Embolization Procedures

Geniculate Artery
Prostate Artery
Uterine Artery

BRANDON CUSTER MD
INTERVENTIONAL RADIOLOGY

1

Embolization Procedures - General

- Minimally invasive outpatient procedures performed through a single 1 cm dermatotomy.
- Procedures are performed under conscious sedation, typically using Fentanyl and Versed.
- Angiography is used to guide catheters to the target vessels, most commonly through a common femoral artery access.
- Once at the target vessel (Geniculate, Prostate, Uterine) microscopic spheres are injected to block the small vessels.
- This minimally invasive technique helps maintain low complication rates, decreases hospital stays, and improves patient satisfaction.
- All three procedures take 1-2 hours to perform and the patient is discharged home the same day after a 2-6 hr recovery

2

Geniculate Artery Embolization

Developed over the past 10 years for treatment of osteoarthritic knee pain

Total Knee Arthroplasty has long been mainstay of treatment for severe OA; however, there are many surgical consideration that limit candidacy

- Young Age, Old Age, DM2, Obesity, malnutrition, CAD

NSAIDS, Joint Injections, and physical therapy are the mainstay of treatment for Mild-Moderate Disease, but commonly are insufficient at controlling pain.

Geniculate artery embolization offers a treatment alternative for patients with moderate OA and symptoms uncontrolled with conventional therapy or patients who are poor surgical candidates.

3

Pathophysiology of Osteoarthritis

- Osteoarthritis (OA) is a degenerative disease of the synovial joints characterized by progressive cartilage loss and bony remodeling which results in joint pain and dysfunction.
- Classically this was viewed as a degenerative "wear and tear" process; however, we now know the process is more complex.
- OA is a whole joint disease with low grade, chronic inflammation of the synovial lining playing a central role. OA is now viewed as a complex joint pathology caused by multifactorial inflammatory and metabolic factors which lead to joint damage.
- Chronic synovitis leads to the release of pro-inflammatory mediators such as cytokines, lipid mediators, and reactive oxygen species which are responsible for the release of proteolytic enzymes. This is turn results in degradation of the extracellular matrix and mediates cartilage loss.
- An early diagnostic feature of osteoarthritis is **Neoangiogenesis** in the subchondral bone with blood vessel invasion into the avascular cartilage. Angiogenesis is a proven factor in the pathogenesis of OA, Facilitating the invasion of inflammatory cells and increasing local pain receptors which contribute to structural damage and pain.

4

Pathophysiology of Osteoarthritis

- Neoangiogenesis in the joint space leads to the creation of channels into the noncalcified cartilage from the subchondral bone spaces which mechanically weakens the cartilage.
- The pro-angiogenic factors that lead to new vessel formation share a common pathway with sensory nerves. Therefore, **new sensory nerves are produced** along these vascular channels, invading the noncalcified cartilage, osteophytes, and inner regions of menisci. These areas are not typically innervated **and now contribute to pain response**.
- A Negative Feedback loop:
  - Joint destruction/pain → inflammatory cytokines, ROS, immune mediators → Neoangiogenesis and Neuroinflammation → More joint destruction/pain
- **Geniculate Artery Embolization acts to break this Cycle**.

5

Patient Selection

Any patients with Moderate-Severe Osteoarthritis uncontrolled with conservative measures and not Surgical Candidates.

Uncontrolled pain is Quantified using a Visual Analog Scale, with a score of at least 5/10 being an indication.

Contraindications:
- Mild knee pain (VAS <5)
- Severe Peripheral Artery Disease
- Severe Renal Insufficiency (eGRF <45)
- Active Infection
- Uncorrectable coagulopathy

6

Workup

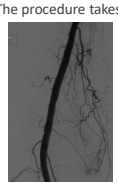
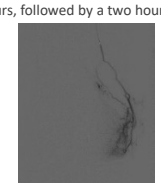
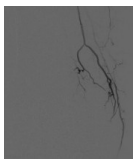
- Clinic Visit for History and Physical: This includes Identifying the points of most severe pain (usually 1-3 points)
- Review of Imaging
  - Preprocedural MRI to exclude underlying structural issues that could account for knee pain.
- Labs: CBC, BMP, INR
- Visual Analog Scale for Pain for pre-procedural Baseline
- Procedural Expectations:
  - Elective outpatient procedure
  - Preprocedure fasting at midnight
  - Hold Oral anticoagulation or antiplatelet medications
  - On average, 2.3 geniculate treated/procedure and procedure time is 80 minutes.

