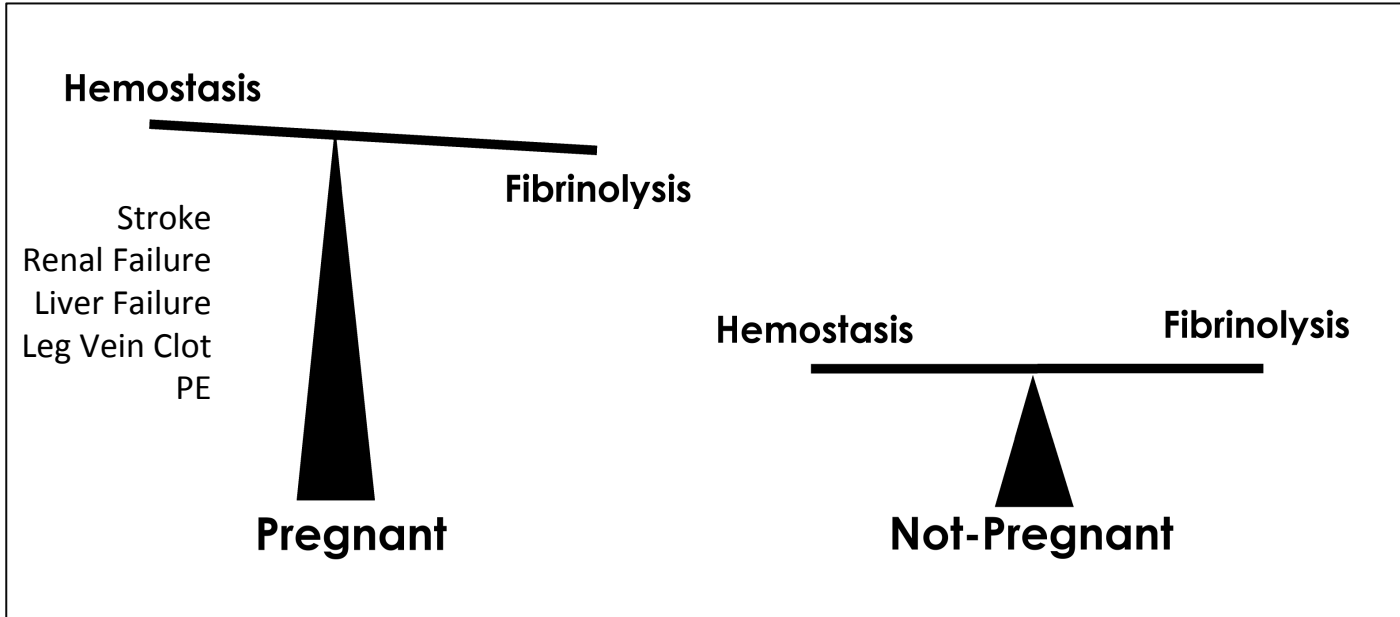
Lytic Factors

Mutoh S, Teh A, Saito M, Maki M, Abe T, and Ohno Y. Studies of fibrinopeptide A, fibrinopeptide B beta 15-42 HMW-kininogen and kinin during normal pregnancy labor and puerperium. *Adv Exp Med Biol.* 1986; 198 Pt B41-4.

Hellgren M. Hemostasis during normal pregnancy and puerperium. *Semin Thromb Hemost.* 2003 Apr; 29(2):125-30.



