

**THREE-DIMENSIONAL COLOR DOPPLER
SONOGRAPHIC ASSESSMENT OF CHANGES IN
VOLUME AND VASCULARITY OF FIBROIDS -
BEFORE AND AFTER UTERINE ARTERY
EMBOLIZATION**

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CERTIFICATE

This is to certify that the dissertation entitled “**THREE DIMENSIONAL COLOR DOPPLER SONOGRAPHIC ASSESSMENT OF CHANGES IN VOLUME AND VASCULARITY OF FIBROIDS - BEFORE AND AFTER UTERINE ARTERY EMBOLIZATION**” presented here is the bonafide original work done by **Dr.S.Anbumalar**, in the Barnard Institute of Radiology and Madras Medical College, Chennai 600003, in partial fulfilment of the requirements for the **M.D Radiodiagnosis**, Branch - VIII Examination of the Tamil Nadu Dr.MGR Medical University to be held in April 2012.

Dr.S.KALPANA,
Associate Prof. and Guide,
Barnard Institute of Radiology,
Madras Medical College,
Chennai – 600 003.

Dr.S.SUNDARESWARAN,
Chief Civil Surgeon and Co-Guide,
Barnard Institute of Radiology,
Madras Medical College,
Chennai – 600 003.

Prof.N.KAILASANATHAN,
Professor of Radiology,
Barnard Institute of Radiology,
Madras Medical College,
Chennai – 600 003.

Prof.VANITHA .K,
Director and Professor,
Barnard Institute of Radiology,
Madras Medical College,
Chennai – 600 003.

DEAN

**Rajiv Gandhi Government General Hospital and
Madras Medical College, Chennai - 600 003.**

DECLARATION

I, **Dr.S.Anbumalar**, solemnly declare that this dissertation entitled, **“THREE DIMENSIONAL COLOR DOPPLER SONOGRAPHIC ASSESSMENT OF CHANGES IN VOLUME AND VASCULARITY OF FIBROIDS - BEFORE AND AFTER UTERINE ARTERY EMBOLIZATION”** is a bonafide work done by me for the degree of M.D. during the period of **June 2009 to May 2012** under the guidance and supervision of **Prof.Vanitha .K, M.D., D.M.R.D., D.R.M.**, Director and Professor, Barnard Institute of Radiology, Madras Medical College, Chennai – 600 003. This dissertation is submitted to The Tamil Nadu Dr.M.G.R. Medical University, towards partial fulfillment of requirement for the award of M.D. Degree in Radiodiagnosis, (Branch- VIII).

Place: Chennai
Date:

Signature of the Candidate
(Dr.S.Anbumalar)

Dr.S.KALPANA,
Associate Prof. and Guide,
Barnard Institute of Radiology,
Madras Medical College,
Chennai – 600 003.

Dr.S.SUNDARESWARAN,
Chief Civil Surgeon and Co-Guide,
Barnard Institute of Radiology,
Madras Medical College,
Chennai – 600 003.

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INTRODUCTION

Menorrhagia is defined as bleeding that originates from the uterus . In developing countries, the majority of cases are due to fibroid uterus. Massive menorrhagia is a major clinical and surgical problem with a mortality of 80%, which is most often related to hemodynamic instability.^{3,4}

Uterine fibroids are the most frequent tumors of the female genital tract, occurring in 20–50% of women who are older than 40 years. Uterine fibroid, the most common cause of nonacute abnormal uterine bleeding, is also the most common solid uterine neoplasm occurring in 20–40% of all women during their reproductive period¹⁰.

Uterine artery embolization (UAE) was introduced in the 1970s to treat postpartum hemorrhage¹⁴. In the 1990s, this technique was successfully used preoperatively 3–10 days before myomectomy to reduce bleeding during the surgical phase¹⁴. In 1995, Ravina et al.¹⁵ proposed embolization of uterine arteries as an alternative to surgical treatment of uterine leiomyoma.

MASSIVE MENORRHAGIA :

A) DEFINITION

Menorrhagia is defined as heavy or prolonged uterine bleeding that occurs at regular intervals. Some sources define menorrhagia further as the loss of ≥ 80 mL blood per cycle or bleeding > 7 days.

B) CLINICAL CONSIDERATIONS

Conservative management of massive menorrhagia carries a mortality rate of 50%–100%⁵ and the mortality is up to 35% even in patients undergoing operation⁶. Surgery remains the procedure of choice in the treatment of massive menorrhagia caused by specific conditions, such as dysfunctional uterine bleeding, hypertension, and endocrine etiology, that is resistant to other therapies¹².

Embolization has become a first-line treatment for symptomatic uterine fibroid⁸. Therapeutic uterine artery embolization is a good treatment adjunct to control uterine bleeding and reduces the need for high-risk hysterectomy⁷. UAE may help to avoid surgery in patients who are not good surgical candidates. Should menorrhagia recur in these patients, repeat embolization can be performed safely¹⁰. Even in surgical candidates, UAE is effective in preparing the patient for elective rather than high-risk surgery⁷.

The goal of uterine fibroid embolisation is to stop blood flow to the uterus through the uterine arteries, thus depriving myomas of their blood supply⁹ to produce ischemic infarction .

Various non uterine systemic arteries, as well as ovarian arteries, may also contribute to menorrhagia, and their implication is dependent on the underlying location of fibroid^{13,14,15,16,17,18}. Non Uterine systemic collateral vessels must be particularly suspected when there is evidence of larger size of

fibroid^{11,19}. Recognition and occlusion of Non Uterine systemic collaterals providing blood to hypervascular fibroid lesions is essential for successful percutaneous embolotherapy of fibroid^{2,17,18,19,20}. Prior to embolization, the interventional radiologist needs to be aware of the dominant side of the uterine artery bleeding, and the most likely source of bleeding has to be identified to determine which vessel is to be occluded. Since the uterine circulation is the most frequent source of menorrhagia, embolization of uterine arteries is usually the favored therapeutic option to stop the bleeding^{11,21}.

Recent important technologic advances in three dimensional color doppler sonography, have introduced a comprehensive, noninvasive method of evaluating the entire uterus, allowing detailed assessment of the vascularity and volume of fibroid^{1,2}. Three dimensional color doppler sonography can also help in the planning of a focused and efficient non uterine systemic artery embolization. It provides a precise road map for the interventional radiologist in performing an endovascular treatment for menorrhagia. Uterine artery embolization leads to good technical success and fibroid volume reduction¹⁰.

The aim of this study was to evaluate the effectiveness of three dimensional color Doppler sonography in assessment of volume and vascularity reduction of fibroids treated by uterine artery embolisation.

AIM OF THE STUDY

The purpose of the present study is to prospectively evaluate the accuracy of three-dimensional color doppler sonography in depicting changes in fibroid volume and vascularity of pre and post uterine artery embolisation in patients undergoing treatment of fibroid.

REVIEW OF LITERATURE

RELEVANT ANATOMY

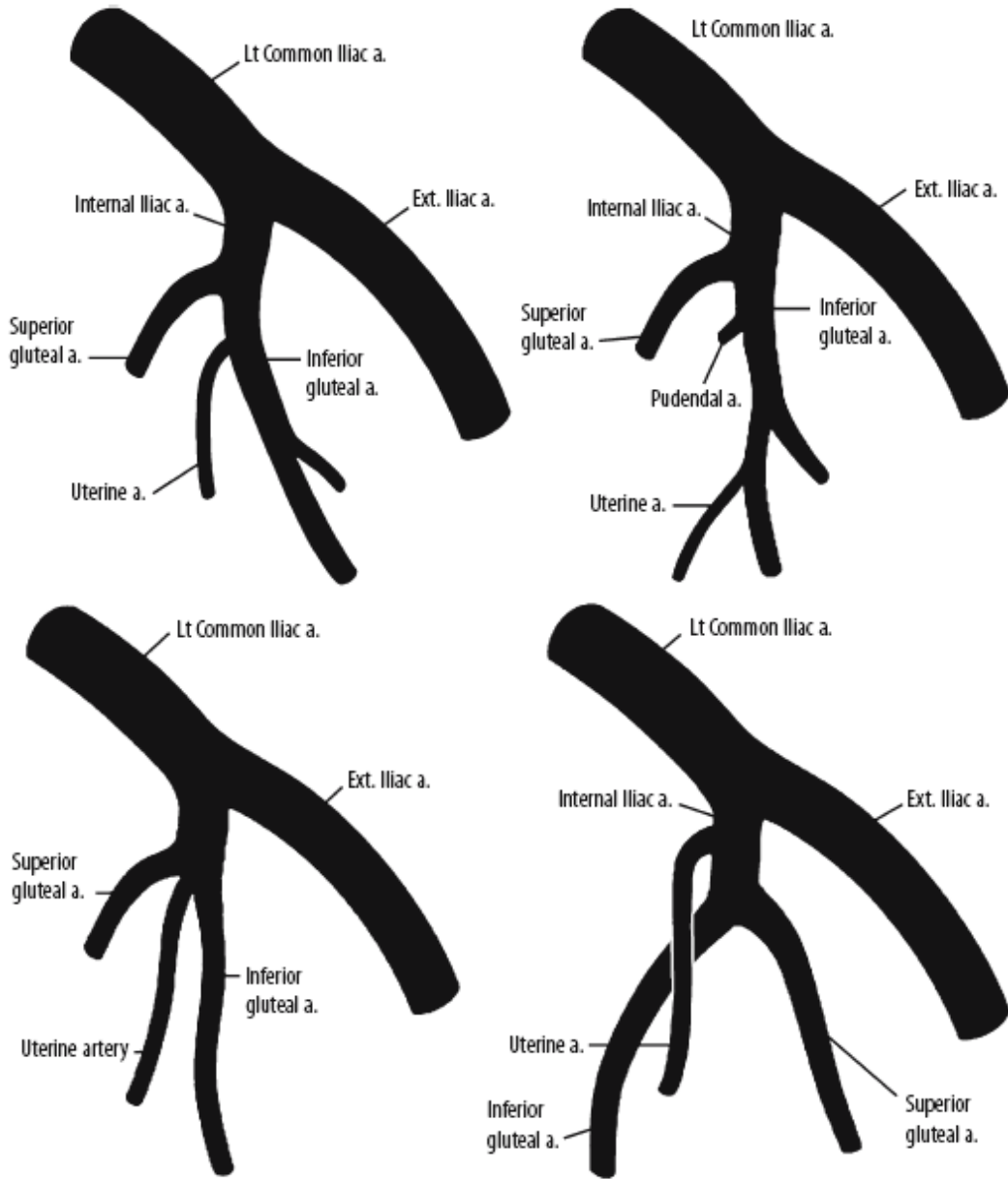
Branches of internal iliac artery is given below,

Internal iliac artery	
Branches of Anterior divisions	Branches of Posterior divisions
Superior vesical	Superior gluteal artery
Uterine artery	Illiolumbar artery
Middle rectal	Lateral sacral artery
Obturator	
Internal pudendal artery	
Inferior gluteal artery	

Uterine Artery is the first branch of anterior division of internal iliac artery . It has 3 segments

- Descending segment goes along pelvic wall
- Transverse segment goes to the midline
- Ascending segment along the uterus

COMMON VARIANTS IN BRANCHING OF INTERNAL ILLAC ARTERY



The uterus is supplied by a single arterial vascular system composed of the uterine artery, which account for 99% of the arterial blood supply to the uterus. Uterine artery has a characteristic U shape with descending segment that parallels lateral pelvic wall , a transverse segment that crosses the distal ureter at the level of cervix and a ascending segment that courses along the uterine margin at the edge of the broad ligament

The uterine vasculature feeding the uterus is situated close to the ovarian arteries and the two systems are connected by anastomoses.

NORMAL AND VARIANT ARTERIAL SUPPLY TO THE UTERUS

Normal arterial anatomy and variants are the key to the uterine artery embolisation.

Normal variants : abdominal aorta origin , <1% congenital absence of both uterine arteries. 5- 10% can have retrograde utero – ovarian anastomosis of size less than 500micrometer

Possible variation in uterine artery;

- Cervico vaginal artery
- Perforating arteries, terminal branches to the fallopian tubes and ovaries
- Inferior vesicle artery has common origin

- Can have completely or partially absent uterine artery which can be bilateral.

Ovarian artery : anteromedial origin from abdominal aorta shows characteristic cork screw appearance in angiogram . 5- 10 % of ovarian artery may supply uterine fibroid.

Other sources of fibroid supply is from :

Round ligament artery and lumbar artery which necessitates flush aortography after embolisation that identifies specific feeding artery.

Identification of the normal arterial anatomy and main variations in uterine fibroid tumor vascularization are key to the safety and success of the procedure²² Ovarian supply to the leiomyoma should be excluded by placing the tip of the catheter at L1 level during initial flush aortogram. If discovered, ovarian artery can also be safely embolized⁵⁵.

Special mention :

Pedunculated subserosal fibroid may have arterial pedicle from adjacent iliac, renal or aortic branches. After embolisation it may separate from uterus and drift into peritoneal cavity⁵⁵. Bicornuate uterus may be supplied by one uterine artery only .

Differential diagnosis

1. Endometrial polyp with a single feeding vessel from an intracavitary submucosal fibroid.
2. Adenomyosis is distinguished by rain drop appearance, multiple scattered vessels or intratumoral vascularity, but fibroid has feeding from peripheral vessels.

3. EMBOLOTHERAPHY:

Embolization is defined as the "therapeutic introduction of various substances into the circulation to occlude selective vessels, either to arrest or prevent haemorrhage, to devitalize a structure, tumour or organ.

UAE- EMBOLIC AGENTS:

There are two different embolic agents used commonly

1. Permanent embolic agent is polyvinyl alcohol particles (PVA).
2. Temporary embolic agent is gelfoam.

Polyvinyl alcohol particles (PVA):

- PVA is the most often used embolic agents in patients with uterine fibroids.

- PVA is permanent embolic agent is injected to occlude predominantly peri - fibroidal arterial plexus seen surrounding the fibroid .
- Varying Particle sizes of 355-500 μm and 500-710 μm are available commercially. Commonly used particle size is of 355-500 μm .

GELFOAM (GELATIN SPONGE) :

- Following gelfoam is injected to occlude the main uterine artery .
- Gelfoam (gelatin sponge) is the most commonly used material. It is a readily available, slowly resorbable material that can be used as individual pledgets, torpedoes, or part of a slurry. For initial distal occlusion, 0.5- to 2.0-mm cubes can be used followed by 3- to 4-mm pledgets or torpedoes for more proximal occlusion. Gelfoam pledgets are mixed with dilute contrast within a 1 - or 3-ml syringe. Since the Gelfoam pledgets float within the contrast saline solution, the tip of the syringe should be pointed upward. A theoretical disadvantage of Gelfoam particles is that their resorption may lead to more rapid recanalization and recurrent bleeding.

Three-Dimensional Color Doppler Sonography in pre and post Uterine Artery Embolisation of Fibroids :

Arthur C. Fleischer, Edwin F. Donnelly, et al. Three-Dimensional Color Doppler Sonography (3D CDS) before and after fibroid embolization 2000⁹. Quantitated 3D CDS provides global depiction of the small arteries and veins within the fibroid and provides an estimate of completeness of embolization. 3D CDS can be used to for predict which patients will be responders or nonresponders. 12 of 31 fibroids were hypervascular, 10 of 31 were isovascular, and 9 of 31 were hypovascular. Of the 12 hypervascular fibroids, 10 (83%) became reduced in volume by 50%, whereas only 4 of 10 (40%) isovascular fibroids and 2 of 9 (22%) hypovascular fibroids decreased in volume by 50%.