7

Procedure

Procedure performed as outpatient under conscious sedation using a single femoral artery access

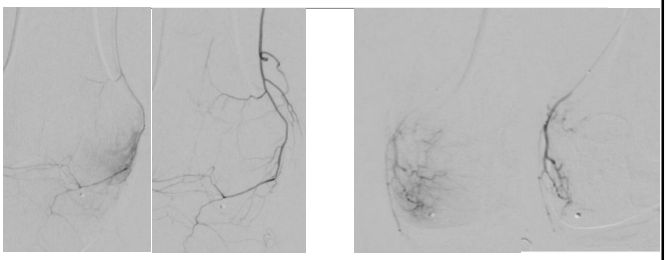
The procedure takes 1-2 hours, followed by a two hour recovery

Post Procedure: No lifting more than 10 lbs or strenuous activity for 7-10 days

8

Procedural Images



9

Efficacy

Decreased Pain is Primary outcome

Outcome and Time	Score Change from Baseline*	Percent Change from Baseline*
VAS pain		
Month 1	−4.5 (−9 to 2)	−60.20 (−100 to 33.33)
Month 3	−4.5 (−10 to 2)	−60.20 (−100 to 33.33)
Month 6	−5.0 (−8.5 to −1)	−62.50 (−100 to −10)
Month 12	−5.0 (−9 to 0)	−66.67 (−100 to 0)

Maximum improvement tends to occur by three months, but improvement is common at 1 month

Newer studies have shown durable improvement in pain score for over 24 months.

Studies are also showing improvement in patients with severe Osteoarthritis (Bone on Bone), although improvement is less significant.

10

Complications

- No major adverse events with permanent sequalae have been reported in the literature.
- The most common minor complication is transient skin mottling (10-65%) secondary to nontarget embolization of cutaneous branches. This is self limiting and improves over time without further treatment. Again, Ice pack on the skin during treatment can mitigate this.
- Other Minor Complications (rate):
  - Skin ulceration (0.3%)
  - Groin site hematoma (0.6%)
  - Fat necrosis (0.1%)
  - Bone Infarcts (0.1%)
  - Plantar paresthesia (0.1%) – reduced with larger particles (>200)
  - Nausea/Vomiting (0.1%)

11

Geniculate Artery Embolization Summary

Low Risk, High Reward treatment option for patients with Moderate osteoarthritis inadequately controlled with Conservative measures.

Alternative treatment option for patient with moderate-severe OA who are not surgical candidates.

12

Prostate Artery Embolization (PAE)

Embolization procedure to treat Benign Prostate Hypertrophy (BPH) with Moderate to Severe Lower Urinary Tract Symptoms (determined by IPSS).

Traditionally BPH is treated with Transurethral Prostatectomy (TURP). Unfortunately, TURP is associated with significant morbidity with incontinence and retrograde ejaculation common complications. The risks can be a deterrent to treatment for many patients.

Prostate Artery Embolization was recently recognized by the American Urology Association (AUA) as an alternative treatment modality for the management of LUTS in BPH.

13

Epidemiology of BPH

- One of the most common diseases of aging in men
- The prostate grows 2-2.5% per year (Krimpen and Baltimore, Longitudinal study on aging)
- Clinically Effects 50% of men in their 50s and 80% of men in their 80s
- Strong Genetic component
- Modifiable risk factors: Diet, Physical Activity, Alcohol use, obesity

14

Patient workup

- Outpatient IR Clinic Visit for full History and Physical
- Administration of the International Prostate Symptom Score (IPSS) which is used to quantify the severity of Lower Urinary Tract Symptoms (LUTS) association with BPH
- Discussion of treatment options which include TURP, Urolift, Rezum, HoLEP, Open prostatectomy, and Prostate artery Embolization.
- If patient is a good candidate, a PreProcedural CT Angiogram to evaluate vascular anatomy is ordered and guide treatment planning is ordered.