The Clotting – Lysis System Changes during Pregnancy



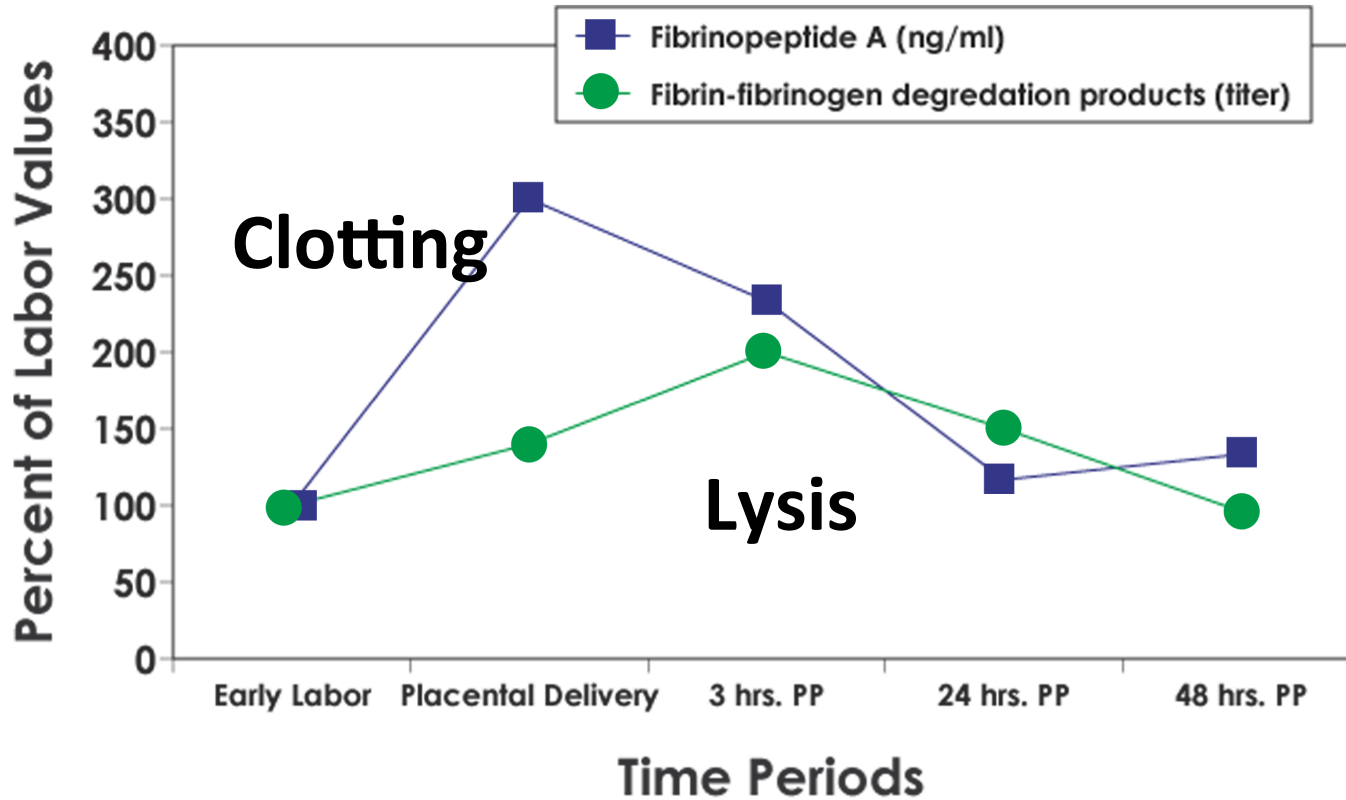


Baby delivery sort of a big thing. The **big thing**:

**Explosion of clot formation
Followed by fibrinolysis
at time of
Labor and Delivery**



Labor & Delivery: First Clotting, then Lysis



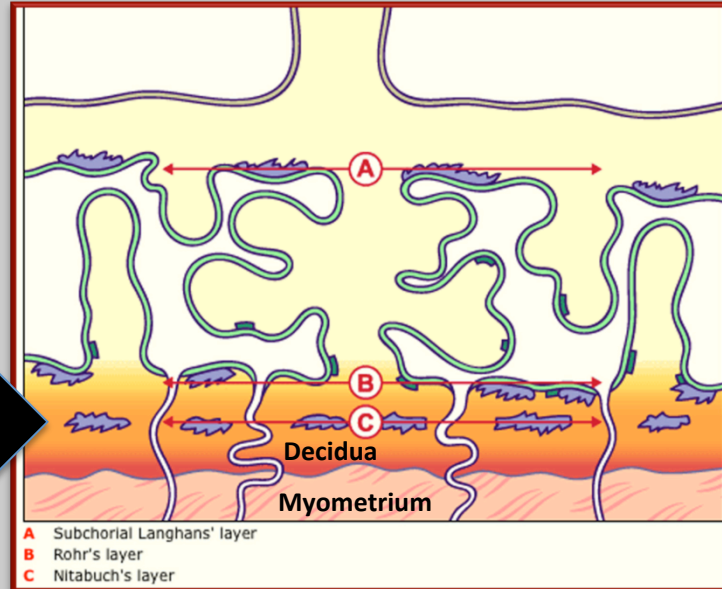


2. Placental Separation = Injury

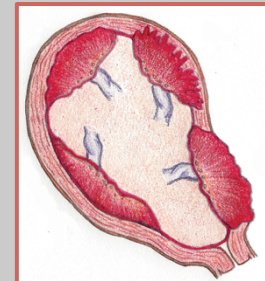


If No Placental Invasion, Easy Separation at Nitabuch's Layer

Ideal

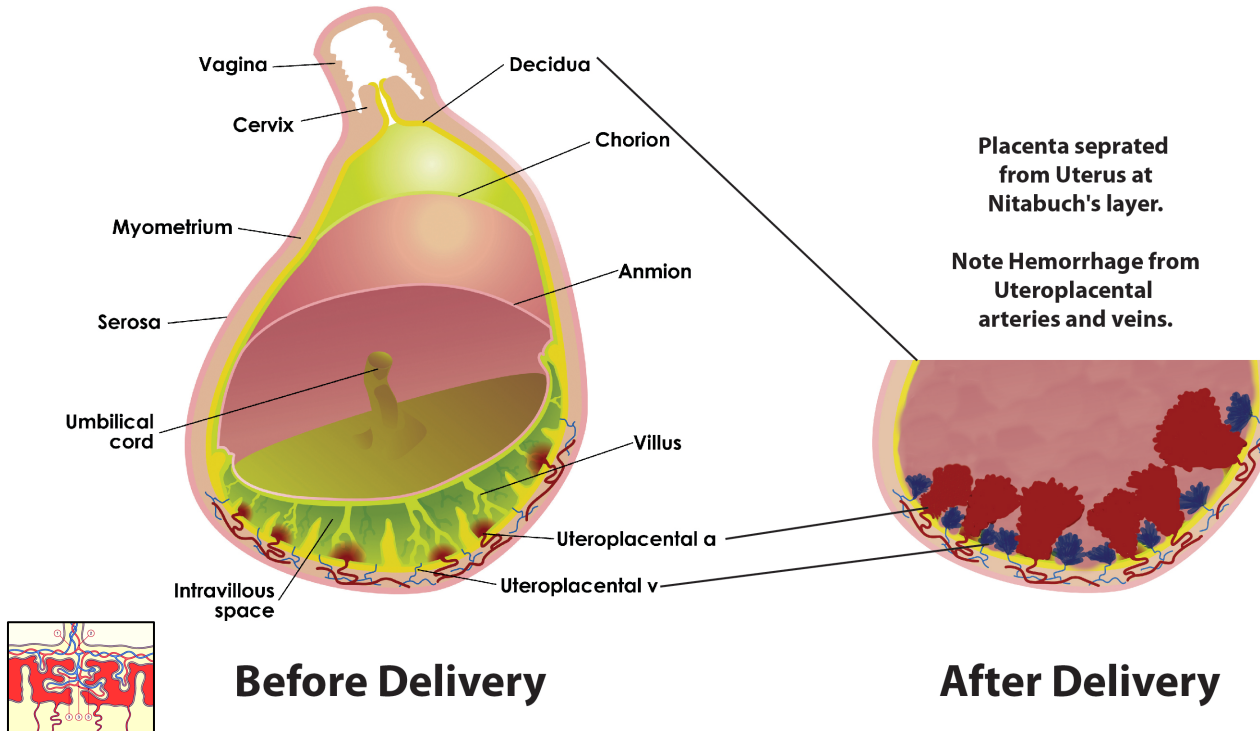


Not so Ideal





Why Don't All Women Bleed to Death?