Sangeet Ghai, MD, Dheeraj K. Rajan, et al . Uterine artery embolization for leiomyomas: Pre and post procedural evaluation with ultrasound (US), 2005⁴⁶. US is a readily available first-line imaging modality and a well-accepted method for both pre- and postprocedural evaluation of patients who undergo UAE. Follow-up imaging is performed at 3, 6, and 12 months after UAE to quantify volume reduction in the uterus and leiomyoma. Volume reduction of the dominant fibroid is greater than that of the uterus, and follow-up US has shown a reduction in uterine size of up to 40%, with the dominant fibroid decreasing in size by up to 70% (9,39,40). The majority of fibroid

shrinkage occurs within a 6-month period following embolization, with further reduction in size occurring between 6 and 12 months.

C. Joseph Muniz, MD, Arthur C. et al⁶ states that the Three-dimensional Color Doppler Sonography and Uterine Artery Arteriography of Fibroids Assessment of Changes in Vascularity Before and After Embolization, 2002 . In 13 (87%) of 15 patients there was agreement; in 2 (13%) of 15 there was disagreement. In both cases of disagreement, three-dimensional color Doppler sonography showed collateral flow not depicted by uterine artery arteriography. The mean reduction in quantitated vascularity after uterine artery embolization was 44% (range, 19%–78%). Three-dimensional color Doppler sonography accurately depicts fibroid vascularity and in some cases can reveal collateral flow not depicted by uterine artery arteriography.

Jean-Pierre Pelage, Julien Cazejust, et al 2005²³. Uterine Fibroid Vascularization and Clinical Relevance to Uterine Fibroid Embolization, Identification of the normal arterial anatomy and main variations in uterine fibroid tumor vascularization are key to the safety and success of the procedure.

Kitamura, Susan M Ascher, et al. Imaging Manifestations of Complications Associated with Uterine Artery Embolization, 2005²⁸ Fibroids in contact with the endometrial surface, including submucosal fibroids or intramural fibroids with a submucosal component, pose an increased risk for

fibroid passage. Women over 45 years of age are at increased risk for ovarian dysfunction after UAE, because they have a higher prevalence of uterine-ovarian arterial anastomoses (43% of cases) compared with women under 45 years of age (5%).

Suhny Abbara, Boris Nikolic et al 2007⁵⁴. Frequency and extent of Uterine Perfusion via Ovarian Arteries observed during Uterine Artery Embolization for Leiomyomas, Of the visualized ovarian arteries ($n = 88$), 52% (46/88) were smaller than, 25% (22/88) were equal to, and 23% (20/88) were larger than the diameter of a 5-French catheter. The aortogram revealed that 61% (54/88) of the ovarian arteries extended into the pelvis, whereas 38% (33/88) did not. Selective injections were performed in 54 ovarian arteries. Of these, 69% (37/54) of the ovarian arteries had residual fibroid perfusion from the ovarian arteries after UAE (10 left-sided, 15 right-sided, six bilateral = 37 ovarian arteries).

Jean-Pierre Pelage et al, 2005²³ Regular PVA particles do not completely occlude the lumen of the occluded arteries because of their irregular shape and heterogeneous calibration and occlusion is completed by thrombus formation. For uterine fibroid, the recommended diameter is 700–900 μm (compared to 500–700 μm tris-acryl microspheres) for PVA microspheres and 900 μm for hydrogel polyzene-F microspheres.

Kenneth Murphy, et al ²⁷ has given that non target embolization of should be avoided to minimize the risk of postembolization sexual dysfunction. the aim of embolization is not to occlude the UA, but to occlude vessels that supply the fibroid(s) while sparing perfusion to the normal uterus proper.

Bruce McLucas, Rita Perrella, et al 2002⁴, Role of Uterine Artery Doppler Flow in Fibroid Embolization, Initial peak systolic velocity was positively correlated with the size and shrinkage of myomas and uterine volume. Peak systolic velocity was positively correlated with the size and load of embolization particles and was significantly lower (mean, 33.2 cm/s) in patients with adenomyosis than those without adenomyosis (mean, 39.3 cm/s). High peak systolic velocity (>64 cm/s) was a significant predictor of failure. Postembolization peak systolic velocity (mean, 21.85 cm/s) was significantly lower than preembolization peak systolic velocity (mean, 40.33 cm/s) and was not correlated with uterine fibroid embolization variables.

TP Jain, DN Srivastava, RP Sahu, et al, (2007)²³ clearly demonstrated Uterine artery embolization for symptomatic fibroids with imaging follow up, All 32 patients had successful procedures. Overall, 25 patients responded, giving a clinical success rate of 78.12%. Mean reduction in volume of uterus and fibroid was 33 and 59.7% and 48.9 and 75.5% on US at 3 and 12 months respectively, and 33.3 and 58.6% on MRI at 3 months. Volume reduction on US and MRI at 3 months was highly correlative.

E. Aitken, A. Khaund, et al 2006, ¹⁰ the normal human myometrium has a vascular spatial gradient absent in small fibroids, A quantitative gradient

within the myometrial vascular system, which is absent in fibroids, has been demonstrated. These structural differences between diseased and healthy tissues are probably because of differing expression of angiogenic growth factors. Regarding UAE common indications are Symptomatic Fibroids and Post Partum Haemorrhage

Uterine ischemia causes pain so limited embolisation is essential, Julien Cazejust, et al ²² Drs.Lussenhop and Spence first occluded a cerebral arteriovenous malformation under radiographic and catheter guidance in 1960. Charles Dotter is acknowledged as founder of the specialty from his landmark work on angioplasty, first published in circulation in 1960. Another who contributed early was Dr. Baum, who developed techniques for controlling G-I bleeding using Vasopressin.

Potential Complications

The common UAE complications are :

Premature menopause	2-5%
Expulsion of fibroid	< 1%
Sepsis	< 1%
Emergent hysterectomy	Nil
Death	Nil

Following Drs. Lussenhops and Doppman in the USA, Japanese physicians developed selective catheter techniques for treating spinal cord AVMs. In 1972, Dr. Dotter and Dr. Rosch³⁵ again developed techniques for controlling bleeding due to ulcer disease by embolizing autologous clots. Dr. White et al first used this technique successfully in 1974 to actually control ulcer bleeding with the survival of patient survived. Early in the 1970s, many radiologists began to use embolotherapy for lifesaving haemorrhages.

Since 1960's, embolization of uterine artery has been used to treat post partum haemorrhage. Uterine artery embolisation was used to control heavy bleeding from cervical carcinoma. A recent case report from Ottawa hospital, Canada says that uterine artery embolisation was used to control bleeding from cervical pregnancy. The embolic agents used are polyvinyl alcohol, acrylic spheres, gelfoam, steel coils and these are approved by the U.S. Food and Drug Administration (FDA) for this purpose.

Uterine Artery Embolization for fibroid uterus was first used as a technique to limit blood loss during surgical removal of fibroids, and performed well before the surgery. However, it was found that after embolization and while awaiting surgery many patients no longer had symptoms and frequently the operation itself proved to be unnecessary. UAE was introduced as a treatment for fibroids in 1992 in Paris by Dr. Jacques-Henri Ravina, a gynaecologist. The treatment was first performed in the U.S. at the University of California at Los Angeles (UCLA). There are now many such

centres on the world performing UAE to treat uterine fibroids. Mahmood et al³² (2002) from Department of Vascular and Interventional Radiology, Stanford University analyzed the outcomes of 111 consecutive patients who underwent abdominal myomectomy (n = 44) or fibroid embolization (n = 67) over a 30-month period. The respective observed success rates in abdominal myomectomy and uterine fibroid embolization patients were 64% versus 92% for menorrhagia ($p < 0.05$), 54% versus 74% for pain (not significant), and 91% versus 76% for mass effect ($p < 0.05$). The complication rates were 25% (abdominal myomectomy) and 11% (uterine fibroid embolization) ($p < 0.05$). The respective secondary end points for the two procedures were 2.9 versus 0 days mean hospital stay, 8.7 versus 5.1 days of narcotics use, and 36 versus 8 days until resumption of normal activities. These differences were all statistically significant. He concluded that uterine fibroid embolization was a less invasive and safer treatment option in women with symptomatic leiomyomas than myomectomy. Menorrhagia may be better controlled with embolization and myomectomy may be a better option in patients with mass effect. Both procedures were equally effective in controlling pain.

Spies (1999)⁵² from Georgetown University Medical Centre presented results of 61 patients who underwent uterine fibroid embolization. During a 16-month period menstrual bleeding was improved in 89%, with 81% of patients moderately to marked improvement. Pelvic pain and pressure was improved in

96% of patients, with moderate to marked improvement in 79%. At initial imaging follow-up (mean, 4.4 months post procedure), median uterine volume decreased 34% ($P = .0001$) and the median dominant fibroid volume decreased 50% ($P = .0001$). Imaging at 1 year (mean, 12.3 months) after the procedure showed continued reduction with a median uterine volume reduction of 48% ($P = .0002$) and median dominant fibroid volume decrease of 78% ($P = .0002$). The authors concluded that UFE appears effective in controlling symptoms and substantially reducing fibroid volume with few complications.

Pron et al (2003)³⁸ reported on the Ontario Uterine Fibroid Embolization Trial, which enrolled 555 women. The median follow-up was 8.9 months. Menorrhagia improved in 83% of women following the procedure, dysmenorrhea improved in 77% and urinary frequency improved in 86% of women. The mean fibroid volume reduction for the dominant fibroid was 33% at 3 months. Amenorrhea occurred in 8% of women. The complication-related hysterectomy rate in the Ontario UFE Trial was 1.5% within 3 months of the embolization. 12 of the 8 procedures, 2 were for infection, 4 for persistent post embolization pain, 1 for a 10 cm prolapsed leiomyoma, and 1 for persistent vaginal bleeding.

Spies J, et al (2004)⁵⁰ done a multicenter control trial comparing the Outcome of Uterine Embolization and Hysterectomy for Leiomyomas. Study published in American Journal of Obstetrics & Gynaecology. Spies J, et al states that shorter hospital stay with UFE: < one day versus Hysterectomy 2.3

days. Return to work UFE: 10.7 days versus Hysterectomy: 32.5 days and Fewer complications (after 30 days) UFE: 12.7% versus Hysterectomy: 32%

Jain et al (2004)²¹ from All India Institute of Medical Sciences, New Delhi carried out a study to determine the effectiveness of uterine artery embolization (UAE) as a primary treatment of symptomatic fibroids. Study was carried out in total of 32 patients aged 25–49 years (mean 40.9 years). Procedure was carried out through unilateral femoral puncture using poly vinyl alcohol (PVA) particles 355–500 µm in size. All 32 patients had successful procedures. Overall, 25 patients responded, giving a clinical success rate of 78.12%. Mean reduction in volume of fibroid was 59.7% (range 31.6–83.3%) and 75.5 % (range 46.2–96.8%) on USG at 3 and 12 months. He concluded that uterine artery embolization leads to good technical success and fibroid volume reduction.

Tranquart et al (2005)⁵⁷ from France evaluated the sonographic feature of 58 women following uterine artery embolization and to assess the efficacy of embolization as the primary treatment of fibroids. Most patients were improved or free of symptoms at 3 months (90%), 6 months (92%) and 1 year (87%) and all monitored patients were free of symptoms at 2 years. Clinical failure of treatment occurred in only two cases (3%). Progressive significant reduction in fibroid size with reference to the baseline was demonstrated during follow-up from 3 months (29%) to 24 months (86%). He concluded that uterine artery embolization was a valuable endovascular method for the treatment of fibroids,

resulting in marked reduction in fibroid size and disappearance of intrafibroid vessels without reduction in uterine vascularisation

Albert. J. Smeets et al (2009)³ from Department of Radiology of St. Elisabeth Ziekenhuis in Netherlands evaluated the controversial issues of Uterine artery embolization (UAE) in patients with a large fibroid burden .Seventy-one consecutive patients (mean age, 42.5 years; median, 40 years; range, 25–52 years) with a large fibroid burden were treated by UAE between August 2000 and April 2005. There were no serious complications of UAE. During a mean follow-up of 48 months (median, 59 months; range, 6–106 months), 10 of 71 patients (14%) had a hysterectomy. Mean volume reduction of the fibroid and uterus was 44 and 43%. Mean infarction rate of the fibroid and overall fibroid infarction rate was 86 and 87%. In the vast majority of patients there was a substantial improvement of symptoms. Clinical results were similar in patients with a dominant fibroid >10 cm and in patients with large uterine volumes by diffuse fibroid disease. Their results indicate that the risk of serious complications after UAE in patients with a large fibroid burden was not increased. Moreover clinical long-term results are as good as in other patients who are treated with UAE. Therefore a large fibroid burden should not be considered a contraindication for UAE.

In another article on Uterine Fibroid Embolization Goodwin¹³ and Spies highlight few contraindications to the procedure like pregnancy, suspected cancer, active infection indeterminate endometrial or adnexal abnormalities.

They also cite the U.K. Hysterectomy or Percutaneous Embolisation for Uterine Leiomyomata (HOPEFUL)¹⁹ study, which showed 2.6% incidence of septicaemia after uterine fibroid embolization, with 1.1% of the women requiring emergency hysterectomy. Severe infection, often necessitating urgent hysterectomy, was a rare but well-established complication of uterine fibroid embolization.

The Fibroid registry²⁶ (Fibroid Registry for Outcomes Data) of 3160 patients showed an emergency hysterectomy rate of only 0.09% at 30 days. Emergency hysterectomy for bleeding has been described 4 months after uterine fibroid embolization.

In the Randomized Clinical Embolization versus Hysterectomy (EMMY)²⁷ trial, researchers in The Netherlands found those six weeks after treatment, women who underwent UFE reported higher satisfaction scores than those who had hysterectomies. Two years later, 90 percent of the women in both categories said they were satisfied with their therapies, the researchers reported in the March 2008 edition of Radiology.

Ninety percent of women who underwent UFE avoided a hysterectomy, said Scott Goodwin, M.D,⁴⁸ the lead author and a professor and chair of the Department of Radiological Sciences in the School of Medicine at the University of California, Irvine. Study results were published in the January 2008 issue of Obstetrics & Gynaecology.

Research at Georgetown University till 1999, 20,000 to 25,000 patients has had this procedure world-wide. Their initial results, along with those that have been published or presented at scientific meetings, says that symptomatic improvement in 85-90% of patients with the large majority of patients markedly improved. The improvement rate was similar for heavy menstrual bleeding and for pressure and pain symptoms. Most patients have rated this procedure as very tolerable and in almost all cases hospitalization is necessary for only one night. In some centres, the patients are treated and discharged the same day. The expected average reduction in the volume of the fibroids is 40-50% in three months, with reduction in the overall uterine volume of about 30-40%. Over time, the fibroids continue to shrink. With several years follow-up now available, it appear that fibroids which are successfully treated does not re grow.