15

PAE Patient Selection

- Moderate IPSS
- No limit to prostate size
- Poor Surgical Candidates
- Patients Averse TURP
- Patients on Anticoagulation

In the past month:	Not at All	Less than 1 in 5 Times	Less than Half the Time	About Half the Time	More than Half the Time	Almost Always	Your score
1. Incomplete Emptying How often have you had the sensation of not emptying your bladder?	0	1	2	3	4	5	
2. Frequency How often have you had to urinate less than every two hours?	0	1	2	3	4	5	
3. Intermittency How often have you found you stopped and started again several times when you urinated?	0	1	2	3	4	5	
4. Urgency How often have you found it difficult to postpone urination?	0	1	2	3	4	5	
5. Weak Stream How often have you had a weak urinary stream?	0	1	2	3	4	5	
6. Straining How often have you had to strain to start urination?	0	1	2	3	4	5	
	None	1 Time	2 Times	3 Times	4 Times	5 Times	
7. Nocturia How many times did you typically get up at night to urinate?	0	1	2	3	4	5	
Total I-PSS Score							

Score: 1-7: *Mild* 8-19: *Moderate* 20-35: *Severe*

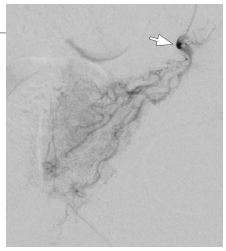
16

Procedure

Procedure performed through a single femoral artery access.

Procedure takes 1-2 hours, followed by a two hour recovery

Post Procedure: No Lifting more than 10 lbs or strenuous activity for 7-10 days



17

Safety

Minimally invasive Outpatient procedure performed under Moderate Sedation. (TURP Typically involves hospital admission)

Complications are few and minor: Access site hematoma, temporary hematospermia, arterial injury, and nontarget embolization are most common.

Complex anatomy: risk of non-target embolization to bowel, bladder, penis is low with experienced providers.

Risk of retrograde ejaculation (60-65% in TURP), urinary incontinence, sexual disfunction (some PAE studies actually show improved sexual function) is **0%** in most PAE studies

18

Efficacy

Mean improvement in IPSS is **10 points** and occurs by **one month** following embolization (Not statistically different from TURP)

Symptomatic Improvement is durable for as far as 6 years in studies of PAE.

Improvement in overall quality of life is similar to TURP

Patient satisfaction following the procedure is significantly higher than TURP

Statistically significant improvement in quantitative measures such as prostate size, flow rates, and post-void residuals at 6-12 months (TAKES TIME)

- This is improvement is delayed and less robust compared to TURP

19

PAE Summary

Minimally invasive outpatient procedure for the management of lower urinary tract symptoms associated with BPH.

Proven Safety and efficacy with a significantly reduced complications profile compared to the gold standard TURP.

Ideal for patients who are poor surgical candidates, are averse to potential TURP complications such as Retrograde ejaculation, incontinence, or sexual disfunction, or who value short hospital stays and quick return to normal activity.

20

Uterine Artery Embolization (UAE)

Fibroids (Leiomyomas)

- Benign smooth muscle tumor of the uterus
- Most common solid and symptomatic neoplasm in women, affecting 1 in 4 adult women
- Leading indication for hysterectomy which is the gold standard therapy. This is a big surgery requiring general anesthesia with associated risks and hospital stays.
- Uterine artery embolization is an American College of Obstetricians and Gynecologists (ACOG) alternative therapy for patients who **desire future fertility or would like to retain their uterus**

21

Fibroid Risk Factors

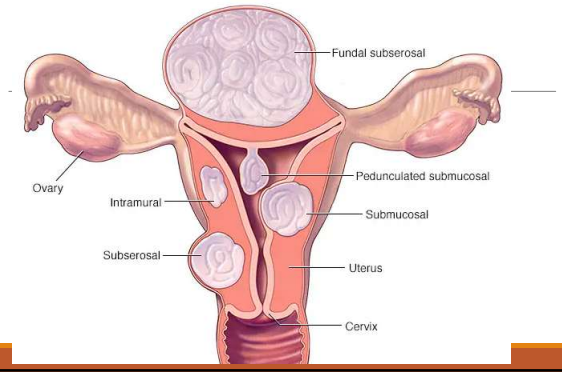
- Age 30-50, increasing prevalence with increasing age during reproductive years
- African Americans have 2-3 times higher rates.
- Genetics/Family history
- Obesity
- Hormonal exposure during reproductive years
- Nulliparity