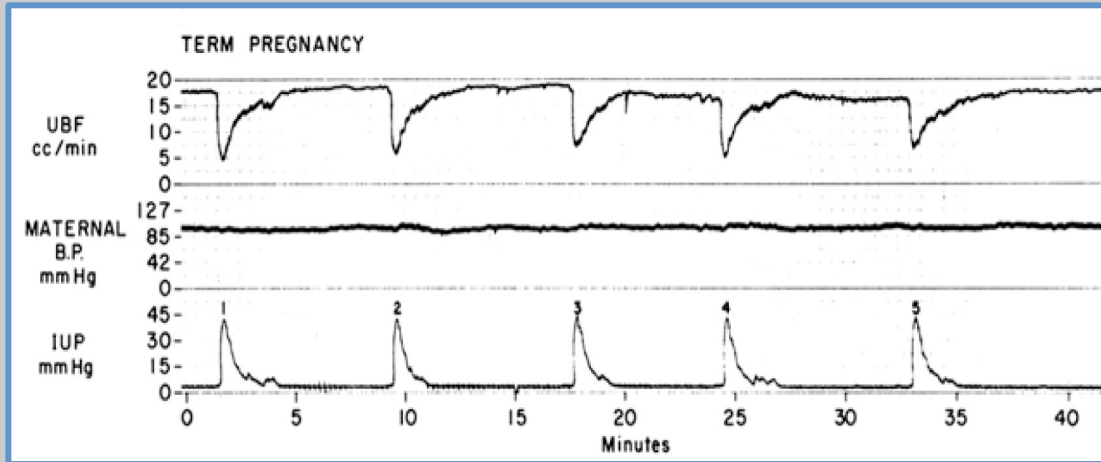




3. PP Contractions Stop / Slow Blood Flow



Uterine Artery Blood Flow Decreases With Each Contraction



↓ UA Blood Flow



Intra-uterine pressure



Uterine Contractions Continue After Delivery:

Second Stage Labor	1.9 ± 0.3 min
Third Stage Labor	2.4 ± 0.9 min

1 st Hour Post Placental Delivery	4.2 ± 0.7 min
2 nd Hour Post Placental Delivery	7.9 ± 2.1 min



The Whole Uterus

(and draining veins) Clot!



Khalil, et al “...identified a high prevalence of definite pelvic vein intraluminal filling defects [= clot] ... [which] may be a normal finding” in 67% of vaginal births.

TABLE 2

Pelvic magnetic resonance venography results

MRV	n/N (%)	95% CI
Definite thrombosis	9/30 (30)	13.6–46.4%
Probable thrombosis	8/30 (27)	10.3–41.7%
Possible thrombosis	3/30 (10)	0–20.7%
No thrombosis	10/30 (33)	16.2–49.8%

CI, confidence interval; MRV, magnetic resonance venography.

Khalil. Natural history of pelvic vein thrombosis on MRV after vaginal delivery. *Am J Obstet Gynecol* 2012.