Giovanna Tropeano et al¹¹ from Department of Obstetrics and Gynaecology, University Catholic del Sacro Cuore, Italy reports 50–60% reduction in fibroid size and 85–95% relief of symptoms following UAE. UAE offered shorter hospital stays (1–2 days for UAE versus 5–5.8 days for hysterectomy) and recovery times (9.5–28 days for UAE versus 36.2–63 days for surgery) and major complication rates (2–15% for UAE versus 2.7–20% for surgery), in 3 Randomised control trials. Four studies analysing cost-effectiveness found UAE more cost-effective than surgery. There is insufficient evidence regarding fertility and pregnancy outcome after UAE. They

concluded that good quality evidence supports the safety and effectiveness of UAE for women with symptomatic fibroids. The current available data are insufficient to routinely offer UAE to women who wish to preserve or enhance their fertility.

Hayden Homer¹⁶ Department of Obstetrics and Gynaecology, Institute for Women's Health, University College London has said that data on pregnancy following uterine artery embolisation (UAE) are scarce, with just over 200 pregnancies reported. Two small prospective trials of UAE versus surgical intervention suggest increased levels of adverse pregnancy outcomes following fibroid embolisation. This study suggests that in the absence of more robust evidence, caution should be exercised in recommending UAE to women who wants to retain their reproductive ambitions.

Joao and Marisa (2010)²⁴ studied on pregnancy out come after uterine fibroid embolisation. This study shows comparable fertility rates between the two primary uterus-sparing treatments uterine fibroid embolization (UFE) and surgical myomectomy, which is considered the gold standard for symptomatic fibroids in women who wish to conceive. Of the 743 patients who received UFE treatment, 74 wanted to conceive and had been unable. Most women opted for UFE as a fertility treatment after failure of myomectomy or in vitro fertilization or because hysterectomy was the only suggested option. Of the 74 women who wanted to become pregnant, 44 of them became pregnant

(59.5%). There are five (11.3%) ongoing pregnancies and 39 (88.7%) finished pregnancies, with 33 successful live births (84.6%), four spontaneous abortions (10.3%), one induced abortion and one stillbirth. There were 22 caesarean deliveries (66.6%), two preterm deliveries at 36 weeks (6.1%) and five low birth weights. This study concluded that in the future, UFE will probably be a first-line treatment option even for women who wish to conceive and are unable due to the presence of uterine fibroids.

Rashid. S. et al ⁴⁰ studied the effects of Uterine Artery Embolisation and Surgical Treatment on Ovarian Function in Women with Uterine Fibroids. Some studies have shown that patients treated with UAE develop amenorrhea (with rates varying from 1%–8% and as high as 14%) and have increased follicle-stimulating hormone (FSH) levels (within the menopausal range) suggesting ovarian dysfunction may occur as a consequence of UAE. This study compares the effects of UAE and surgery on ovarian function and menstrual cycle characteristics in women with uterine fibroids. The impact of age on ovarian function was also studied. All surgical patients had ovarian conservation at the time of surgery. Ovarian function assessed by the levels of serum FSH were measured on day 3 of the menstrual cycle before treatment, and at 6 and 12 months post-treatment and menstrual cycle characteristics. No significant difference was found between the two treatment groups in the rate of ovarian failure at 12 months (UAE: 11% versus surgery: 18%; $P = 0.44$).

These findings provide no evidence that UAE accelerates deterioration in ovarian function at 1 year, in comparison with surgery.

Van der Kooij SM et al (2010)⁵⁸ from Department of Radiology, Academic Medical Center, Amsterdam compared the clinical outcome and health related quality of life (HRQOL), 5 years after uterine artery embolization (UAE) or hysterectomy in the treatment of menorrhagia caused by uterine fibroids. Patients with symptomatic uterine fibroids who were eligible for hysterectomy were assigned randomly 1:1 to hysterectomy or UAE. Endpoints after 5 years were re-intervention rates, menorrhagia and HRQOL measures that were assessed by validated questionnaires. UAE had a positive effect both on urinary and defecation function.

MATERIALS AND METHOD

30 patients (mean age, 31.67 years, age range 26-35years) referred to our institution in a six-month period for endovascular treatment of menorrhagia underwent three dimensional color Doppler as part of pre and post therapeutic evaluation.

Study Design: Prospective interventional trial

Study Place: Barnard Institute of Radiology, Madras Medical College.

Collaborating Unit: Institute of Obstetrics and Gynaecology,
Madras Medical College, Chennai.

Study Population: Women with symptomatic fibroid

Sample Size: 30 Women with symptomatic fibroid.

METHODOLOGY :

Patient Selection Criteria

* **Inclusion criteria :**

1. Women with symptomatic fibroid (menstrual disturbances or pressure symptoms due to size or pain) who want to retain their uterus and avoid surgery.

2. Solitary or multiple intramural fibroids of less than 7 cm.
3. Parous women who completed family and age less than 40 yrs.
4. Ultrasound findings without any degeneration of fibroid
5. Women who gave consent to undergo uterine artery embolisation and participate in study.

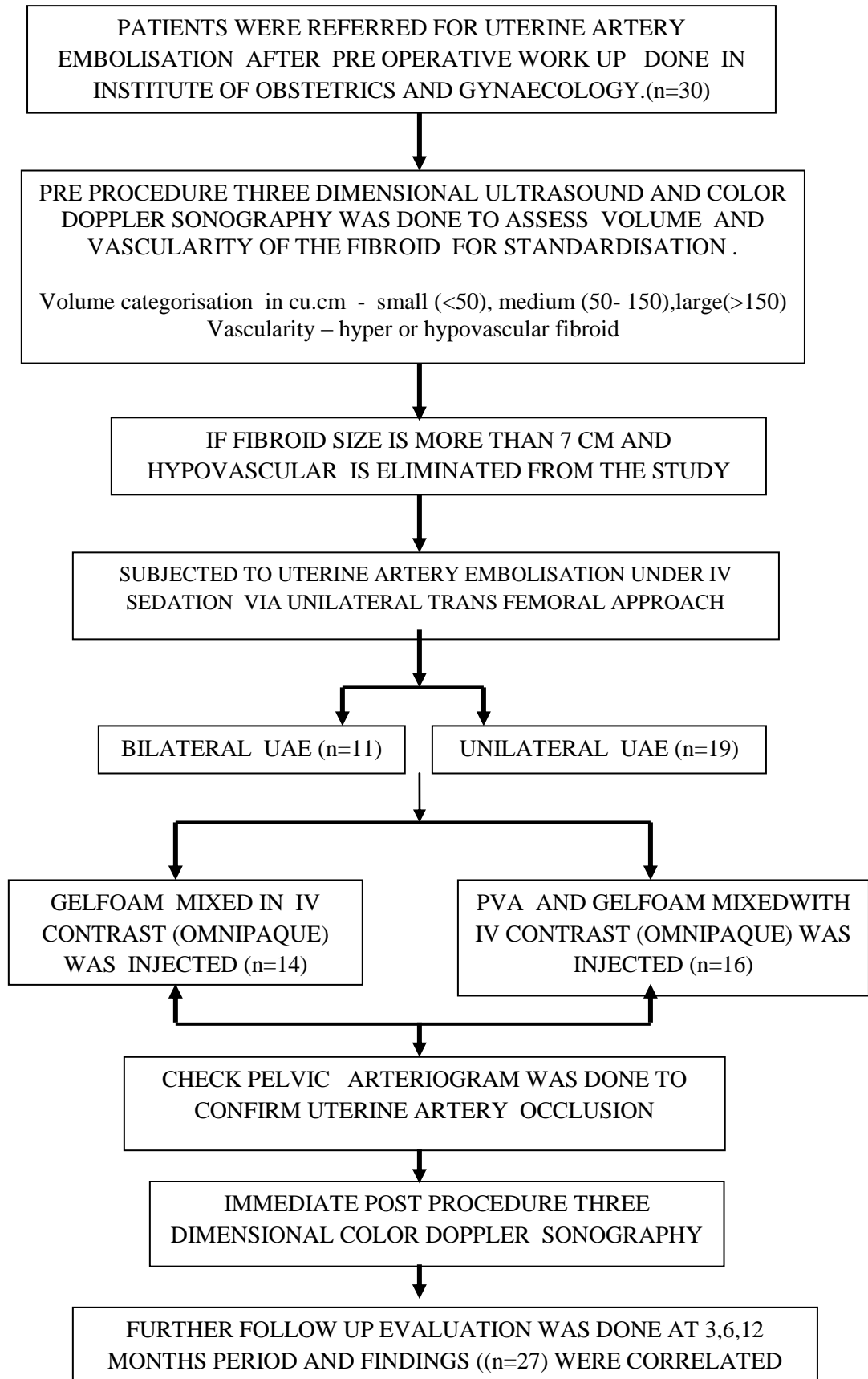
* **Exclusion criteria :**

1. Women with asymptomatic fibroid.
2. Infertile women or parous women who want to conserve uterus for future pregnancy.
3. Fibroids of more than 7 cm or with degenerative changes or hypovascular in Doppler study.
4. Sub mucous or pedunculated Sub serosal fibroid.
5. Associated pelvic / adnexal and endometrial pathologies .
6. Previous history of anaphylaxis to contrast.
7. Renal function test abnormality.
8. Systemic illness like HIV, HbsAg +ve, abnormal renal profile, Coagulation disorders.

Preoperative work up

- History, pelvic exam .
- Basic blood investigations done including Hb%, CBC, Blood Urea, Serum creatinine, HIV, HbsAg, Coagulation profile (BT, CT,PT,PTT).
- FSH (day 3) to assess ovarian reserve
- USG of Pelvis and abdomen done to know the location, size, number and volume of fibroid. Those who had degeneration (calcification or cystic degeneration) are excluded from the study.
- Doppler USG done to know the vascularity of fibroid. Hypo vascular fibroids are excluded from study.
- Fractional curettage performed to rule out any associated malignant changes in endometrium.
- Pap smear to rule out cervical carcinoma.
- Informed consent

Procedural sequence:



Clinical symptoms :

In this prospective study 30 patients (n=30) with fibroid uterus having at least one of the following symptoms were selected.

Symptoms related to leiomyomas were classified into three categories:

- abnormal bleeding (menorrhagia, metrorrhagia),
- Pressure symptoms like (Increased frequency of urination, lower abdominal heaviness, Constipation, uni-or bilateral hydronephrosis),
- Pelvic pain.

SONOGRAPHIC EXAMINATIONS :

All 30 patients were screened with a 3.5-MHz three dimensional trans abdominal ultrasound probe, SIEMENS ACUSON ANTARES PREMIUM EDITION ultrasound machine with Siemens C7F2 4D Array probe (Fig5.1).

- * Three Dimensional Transabdominal Ultrasound: to confirm and to assess the size, location, number, volume of fibroids.
- * Three Dimensional Color Doppler Sonographic assessment of the fibroid vascularity is done. Vascularity of fibroid was classified as hypervascular and hypovascular. Hypovascular fibroid patients are eliminated from this study.

FIG 5.1: SIEMENS ACUSON ANTARES PREMIUM EDITION



**Siemens CH4 – 1 convex probe -
Two dimensional color Doppler
sonographic probe**



**Siemens C7F2 4D Array -
Three dimensional color
Doppler sonographic probe**

UTERINE ARTERY EMBOLISATION :

Patients selected according to the inclusion criteria were taken up for uterine artery embolisation (UAE) after adequate counselling. Eligible patients were advised to use contraception before the procedure and LMP confirmed.

PATIENT PREPARATION:

History of any medications ?

Any allergies, especially to contrast materials.

Any recent illnesses or other medical conditions.

If there is any possibility for pregnancy.

Nil oral previous night prior to the procedure.

1. All patients were explained about the procedure and its possible complications.
2. They were also informed about alternative treatment options available.
3. Written consent was obtained from all patients.

Informed consent obtained from all the patients before the procedure.

Patient has to be shaved in both groins & axillary region if femoral pulse is absent; clotting time, bleeding time, blood urea, serum creatinine levels should be within normal limits .

PROFORMA : See annexure

PRE PROCEDURE :

This examination is usually done as an inpatient procedure in our hospital.

PROCEDURE:

Patient position : Supine

Pre Anaesthetics

- Inj Dexamethasone 8mg I.V Stat
- Inj. Pheniramine Maleate 1 amp I.M Stat
- Inj. Atropine 1amp I.V.Stat

Anti biotic prophylaxis:

- * Inj Ampicillin 1gm I.V (ATD)

Anesthesia/ Sedation :

- Inj Tramadol 1 amp IM

A nurse or technologist will insert an intravenous (IV) line into a small vein premedication is given (1cc of atropine & 1cc of phenramine maleate).

Small dose of sedative is given through the IV to lessen the anxiety of the patient during the procedure.

Approach : Percutaneous right or left trans femoral approach.

PROCEDURE :

Uterine artery embolisation technique done in our hospital

- Angiography and Embolisation was performed using an SCHIMADZU, JAPAN 800mA conventional angiographic unit with digital dicom fluoroscopy (FIG 5.2)
- (A). With aseptic precautions under local anaesthesia femoral puncture was made. A line is drawn from the anterior superior iliac spine to the pubic symphysis & 1 cm below the midpoint of the line, a point is marked. Local anaesthetic given by keeping the middle finger & index finger the pulse is felt. A small incision in the skin is made & the subcutaneous tissue is separated with the artery forceps. By using the Seldinger's technique, Seldinger single puncture needle (FIG 5.3), is used to puncture the artery. When the spurt of blood comes out of the needle, the guide wire (FIG 5.5) is inserted through the needle with help of the introducer. Once the guide wire is inserted upto the abdominal

aorta by applying pressure at the puncture site, the seldinger needle & the introducer SET (FIG 5.4) is removed. Then the sheath connected with dilator is introduced over the guide wire & inserted into the artery.

- (B) A 4- or 5-Fr pigtail catheter placed at L1 level was used for flush aortogram initially to detect any aberrant supply to the uterus¹⁰.
- Internal iliac artery catheterized with single multipurpose 4F-5F Roberts uterine curve catheter (FIG 5.6).
- Pelvic arteriography with iv contrast omnipaque (FIG 5.5) is done to identify whether the supply is from unilateral or bilateral uterine arteries.
- Superselective catheterisation of Contra-lateral uterine artery was done.

UAE- EMBOLIC AGENTS

- Free flow embolisation was performed just beyond the junction of the horizontal and descending portions of the uterine arteries (keeping the tip of the catheter little bit far of to block the entire feeding vessel) using poly vinyl alcohol as the embolic agent. Following which absorbable gelatine sponge shavings was injected .
- PVA particles sized 355–500 μm (FIG 5.8) have been used successfully in my study.
- In all patients, 2 to 8 gelatin sponge pledgets (FIG 5. 7) were used to cap off the particulate embolization in the main uterine arterial trunk.
- Avoid reflux, nontarget embolization to preserve flow in the main uterine and ovarian arteries
- Catheter withdrawn up to ipsi-lateral common iliac artery then passed into ipsi-lateral internal iliac and ipsi-lateral uterine artery. Embolisation done on the ipsi-lateral side.
- Stagnation of contrast medium was evidenced in the uterine capillary network at the end of embolisation, and an absence of flow was depicted in the uterine artery by injecting contrast medium into hypogastric arteries.