22

Presenting Symptoms

- Menorrhagia (Bleeding Symptoms)
  - Heavy Menstrual Bleeding
  - Prolonged Uterine Bleeding
  - Iron Deficiency Anemia
  - Blood Transfusion
- Bulk Symptoms
  - Abdominal Pain/Pressure
  - Urinary Frequency
  - Urinary Urgency
  - Constipation

23



24

Patient workup

- Outpatient IR Clinic Visit for full History and Physical
- Review of prior and currently up to date Pap Smears to exclude Malignancy.
- Laboratory testing with CBC, BMP, INR
- Up to date imaging with Ultrasound or MRI showing fibroids
- Discussion of treatment options including hysterectomy, myomectomy, and Uterine Artery Embolization including pros and cons of each.
- Procedural and Postprocedural expectations

25

Contraindications

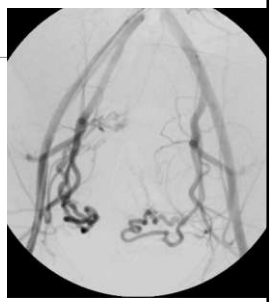
- Active Pregnancy
- Active Infection
- Uterine Malignancy
- Severe Renal Insufficiency (eGFR <45)
- Uncorrectable coagulopathy

26

Procedure

Procedure performed through a single femoral artery access under conscious sedation.

Procedure takes 1-2 hours, followed by a two hour recovery



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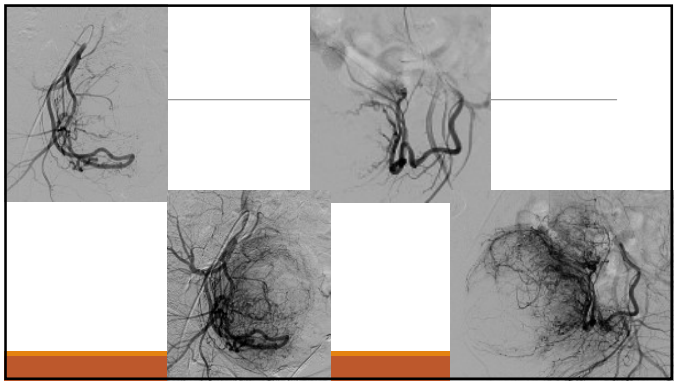

28

Periprocedural Expectations

Unlike previously described embolization procedures, inducing fibroid ischemia is typically **Painful**.

Most patients are still discharged as outpatient with a short course of oral pain medication. Pain typically improves greatly within 24 hours

A small percentage of patients are admitted for overnight pain control using IV medications.

Some patients (especially submucosal or pedunculated fibroids) will experience **sloughing and vaginal discharge** of necrotic material for up to 1 year.

29

Safety

UAE is a minimally invasive therapy with low complication rates and significantly reduced hospital stays compared to surgical options.

Minor Complications are rare and Include:

- Post-Embolization Pain syndrome
- Groin site hematoma
- Nontarget embolization leading to vaginal dryness/dyspareunia
- Abscess/Infection (< 2.5%)
- Effects on Future pregnancy are unknown, although we know future pregnancy is possible

30

UAE Efficacy

Bleeding Symptoms

- Abnormal uterine bleeding improves in up to **95%** of patient after UAE.
- Improvement in bleeding symptoms is almost immediate given mechanism of embolization

Bulk Symptoms

- Bulk symptoms improve in approximately **70%** of patients after UAE
- Improvement in Bulk symptoms **takes time**, Fibroid volume reduces by 40-75% at 6-12 months after treatment.

31

Uterine Artery Embolization Summary

Minimally invasive outpatient treatment options for patients with symptomatic uterine fibroids.

95% efficacy for bleeding symptoms and 70% efficacy for bulk symptoms with minimal complications

Ideal for patients who are poor surgical candidates, are averse to hysterectomy and its complications, who want to maintain fertility, or who value short hospital stays and quick return to normal activity.

32

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33

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34

Questions?

If you think a patient of yours is a good candidate for GAE, PAE,or Urinary Artery Embolization please:

- Place KU IR outpatient referral via FAX to (913)574-0059
  - Include indication, clinic notes, labs, and imaging if possible
- My personal Email: bcuster@kumc.edu
- KU IR Scheduling: (913)588-1030

35

36

37

38