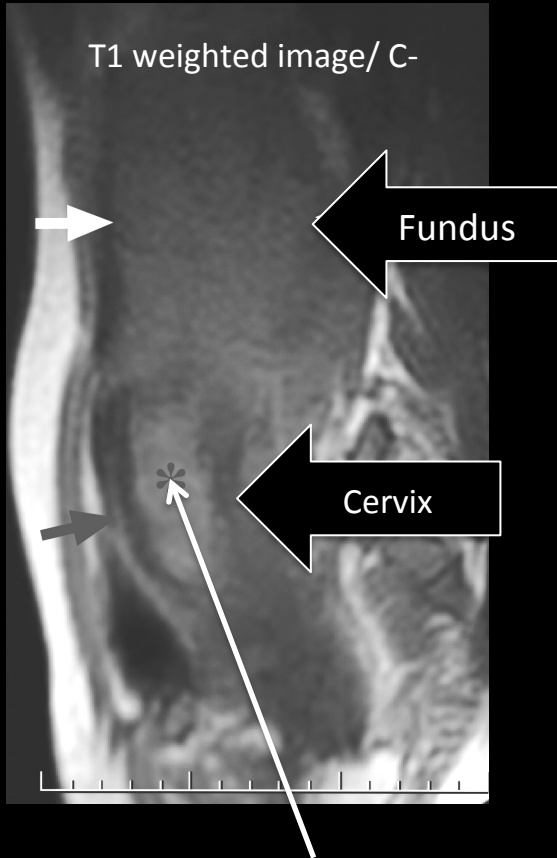
*Khalil H, Avruch L, Olivier A, et al. The natural history of pelvic vein thrombosis on magnetic resonance venography after vaginal delivery. *Am J Obstet Gynecol*. 2012; 206(4): 356 e1-4

Editorial: James AH. The natural history of pelvic vein thrombosis the natural history of involution? *Am J Obstet Gynecol*. 2012 Apr; 206(4): 276-7.



1(Increased
Coagulation
Proteins) + **2**(Vascular
Injury) + **3**(Stasis)