**FIG.5.2 SCHIMADZU 800mA DIGITAL DICOM
FLUOROSCOPY**



FIG 5.3: PUNCTURE NEEDLES

**SINGLE
PUNCTURE
NEEDLE**



**DOUBLE
PUNCTURE
NEEDLE**

FIG 5.4: INTRODUCER SET

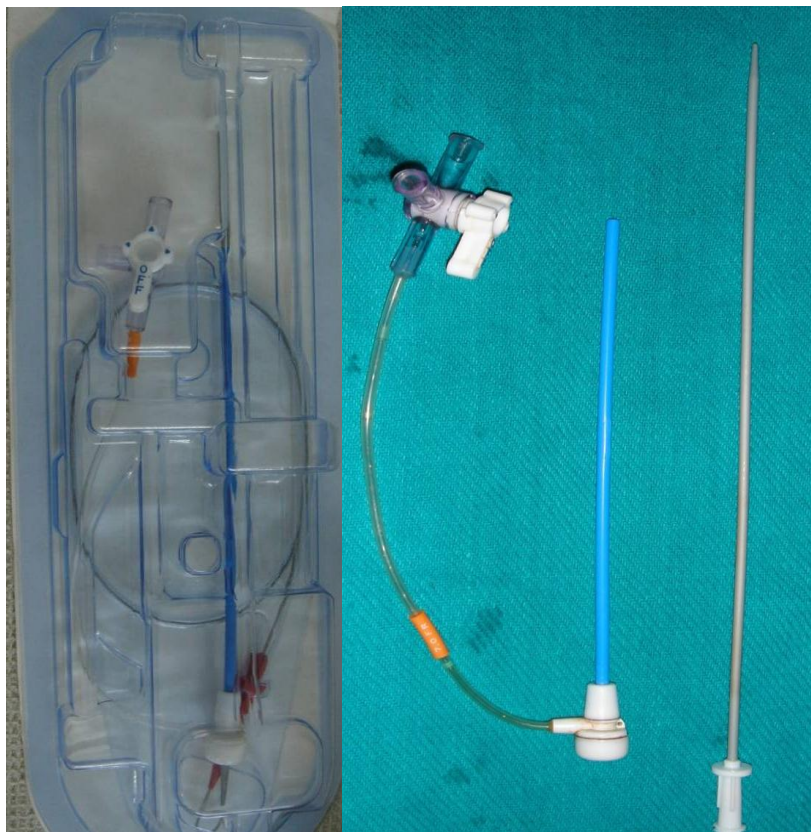
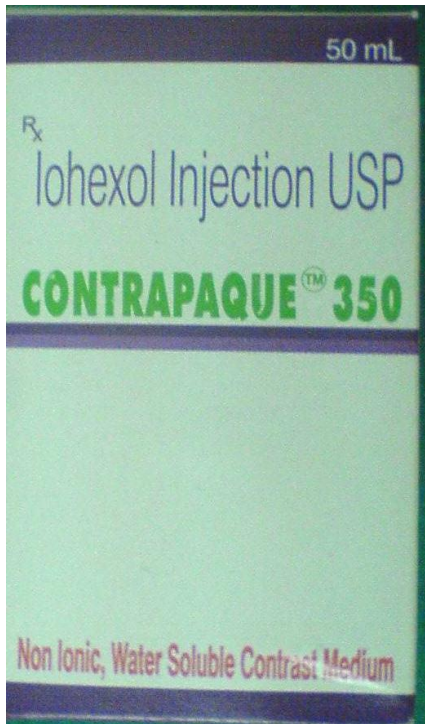
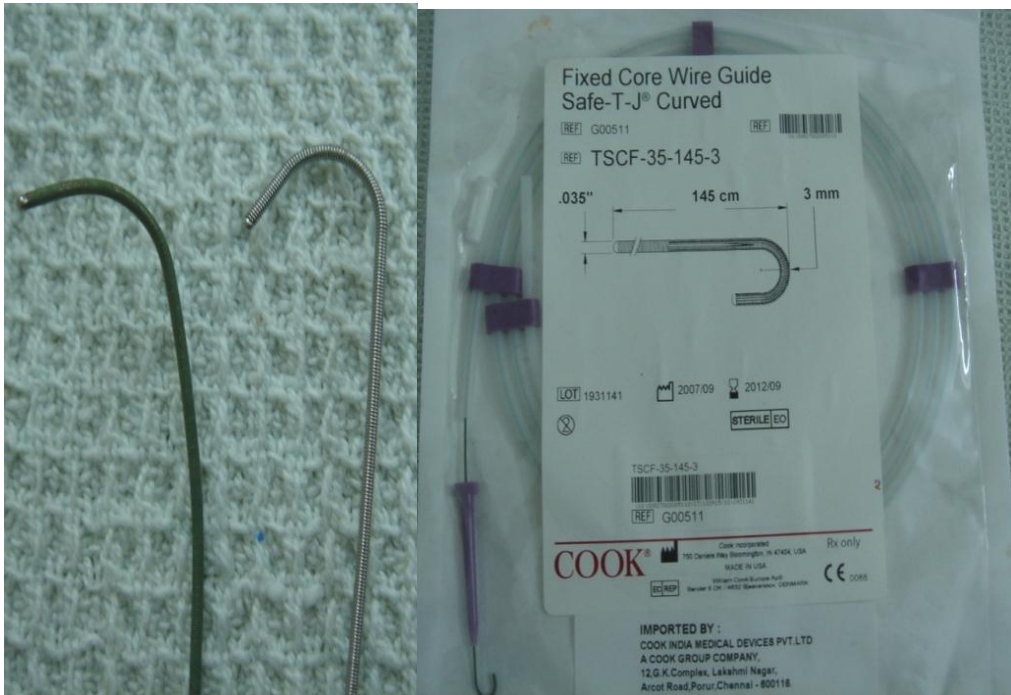


FIG 5.5: GUIDE WIRES



**INTRAVENOUS
CONTRAST MEDIA –
OMNIPAQUE 350**

FIG 5.6: CATHETERS

**ROBERTS UTERINE
CURVE (RUC)
CATHETER**



COBRA CATHETER



PIGTAILED CATHETER



**RENAL DOUBLE CURVE
(RDC) CATHETER**



EMBOLIC AGENTS

FIG 5.7: GELFOAM

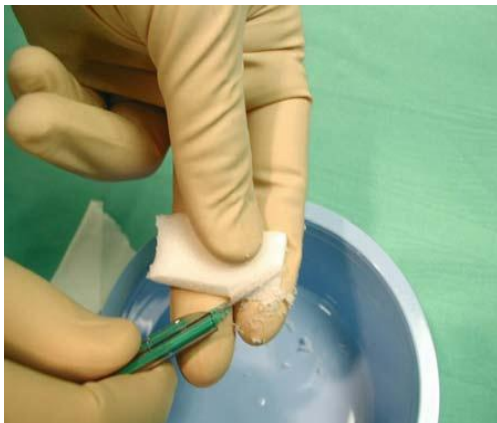
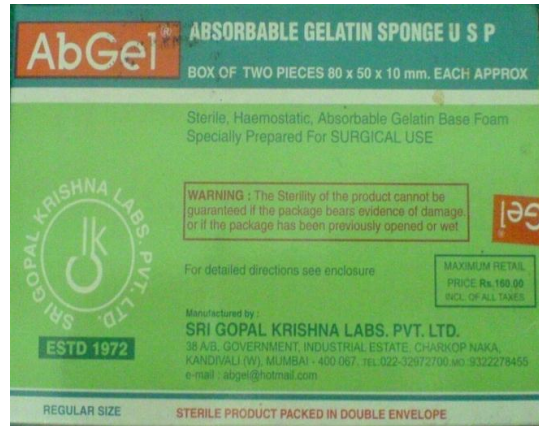


FIG 5.8: POLY VINYL ALCOHOL PARTICLES



Endpoint of Embolisation

Occlusion of the identifiable vessels supplying the fibroids while antegrade flow is maintained in the main uterine artery giving the pruned tree appearance.

- * Evidence of “standing column of contrast” in the uterine artery and reflux towards the uterine origin or into the internal iliac artery.

- * Cessations of flow in the ascending uterine artery with residual flow in the lower uterine segments supplying the normal myometrium

Adverse Complications:

We had subintimal dissection in 2 patients while performing catheterisation of ipsilateral/ contralateral internal iliac artery .

Fortunately we have not had Vessel perforation / Inadvertent embolisation of other organs or / Allergic reaction.

Post procedure events:**Post procedure :**

All 30 patients were subjected to immediate (within an hour) of post embolisation ultrasonography and colour Doppler study .

- Three Dimensional Transabdominal Ultrasound to assess the size and volume of fibroid, and the presence of embolic agents within the fibroid.
- Three Dimensional Color Doppler Sonographic assessment of the fibroid vascularity was done. Hypovascularity in the embolised fibroid patients was noted.

Post procedure monitoring :

Patients were observed in high dependence ward for 6 hrs then at least 48 hrs in the routine wards. All the patients were carefully observed for any complications like groin haematoma /retroperitoneal haematoma. Vitals were checked. Patients were kept nil per oral for 4 hours. They were advised bed rest for 6 hours and then ambulated. Patients were discharged after 48-72 hrs.

On discharge:

Patients were advised to report if appearance of new symptoms like

- Any unbearable lower abdominal pain
- Fever or Purulent vaginal discharge

- Swelling in lower limbs
- Breathing difficulty

All of them were advised to maintain menstrual calendar in detail regarding the duration, number of pads soiled, clots passed and associated pain. Patients were asked to report any hysterectomy or subsequent surgery. Treatment considered failed if any symptom persisted / worsened after embolisation .

Follow up:

At the end of 3rd month all patients were called back and enquired about their menstruation, dysmenorrhoea and pressure symptom.

Three-Dimensional Trans Abdominal USG Pelvis and Three-Dimensional Color Doppler Sonography performed to know the size , volume and the vascularity of fibroid. The greatest decrease in vascularity occurred one day after the procedure. whereas the greatest volume reduction was found at the end of 3 month follow up.

Similarly at 6th and 12th month patients were again reviewed enquired about symptoms with sonographic examination to know the size, volume and the vascularity of fibroid .

ANALYSIS AND RESULTS

32 patients with uterine fibroid selected according to the inclusion criteria were taken up for the study.

Evaluation of clinical symptoms was classified as increased, unchanged, improved, or absent (i.e., symptom-free).

Sonographic examinations were always performed using a 3.5-MHz three dimensional trans abdominal probe with color Doppler sonography (SIEMENS ACUSON ANTARES MACHINE). Findings was analyzed by measuring the size, volume and vascularity of the fibroid.

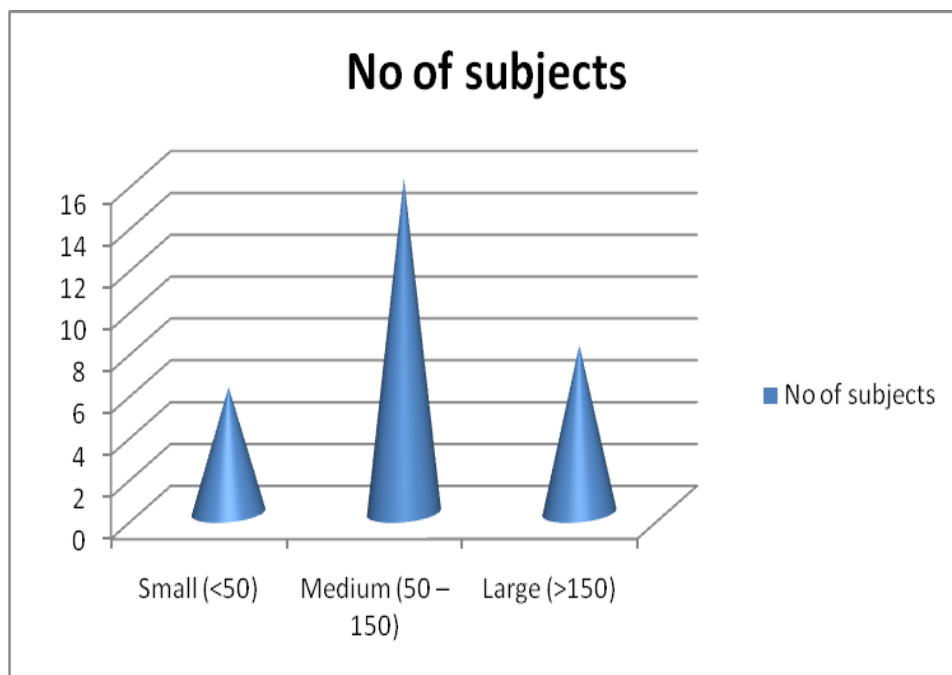
Successful embolization was done in 30 patients. For one patient catheterisation could not be done due to vasospasm on both sides and another patient had subintimal dissection during catheterisation, so procedure abandoned.

We therefore analysed the data for 30 patients but 3 patients was lost to follow up at 12 months so, for statistical calculation we have taken 27 samples.

SIZE AND VOLUME :

Size and volume of the fibroid is calculated by three dimensional sonographic examination. Volume of fibroid ranges from 38.23 - 220 cu cm. Average volume of fibroid before treatment is 113.02 cu .cm. Largest size of fibroid in our study is 220.32 cu.cm . In 2 cases of multiple fibroid the size of the largest fibroid is taken. volume distribution of fibroid is given below,

Volume of fibroid (cu. cm)	No of subjects	%
Small (<50)	6	20.00
Medium (50 – 150)	16	53.33
Large (>150)	8	26.66
Total	30	



CATHETERISATION :

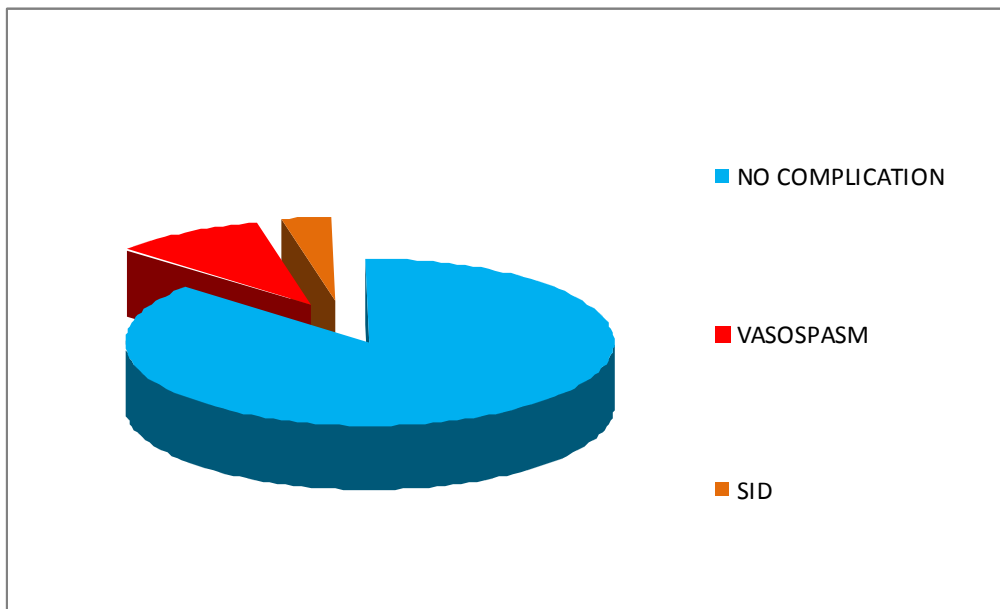
Unilateral or bilateral selective uterine artery catheterization and embolization were carried out by unilateral transfemoral puncture,, successfully in all 30 patients.

	No of subjects	%
Unilateral embolisation	19	70.37
Bilateral embolisation	8	29.62
Un successful catheterisation	2	6.25
Total	32	

COMPLICATIONS:

Procedure related :

Except for the subintimal dissection and vasospasm, no other complications occurred during the procedure. Fortunately we have not come across any major untoward events, infection, septicaemia, pulmonary embolism, fibroid passage, fibroid regrowth. Uterine necrosis, etc.



FOLLOW UP

Clinical Follow Up :

All the 30 patients who had good clinical outcome, resumed normal menstrual cycle at 1–3 months.

- One patient presented with fever and vaginal discharge 1 week after procedure.
- Uterine ischemia causing pain found in all 30 patients ,treated with analgesics.
- Post embolization syndrome⁵⁵ in the form of abdominal discomfort, pain and fever was noted in 2 patients. These symptoms were transient and did not require any treatment except mild analgesics and antipyretics.

ULTRASOUND FOLLOW UP:

VOLUME CHANGES :

Using prolate ellipsoid formula¹⁰, fibroid volume is calculated in our study.

<p>Volume was measured using the formula :</p> $\text{length} \times \text{width} \times \text{depth} \times 0.5233$
--

When computed only 27 patients came for 12 months follow up , so we have selected n= 27 for comparison statistics, the mean reduction in fibroid volume were statistically significant. By using highly correlative friedman's test, volume change after 3 months, at 6 months and at 12 months was significant (P value <0.001) with associated marked reduction in vascularity of all hypervascular fibroid.

In larger volume (>150 cu.cm) fibroids : volume reduction was 42.24 % (range 32.61 - 50.25 %) at 3 months, at 6 months 76.22% (61.47 - 89.38 %) and at 12 months was 88.02 % (range 81.12 - 93.63 %).

For medium volume (50 -150 cu.cm) fibroids : volume reduction was 47.90 % (range 24.81- 67.04 %) at 3 months, at 6 months 72.48% (44.36 - 89.12 %) and at 12 months was 83.86 % (range 61.85 - 93.24 %)

For smaller volume (< 50 cu.cm) fibroids : volume reduction was 42.24 % (range 20.00- 59.60%) at 3 months, at 6 months 76.22% (35.36 - 86.80 %) and at 12 months was 88.02 % (range 44.96- 91.92 %).

On pre - UAE US, all patient had fibroids that were mixed /hypo echoic and were hypoechoic on post- UAE US scans.

In this study moderate to marked reduction in larger fibroid volume was seen in 72.48% 83.86 % at 6 months, and 88% at 12 months respectively while using PVA with gelfoam combination.

VASCULARITY ASSESSMENT

In our study only hypervascular fibroid were selected and we have assessed reduced vascularity in them .

OVERALL RESULTS

A. Three dimensional color Doppler sonographic examination results of volume and vascularity assessment :

- Median uterine fibroid size was reduced by 75 – 88%, better reduction is achieved in
 1. Bilateral approach – 88.32%
 2. Embolic agents (PVA +Gelfoam) – 88.32%
 3. Large volume fibroid - 88.02%
- Dominant fibroid size was reduced by 42%

B. Clinical improvement :

- 83% reduction in menorrhagia
- 77% reduction in dysmenorrhea
- 86% reduction in urinary frequency (Pressure symptoms).

DESCRIPTIVES STATISTICS

REDUCTION PERCENTAGE IN VOLUME OF FIBROIDS OVER TIME ASSESSMENT:

TABLE :1

(A) POST EMBOLISATION REDUCTION PERCENTAGE IN VOLUME OF FIBROIDS IN UNILATERAL VERSUS BILATERAL EMBOLISATION.

REDUCTION PERIOD	UNILATERAL	BILATERAL
After 3 months	43.33	47.34
After 6 months	69.05	77.28
After 12 months	80.86	88.32
P value	<0.001**	<0.001**

P value < 0.001

Note: ** ---denotes significant at 1% level

* --denotes significant at 5% level.

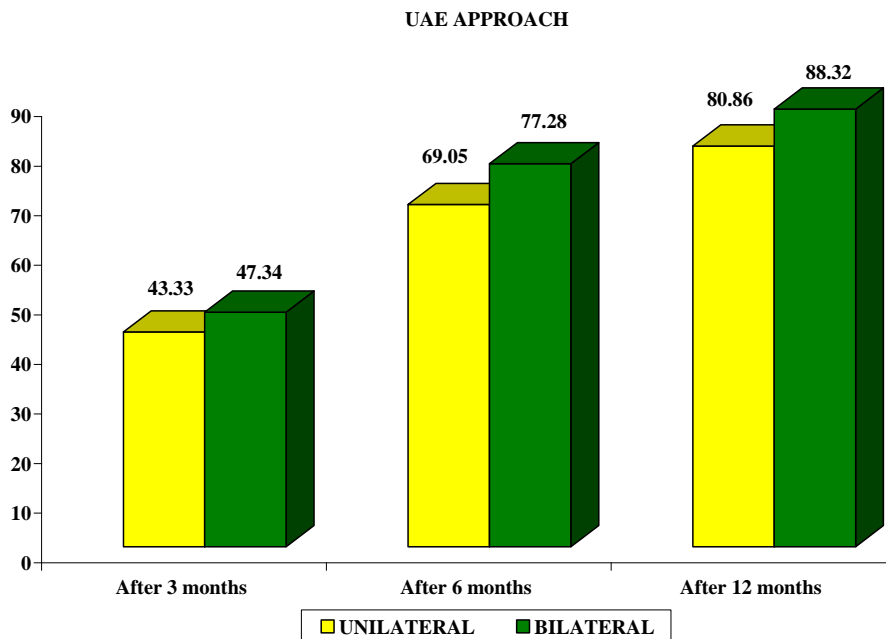


TABLE : 2

(B)POST EMBOLISATION REDUCTION PERCENTAGE IN VOLUME OF FIBROIDS WITH DIFFERING EMBOLIC AGENTS.

REDUCTION PERIOD	GELFOAM	PVA + GELFOAM
After 3 months	37.61	50.04
After 6 months	65.30	76.44
After 12 months	77.76	87.31
P value	<0.001**	<0.001**

P value < 0.001

Note: ** ---denotes significant at 1% level

* --denotes significant at 5% level.

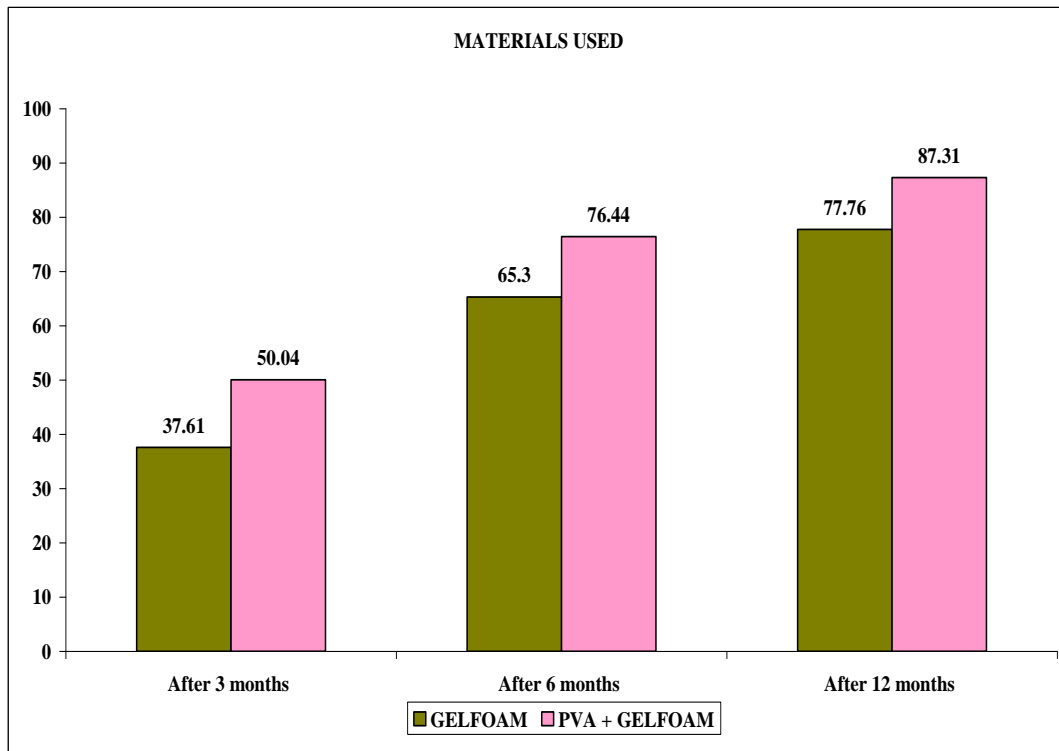


TABLE : 3

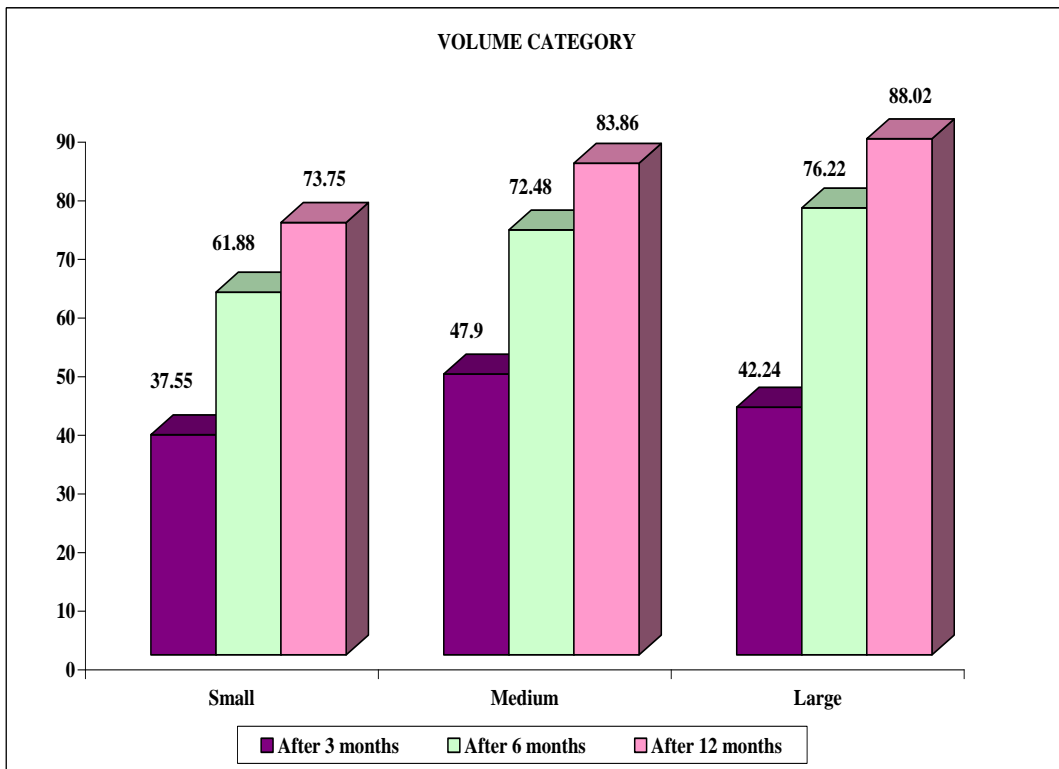
(C) POST EMBOLISATION REDUCTION PERCENTAGE IN VOLUME OF FIBROIDS IN DIFFERING PRE EMBOLISATION FIBROID VOLUME CATEGORIES.

Volume category	Small (<50 cu.cm)	Medium (50-150 cu.cm)	Large (>150 cu.cm)
After 3 months	37.55	47.90	42.24
After 6 months	61.88	72.48	76.22
After 12 months	73.75	83.86	88.02
P value	<0.001**	<0.001**	<0.001**

P value < 0.001

Note: ** ---denotes significant at 1% level

* --denotes significant at 5% level



OVER ALL RESULTS

(D) POST EMBOLISATION REDUCTION PERCENTAGE IN VOLUME OF FIBROIDS IN OVERALL ASSESSMENT.

Reduction Period	Unilateral	Bilateral	Gelfoam	PVA + Gelfoam	Smaller volume	Medium volume	Large volume
After 3 months	43.33	47.34	37.61	50.04	37.55	47.90	42.24
After 6 months	69.05	77.28	65.30	76.44	61.88	72.48	76.22
After 12 months	80.86	88.32	77.76	87.31	73.75	83.86	88.02
P value	<0.001**	<0.001**	<0.001* *	<0.001**	<0.001**	<0.001**	<0.001**

P value < 0.001

Note: ** ---denotes significant at 1% level

* --denotes significant at 5% level.

DISCUSSION

Fibroid uterus causing menorrhagia is one of the common morbidity encountered in the women of child bearing age group. Hence many young women opt to undergo hysterectomy at an early age. Uterine artery embolisation is minimally invasive alternative primary treatment of fibroids with preservation of uterus.

This study was done to assess the efficacy of uterine artery embolisation with three dimensional color doppler sonography. Pre embolization and postembolization three-dimensional color Doppler sonography was prospectively compared in 30 patients who underwent uterine artery embolization as primary treatment of symptomatic fibroids.

3D CDS has recently become available to quantify vascularity that gives good correlation to vessels greater than 100 micrometer. Three-dimensional color Doppler sonography was performed by using a scanner with color power angiographic imaging capability.

For purposes of comparison, fibroids were classified as either hypervascular or hypovascular relative to myometrial vascularity before and minutes to several hours after uterine artery embolization. Changes in fibroid vascularity (i.e., from hypervascular to hypovascular) as depicted by three-dimensional color Doppler sonography are stated in Edwin F⁹ Med 2005.

Totally 32 samples were selected for the study, according to the inclusion and exclusion criteria. Of which for 2 patients embolisation could not be done because of subintimal dissection and vasospasm happened during the procedure. Uterine artery embolisation was performed by using a standard selective catheter and standard embolization technique. Successful embolisation was done for 30 patients. Hence we have followed 30 patients upto 12 months to assess the changes in vascularity .

In this study we have done both unilateral and bilateral UAE, where bilateral embolisation proved statistically significant (P value < 0.001**). In contrast, Edwin F, Arthur C. Fleischer, et al⁹, in their 2005 study, did unilateral UAE for all patients. Also TP Jain, DN Srivastava etal⁵⁵ 2007, demonstrated that Ipsilateral catheterization of uterine artery was safe, cost-effective and with lesser incidence of complications such as haematoma and dissection of arteries.

Uterine artery embolization is an effective and established treatment method to control intractable bleeding, C. Fleischer, et al 2005⁹ due to various other obstetric and gynaecological disorders. Uterine fibroid embolisation acts mainly by occluding the blood supply to the tumour thus it arrests the growth and cause ischemia and necrosis. This causes shrinkage of the tumour and stops appearance of new fibroids as per long term follow up studies ⁵⁵.

Duration of the procedure varied from 45 minutes to 75 minutes. The average duration of the procedure was 65 minutes. This is comparable with results of previous researches.

Radiation dose : 9-20 cgy in 1–2 hours procedure.