**= Global Uterine
Intravascular Clot
Formation**



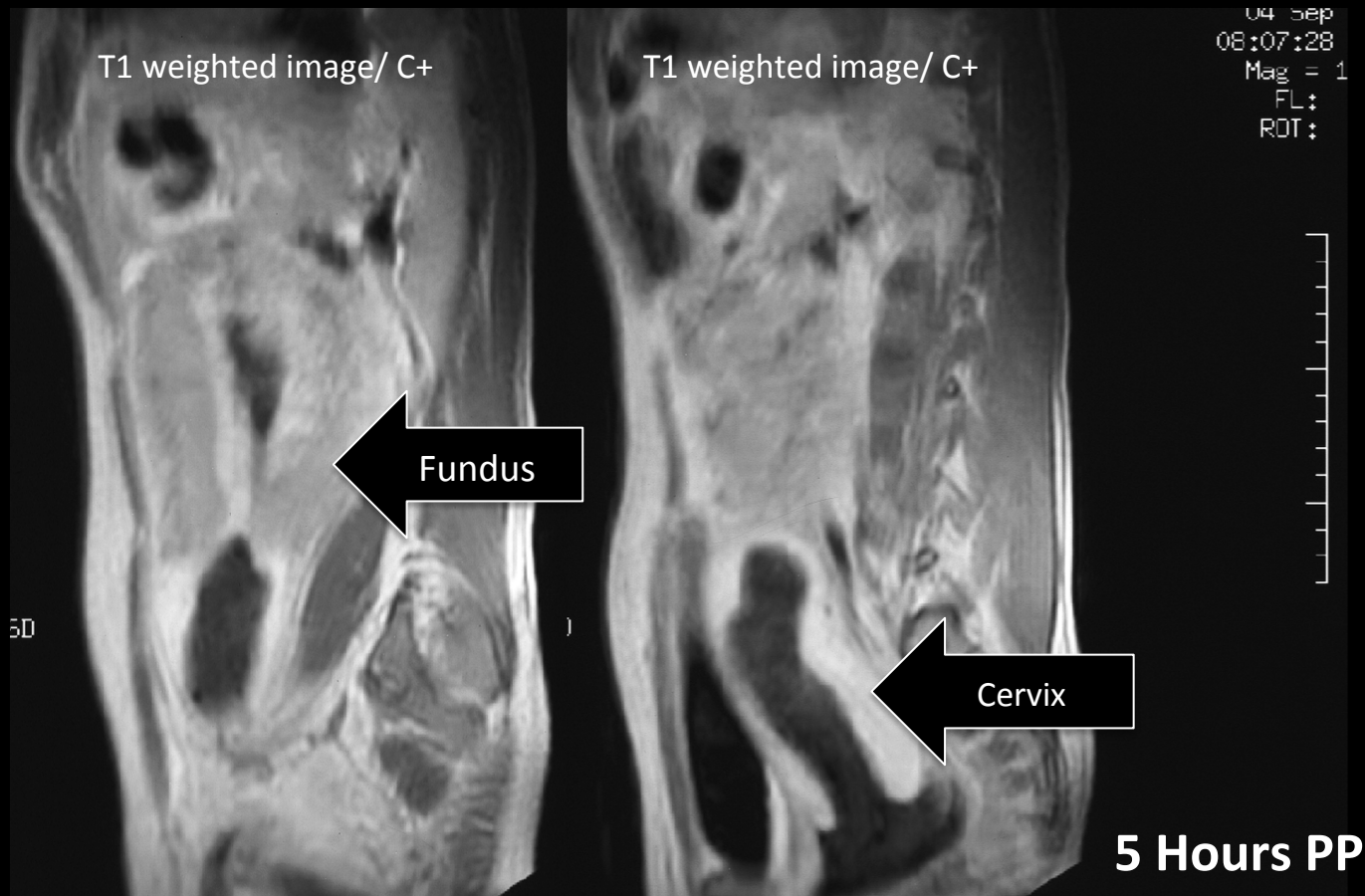
Methemoglobin Maps

Methemoglobin is a form of the oxygen-carrying metalloprotein hemoglobin, in which the iron in the heme group is in the Fe^{3+} (ferric) state, not the Fe^{2+} (ferrous) of normal hemoglobin.

Methemoglobin is paramagnetic because of 5 unpaired electrons in Fe^{3+} , rendering it bright on T1 weighted images, comparable to gadolinium, an MR contrast agent.