The mean total procedure time as reported by other investigators has been 78.4 min for bilateral approach and 44.29 and 61min for unilateral approach. In this study intermittent fluoroscopy was used to reduce the exposure. Fluoroscopic exposure time was 45 min, which is more compared with Boris nikolic MD, james b, et al ⁶⁵ 2001.

In this study, average volume of fibroid before embolisation is 113.02 cu.cm. (ranges 38.23 - 220 cu. cm). Largest fibroid volume in the study population was 220.32 cu.cm. In our series we have not encountered any additional complications in larger fibroids. This correlates with the recent study by Albert J. Smeets Robbert,et al³, 2009, which depicts that the complications were not increased and the clinical response is also good.

Small size fibroid (less than 7 cm) show better response in size reduction and symptomatically feel better. Less than 1 percent of patients undergo hysterectomy due to embolisation failure, Jean-Pierre Pelage et al ²³ 2005.

The greatest decrease in vascularity occurred 1 day after the procedure, whereas the greatest volume change was found at 3 month follow-up examination agreeing with the results depicted by Arthur C. Fleischer, F. Donnelly., et al⁹ in 2000. This statement correlates well in our study, selected hypervascular fibroids showed marked reduction in vascularity.

In another study, hyper vascular fibroids (12 of 30) tended to decrease in size after treatment more than isovascular (10 of 30) or hypovascular (8 of 30). In our study most fibroids were hypervascular before UAE and became hypovascular after UAE as depicted by Arthur C. Fleischer, MD, Edwin F Med 2005⁹.

Jean-Pierre Pelage et al ²³ 2005 states that the main reason for not embolizing the pedunculated fibroids is the potential risk of postprocedural torsion and is also stated in Laurent Brunereau Denis Herbreteau et al³⁰, 2002, who reported sudden and massive necrobiosis changes in the embolised fibroids .

Bruce McLucas, Rita Perrella, et al,⁹ states that largest myoma diameter of greater than 8 cm, PSV values of greater than 64cm/s during screening was found associated with UFE failure. In contrast, our study could not find any significant potential in accurately predicting the UAE failure .

Ultrasound is faster, widely available and cheaper, Three dimensional color doppler are more accurate and reproducible .It is better in selecting

patients for UFE and also best response assessment, Arthur C. Fleischer, MD, Edwin F Med, 2000, 2005⁹.

Previous study shows MR imaging is sub optimal in assessment of fibroid volume, but reliably detect adenomyosis as given by Edwin F, Arthur C. Fleischer, et al⁹ 2005. In our study we have not done MR imaging correlation for all patients as it is not accurately depicting quantification of vascularity.

Uterus always has the capacity to develop new leiomyomas after endovascular embolization with 150- to 250 micrometer particles Sangeet Ghai, et al,² 2005. Several Studies shows that PVA injection followed by gelfoam shows better results than with gelfoam used alone. Gelfoam Vs Poly Vinyl Alcohol is an ideal embolic agent in UAE .

Among 30 patients in the study 14 of them were embolised with gel foam and remaining 16 was embolised with poly vinyl alcohol particles of 350-500 µm size followed by gelfoam. On analysing the volume reduction, both was equally effective with comparative higher statistical significant (p value <0.001) results with PVA followed by gelfoam. This result is comparable with Katz et al²⁶ 1998 who studied the effectiveness of gelatin sponge pledgets versus polyvinyl alcohol for embolization. They concluded that materials are equally effective. This result is in contrary to the statement by Jean-Pierre Pelage et al²³ 2005, for targeted embolisation of the perifibroid arterial plexus,

injection of PVA particles with diameter larger than 500 micrometer is recommended.

Studies by Derdelyn and Pelage et al⁶⁴, 2001 have shown that Tris-acryl microspheres are more uniform in size and the particle sizes do not change in liquids. They have little tendency to clump after injection and animal studies indicate that they have less tissue reaction than is typically seen with PVA.

As in C. Joseph Muniz, MD, Arthur C. et al⁶, 2002 our study analysis showed that almost all of the patients were clinically improved at 3 months, 6 months, and 1 year, and all were symptom-free at 1 year. Sonography was an ideal method to show and follow the progressive reduction in the size of the main leiomyoma procedure as proved by Laurent Brunereau Denis Herbreteau et al,³⁰ in 2000.

Remarkable average Volume Reduction at the 3rd month especially in larger volume (>150 cu.cm) of fibroid was 42.24 % (range 32.61 - 50.25 %) at 3 months, at 6 months 76.22% (61.47 - 89.38 %) and at 12 months was 88.02 % (range 81.12 - 93.63 %) (p<0.0001 highly significant). It is comparable with that seen in the study by Spies JB, Scialli AR, et al⁵³ in 1999 who has reported 50% reduction at 6th month and 78% reduction at 1st year.

All patients should be monitored with clinical and sonographic examinations for more than 2 years after the endovascular procedure, Embolization cannot therefore be considered a radical treatment compared with

hysterectomy, depicted by Laurent Brunereau Denis Herbreteau et al,³⁰ in 2000.

Jean-Pierre Pelage et al²³ 2005; Vaginal discharge and fibroid expulsion are more common with intramural fibroid.

Overall, the information regarding fibroid vascularity ideally obtained on 3D CDS may be useful in determining which patients are best suited for UAE therapy⁹. 3D CDS is less expensive and more extensively available and can depict actual vessels within and surrounding fibroids . Good results of UAE were seen in a larger volume hypervascular fibroids approached bilaterally with PVA followed by gelfoam embolic agents.

LIMITATIONS

1. For one patient catheterisation could not be done due to vasospasm on both sides and another patient had subintimal dissection during catheterisation, so procedure abandoned.
2. Since all 30 patients, responded to fibroid embolization, it is not possible from data acquired in this small series to come to any conclusions regarding the use of 3D CDS for predicting which patients will be responders or nonresponders .
3. Few patients have lost their long term follow up at 12 months or later of post embolisation.

CONCLUSION

- * From this study we have found that Uterine Artery Embolisation for the patients having symptomatic uterine fibroid is an effective and safe alternate treatment with significant reduction in volume and vascularity of fibroid particularly in less than 7 cm fibroids.
- * Three dimensional color Doppler sonography assists in assessing the vascularity within the fibroid before and after embolisation.
- * Single trans femoral approach with bilateral uterine arteries embolisation technique was used successfully in most of our patients. Combined PVA - Gelfoam is one of the ideal embolic agents effective in causing volume and vascularity reduction along with relief of the symptoms in patients with fibroid. Hypervascular fibroid respond well to embolisation . It has less failure rates in long term follow up. This procedure has good patient's tolerance, short recovery time, quick and sustained symptomatic improvement. This procedure may reduce the need for invasive surgery in many patients.
- * From this study we conclude that Three Dimensional Color Doppler Imaging can be a tool for pre and post UAE evaluation in assessing reduction in fibroid vascularity and volume. It is less expensive, more extensively available and provides an estimate of completeness of embolisation.

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PROFORMA

Name:

Indication for UFE: opted / anaemia / previous surgeries / obesity / others

Age (yrs): 25-30 31-35 35-40

History:

- Menorrhagia - Assessed by Pictorial Blood Loss Assessment Chart
- Dysmenorrhoea – Assessed by Visual Analogue Scale
- Pressure Symptoms: Yes/no
- Increased frequency and urgency: Yes/no
- Lower abdominal heaviness: Yes/no
- Constipation: Yes/no
- Marital status: married/unmarried
- Obstetric history: No of children Nil / 1 / 2 / >2
- History of Allergy: Yes/no
- History of previous surgeries: Yes / No

Clinical Examination:

- General Examination:
 - Height : Weight: BMI:
 - Anaemia:
 - Peripheral edema:
 - Miscellaneous:
- CVS:
- RS:
- Abdomen:
- Gynaecological Examination:
- Speculum examination:
- P/V:

Investigations

- Hb%:
- Blood sugar :
- Urea: Sr. creatinine:
- TC : DC: ESR:
- HIV:
- HbsAg:
- BT: CT:

Fractional Curettage Report:**PAP smear:****USG:**

- Mean Uterine sizes:
- No. of fibroids:
- Size of fibroids:
- Largest axis of largest fibroid:
- Volume of fibroid:
- Calcification / degeneration:

Doppler:

- hypovascular / hypervascular

Uterine Artery Embolisation:

Done on:

Duration of procedure:

Catheterisation: unilateral

Embolisation: No / unilateral / bilateral

Embolic particle used: Gel foam /PVA+Gelfoam

Complication During procedure:

- Vasospasm :Yes/No
- Vascular-perforation :Yes/No

- Subintimal-dissection :Yes/No
- Allergy :Yes/No
- Mis-embolisation :Yes/No
- Miscellaneous.

Immediate post procedure complications

- Pain :Yes/No
- Vomiting :Yes/No
- Post embolic syndrome :Yes/No
- Deep vein thrombosis :Yes/No

Late complication

- Vaginal discharge :Yes/No
- Fever :Yes/No
- Trans cervical expulsion :Yes/No
- Amenorrhoea :Yes/No

Patient discharged on:

Follow up at 3months:

- Menstrual blood loss:
- Dysmenorrhea:
- Pressure symptom:

Transabdominal and Three-Dimensional Color Doppler Sonography:

- Fibroid size :
- Volume:
- Vascularity :

Follow up at 6months:

- Menstrual blood loss:
- Dysmenorrhea:
- Pressure symptom:

Transabdominal and Three-Dimensional Color Doppler Sonography:

- Fibroid size :
- Volume:
- Vascularity :

Follow up at 12 months:

- Menstrual blood loss:
- Dysmenorrhea:
- Pressure symptom:

Transabdominal and Three-Dimensional Color Doppler Sonography:

- Fibroid size :
- Volume:
- Vascularity :

ABBREVIATIONS

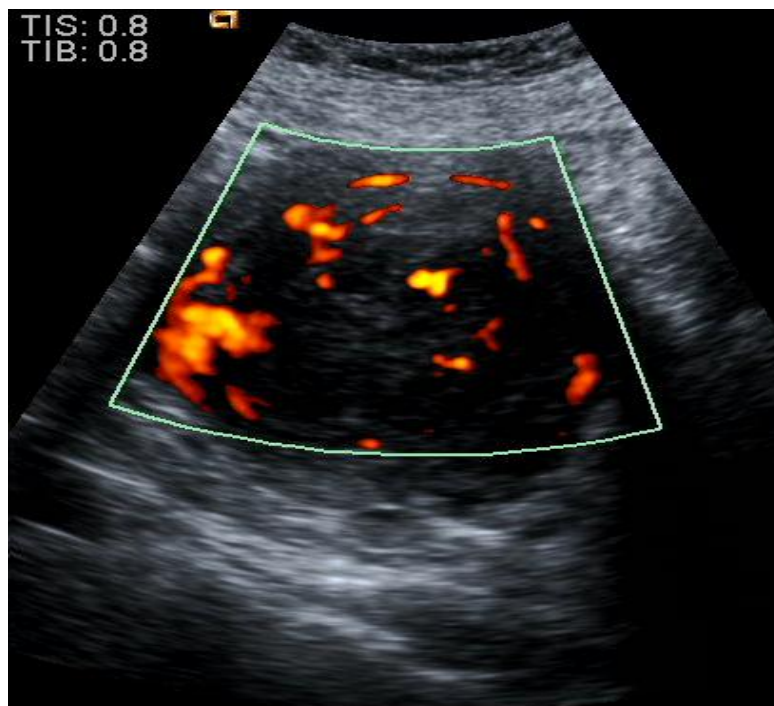
UAE	-	Uterine Artery Embolization
UFE	-	Uterine Fibroid Embolization
3D CDS	-	Three-Dimensional Color Doppler Sonography
UAA	-	Uterine Artery Arteriography
LMP	-	Last menstrual period
PBLA Scoring	-	Pictorial Blood Loss Assessment Scoring
VAS	-	Visual Analogue Scale
USG	-	Ultrasound
PES	-	PostEmbolisation Syndrome
AVMs	-	Arterio Venous Malformations
PES	-	Post embolisation syndrome
GF	-	Gel Foam
PVA	-	Poly Vinyl Alcohol
SID	-	Subintimal dissection
VS	-	Vasospasm

CASE: 1



PRE EMBOLISATION – GREY SCALE IMAGE ULTRASONOGRAPHY

VOLUME MEASURES 164.27 cu. cm

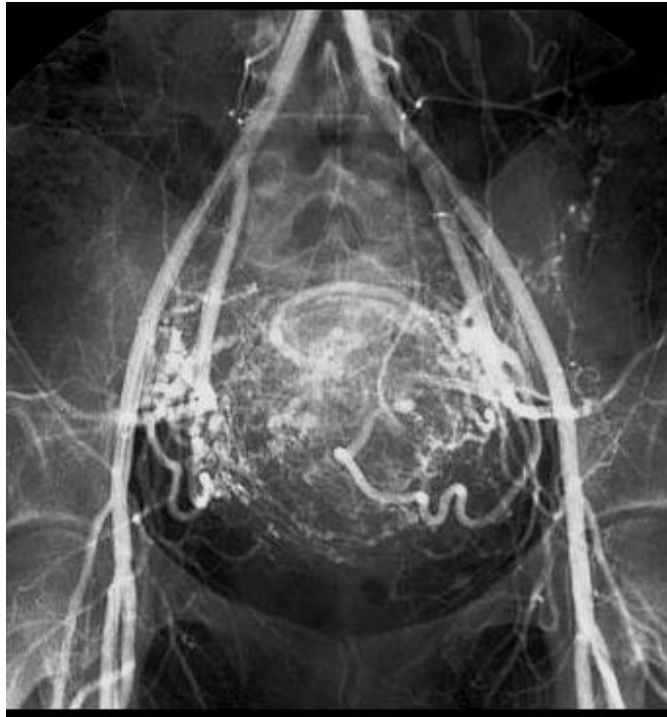


PRE EMBOLISATION - 3D COLOR DOPPLER SHOWS

HYPER VASCULAR FIBROID

UTERINE ARTERY EMBOLISATION

**FLUSH AORTIC ANGIOGRAM TO DETECT ABBERRANT VASCULAR
SUPPLY**



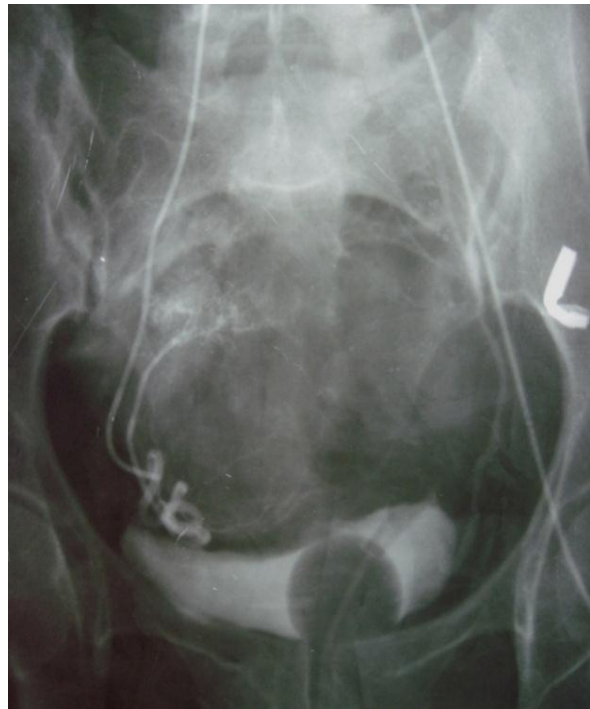
**CONTRALATERAL PELVIC ANGIOGRAM VIA LEFT TRANSFEMORAL
APPROACH**



IPSI LATERAL PELVIC ANGIOGRAM



SUPER SELECTIVE ANGIOGRAM OF UTERINE ARTERIES



ARTERIAL PHASE OF CONTRAST



VENOUS PHASE OF CONTRAST



DURING EMBOLISATION

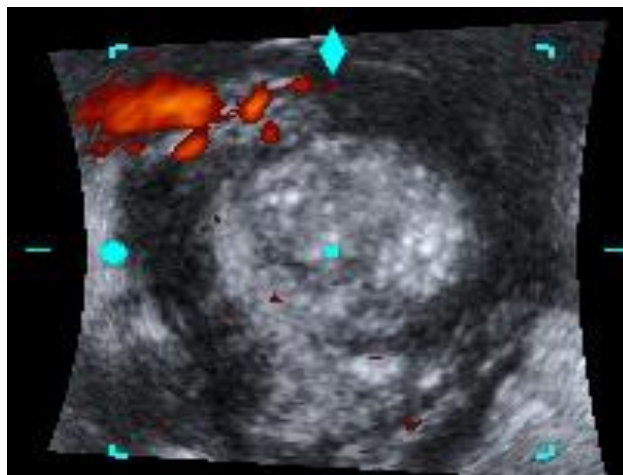
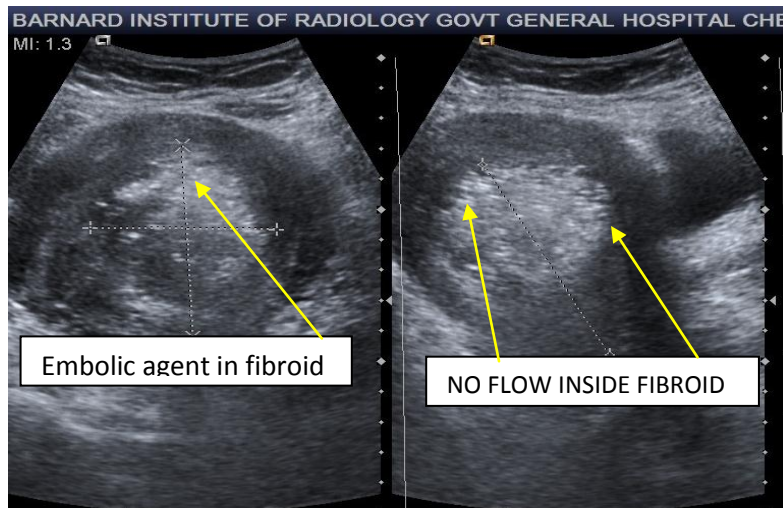