Clot in Cervical Canal and Body of Uterus

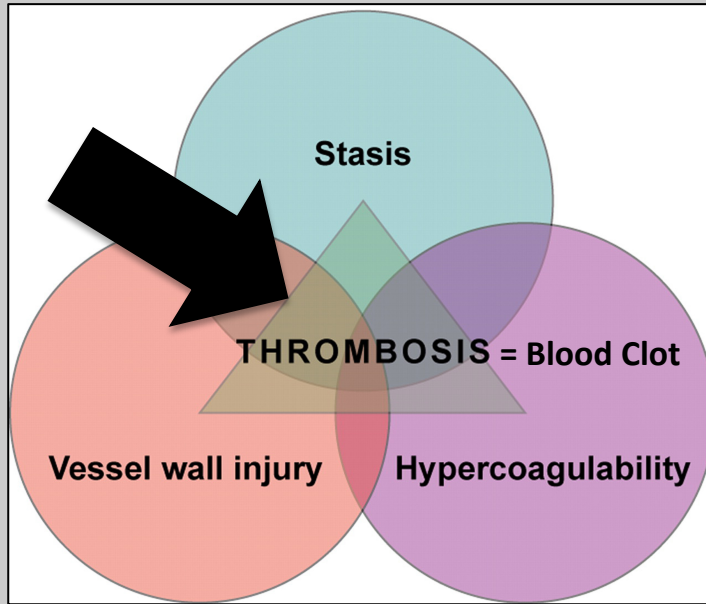
Entire Myometrium Clots then Lyses





PPH

Treatments

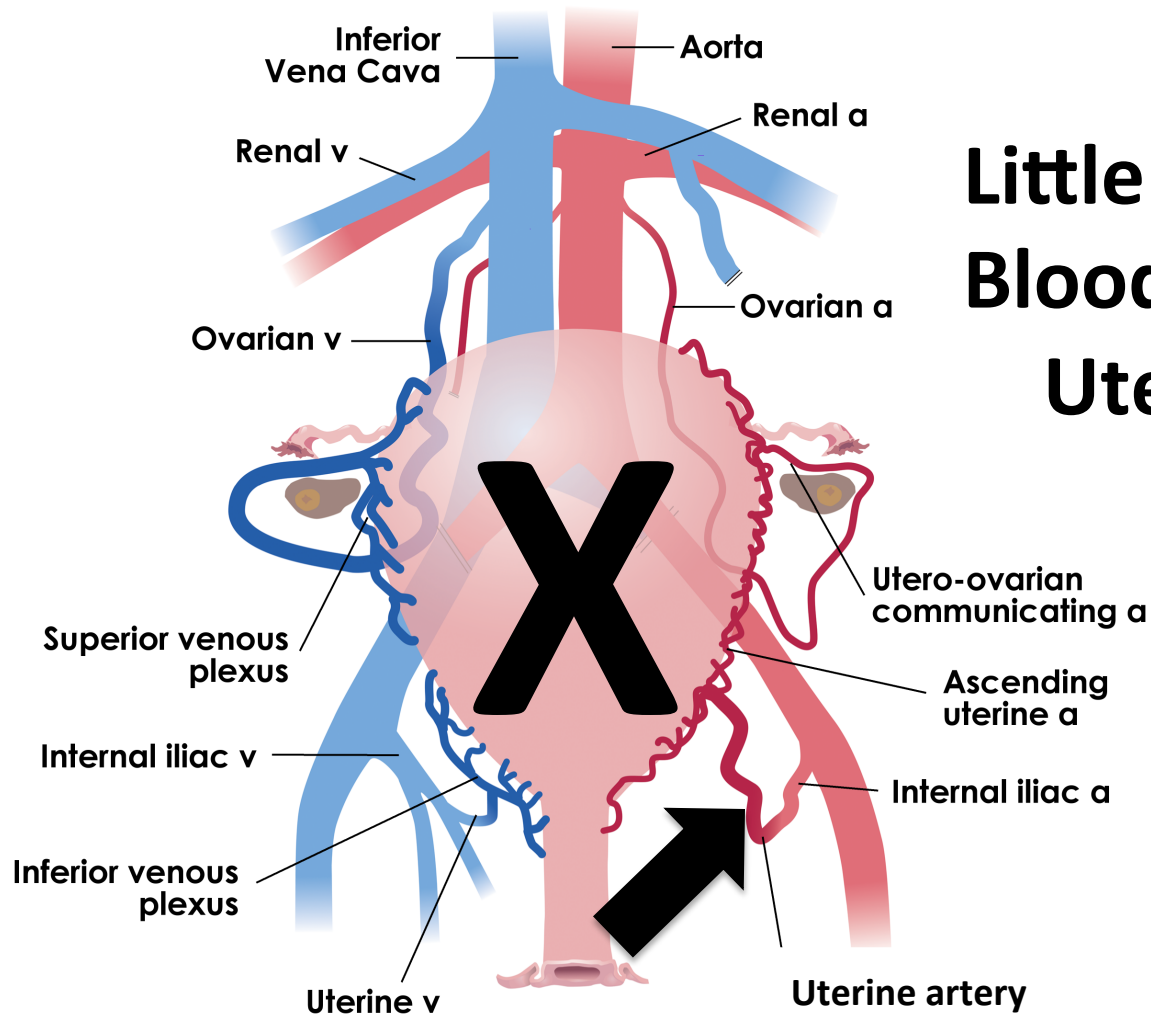


Virchow's Clot-formation Triad



Rudolf Virchow
1821 - 1902

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- 2. Vessel wall injury = Placental Separation** (Rx: Active Mgt – Traction)
- 3. Stasis = Contractions** (Rx: Drugs, Massage, Balloons, Direct arterial inflow control)



**Little or No
Blood Flow
Uterus**



Definitive Treatments: Stop blood flow Uterine Arteries

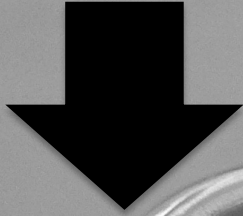
Surgical Ligation of the Uterine Arteries

Catheter-directed Uterine Artery Embolization

Doppler-directed Uterine Artery Clamps



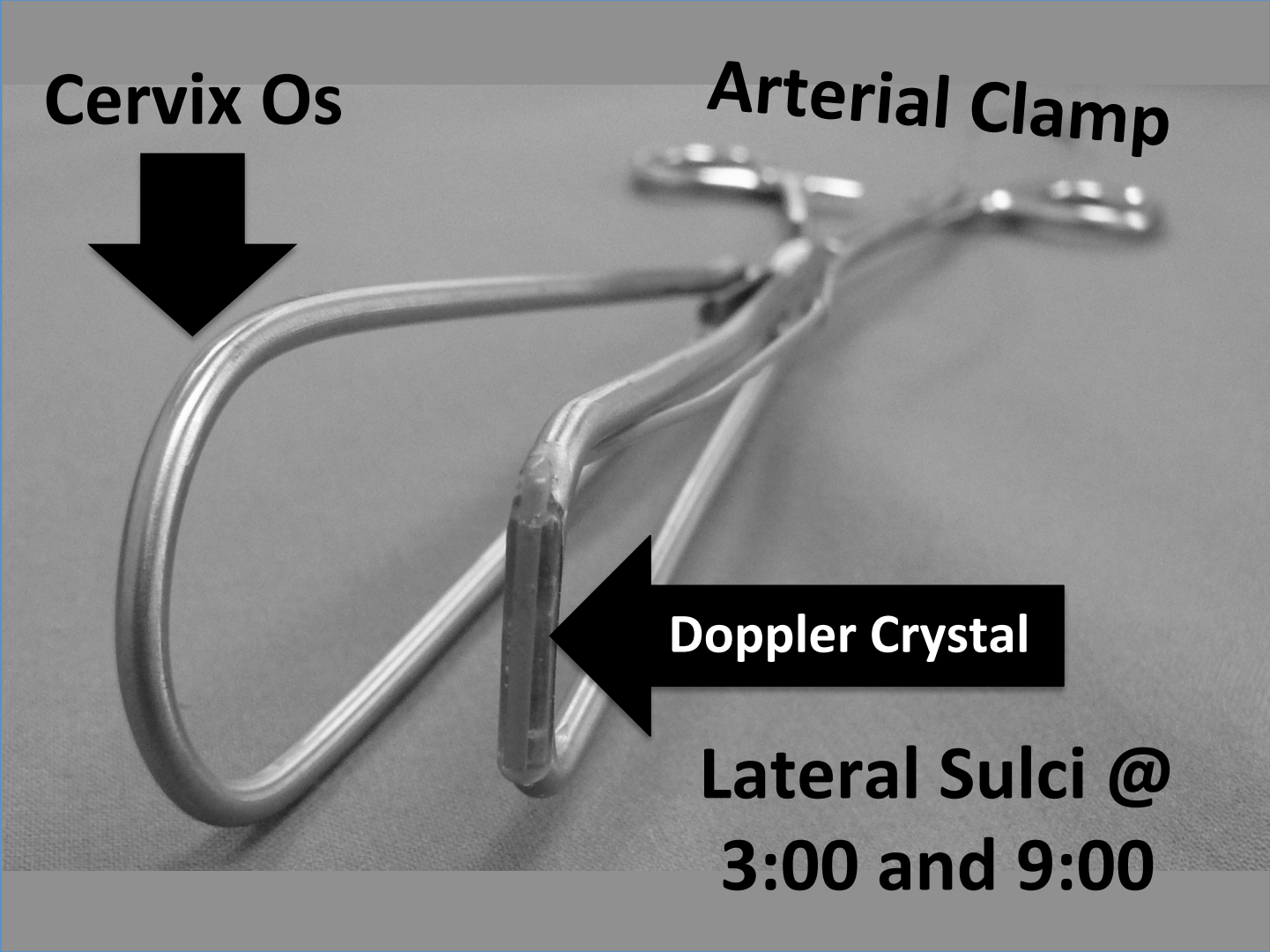
Cervix Os



Arterial Clamp

Doppler Crystal

**Lateral Sulci @
3:00 and 9:00**



The End