**POST EMBOLISATION
STANDING COLUMN OF
CONTRAST**

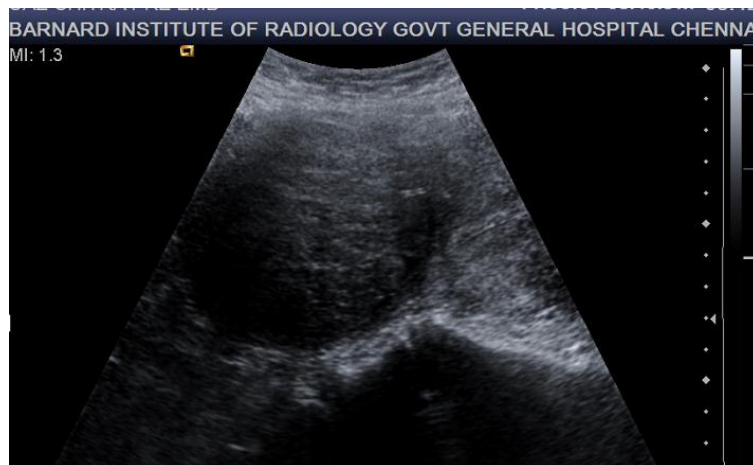


**POST-EMBOLIZATION PELVIC ANGIOGRAPHY PERFORMED TO
DOCUMENT ARTERIAL OCCLUSION**

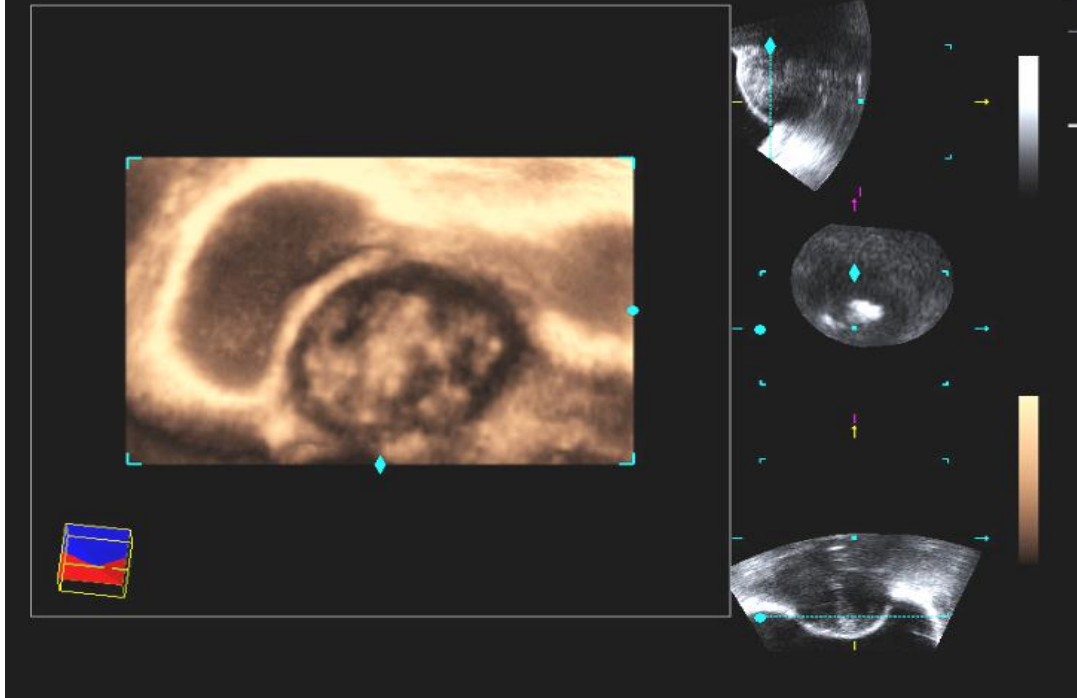
**IMMEDIATE POST EMBOLISATION GREY
SCALE IMAGE**



**IMMEDIATE POST EMBOLISATION 3D COLOR DOPPLER IMAGE
SHOWING HYPO VASCULARITY**

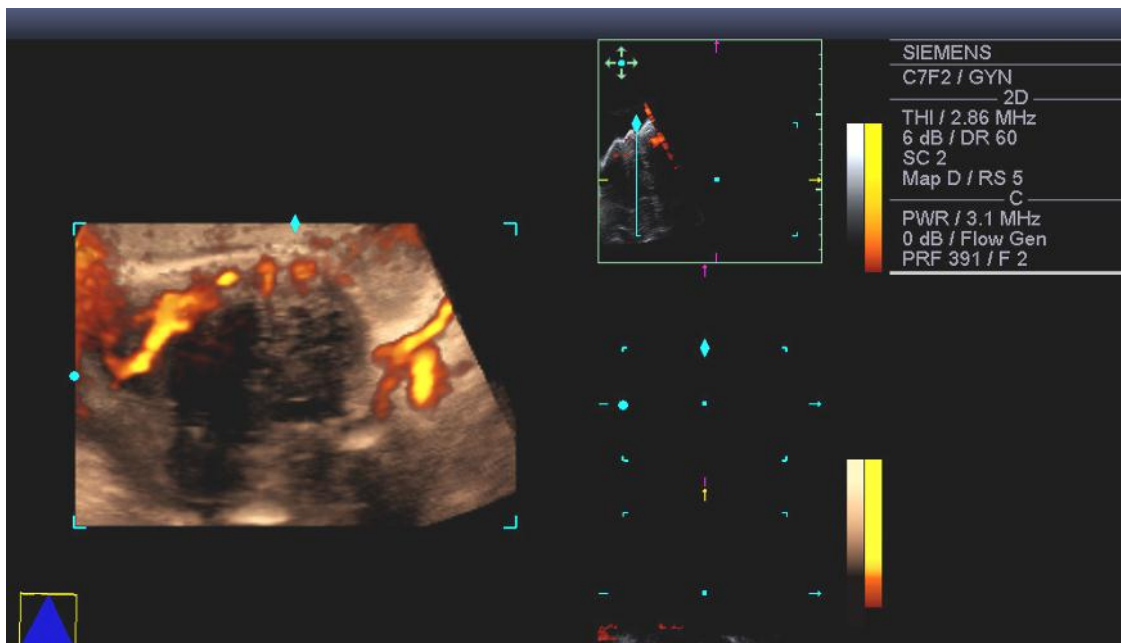


**POST EMBOLISATION 3 MONTHS FOLLOW UP IMAGE
42.24% VOLUME REDUCTION DETECTED**



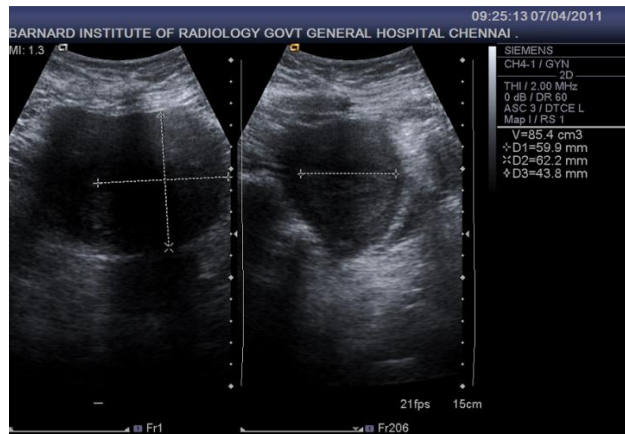
POST EMBOLISATION 6 MONTHS FOLLOW UP 3 D IMAGE

76.22% VOLUME REDUCTION DETECTED

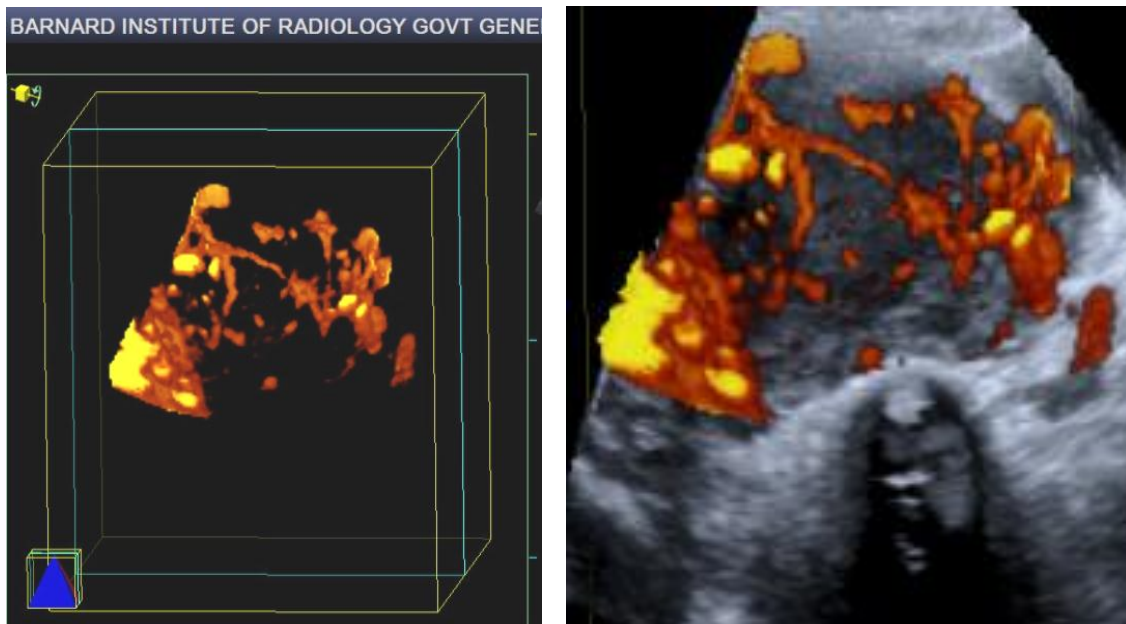


**POST EMBOLISATION 12 MONTHS FOLLOW UP 3D COLOR DOPPLER -
88.02% VOLUME REDUCTION DETECTED AND HYPOVASCULAR**

CASE - 2

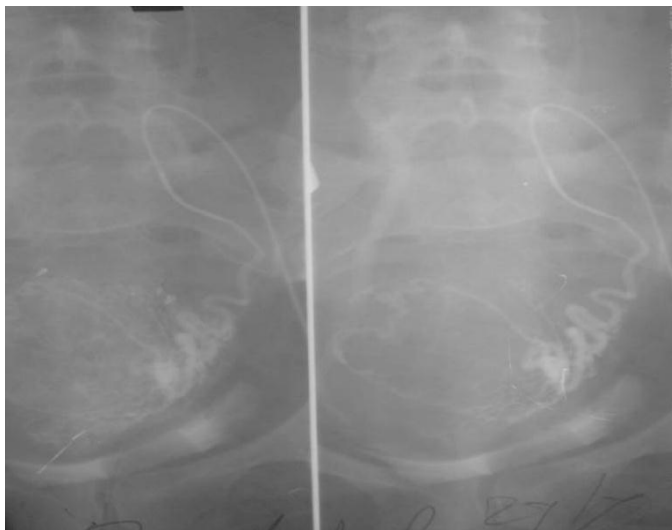


**PRE EMBOLISATION – GREY SCALE IMAGE ULTRASONOGRAPHY -
VOLUME MEASUREMENT - 147 cu.cm**



**PRE EMBOLISATION - 3D COLOR DOPPLER SHOWING
HYPERVASCULAR FIBROID**

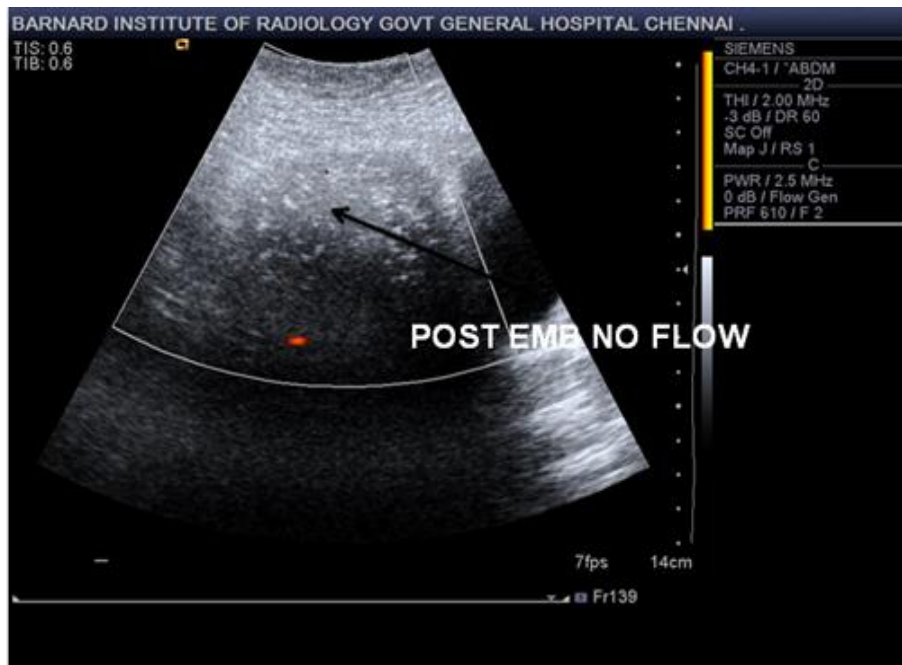
**UTERINE ARTERY EMBOLISATION
EMBOLISATION IN A PATIENT WITH PELVIC KIDNEY**



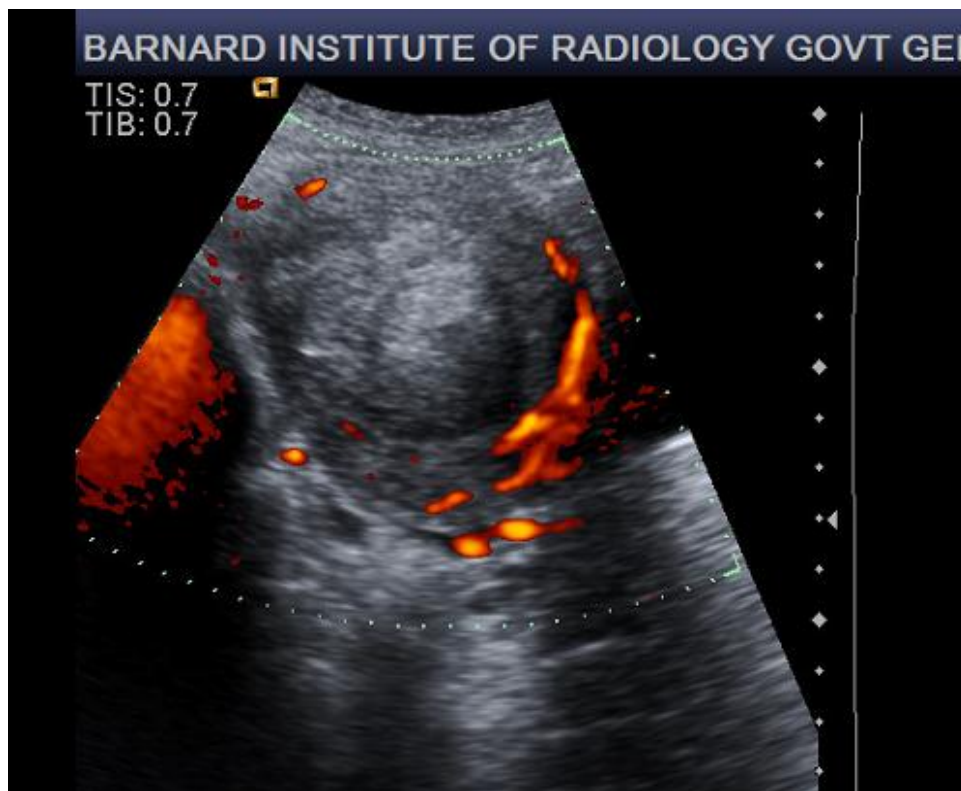
SUPER SELECTIVE ANGIOGRAM OF IPSILATERAL LEFT UTERINE ARTERY



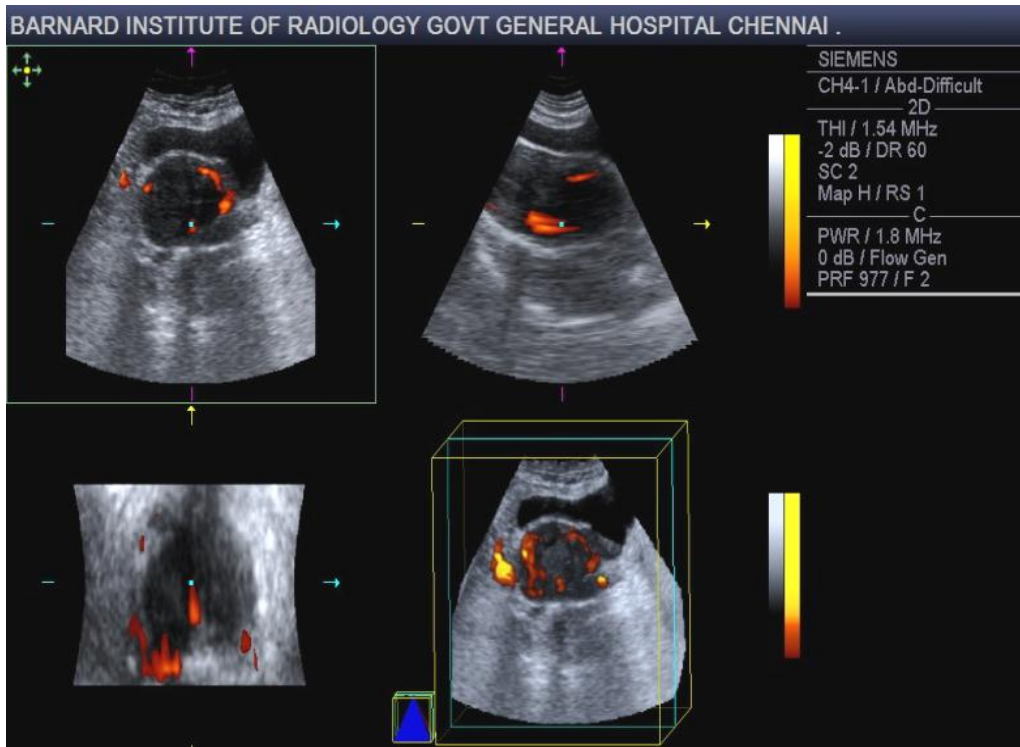
**POST-EMBOLIZATION PELVIC ANGIOGRAPHY SHOULD BE PERFORMED TO
DOCUMENT ARTERIAL OCCLUSION**



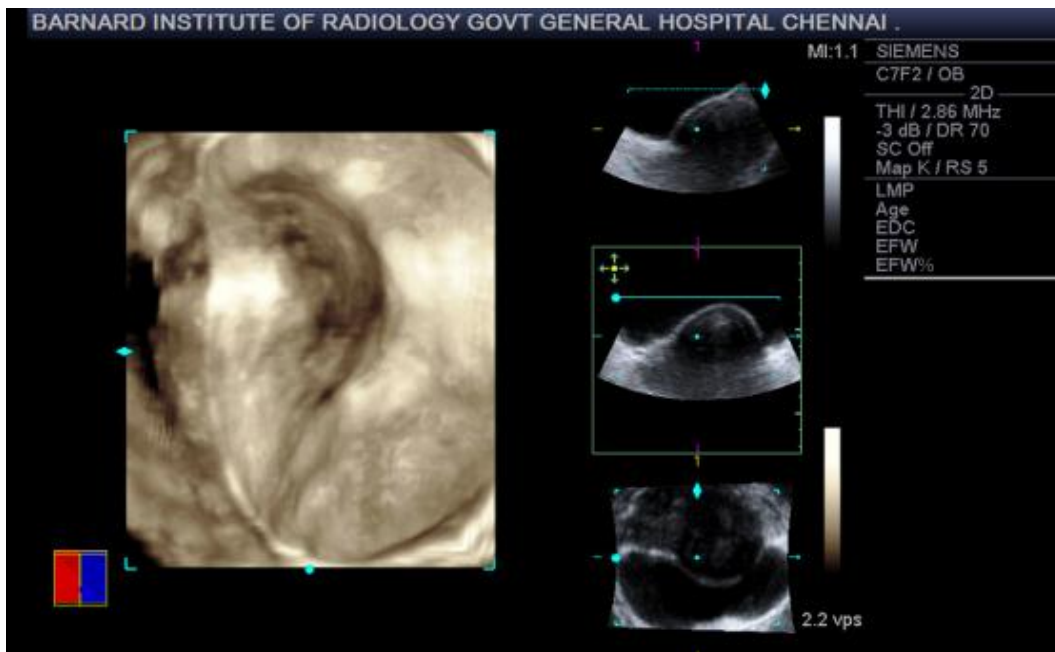
IMMEDIATE POST EMBOLISATION - COLOUR DOPPLER IMAGE - SHOWING HYPOVASCULARITY



POST EMBOLISATION 3 MONTHS FOLLOW UP COLOR DOPPLER IMAGE - 47.90% VOLUME REDUCTION DETECTED AND HYPOVASCULAR

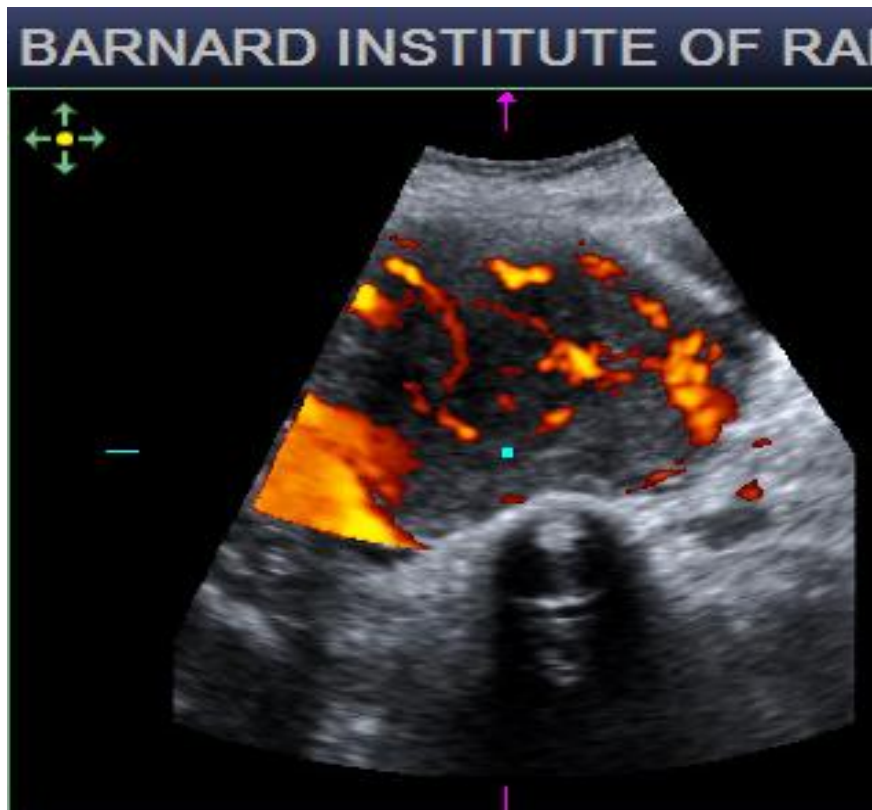


**POST EMBOLISATION 6 MONTHS FOLLOW UP IMAGE –
72.48% VOLUME REDUCTION DETECTED AND HYPOVASCULAR**



**POST EMBOLISATION 12 MONTHS FOLLOW UP IMAGE -
83.86 % VOLUME REDUCTION DETECTED AND HYPOVASCULAR**

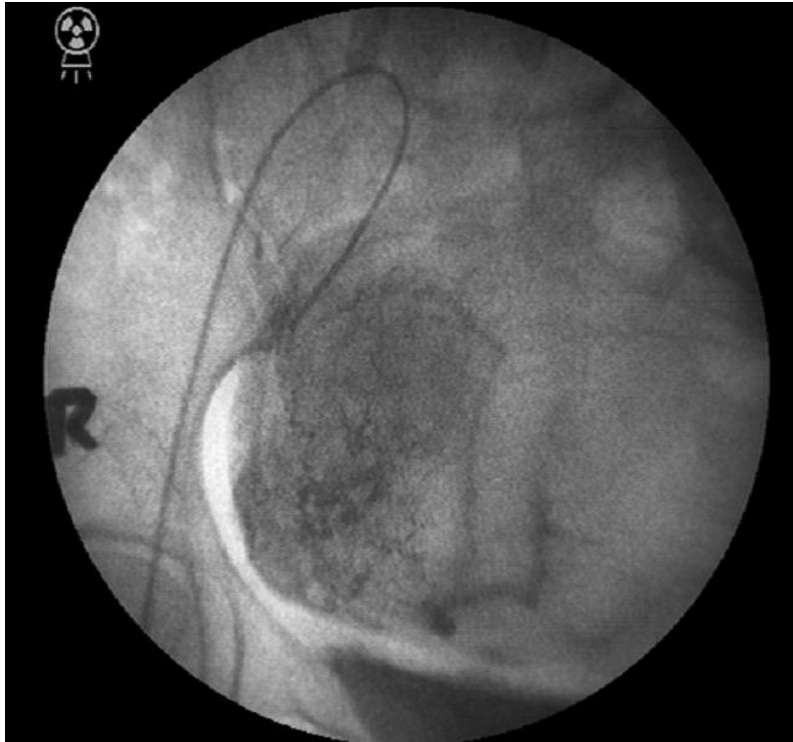
CASE - 3



**PRE EMBOLISATION 3D COLOR DOPPLER IMAGE
98 cu. cm VOLUME DETECTED AND HYPER VASCULAR FIBROID**



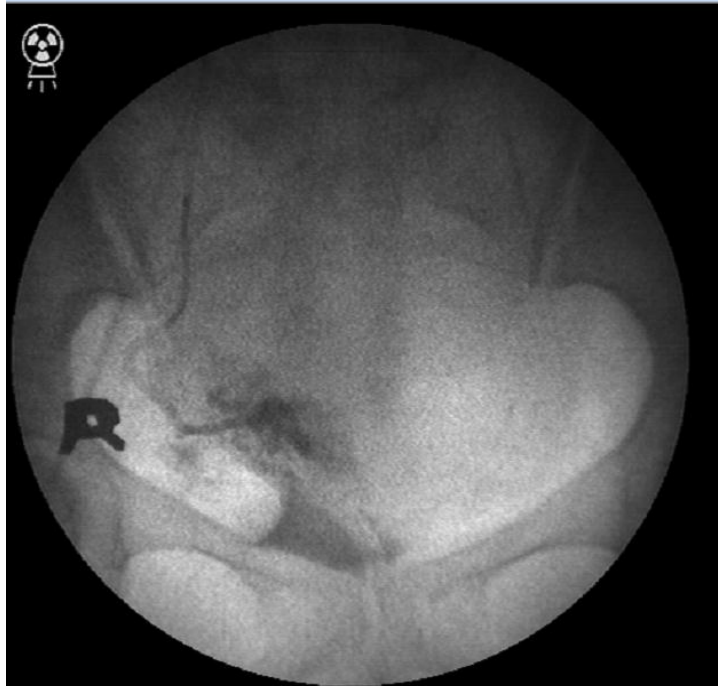
**SELECTIVE IPSILATERAL RIGHT UTERINE ARTERY ANGIOGRAM VIA
RIGHT TRANSFEMORAL APPROACH**



VENOUS PHASE OF UTERINE ARTERY ARTERIOGRAPHY



DURING PVA PARTICLES EMBOLISATION OF RIGHT UAE

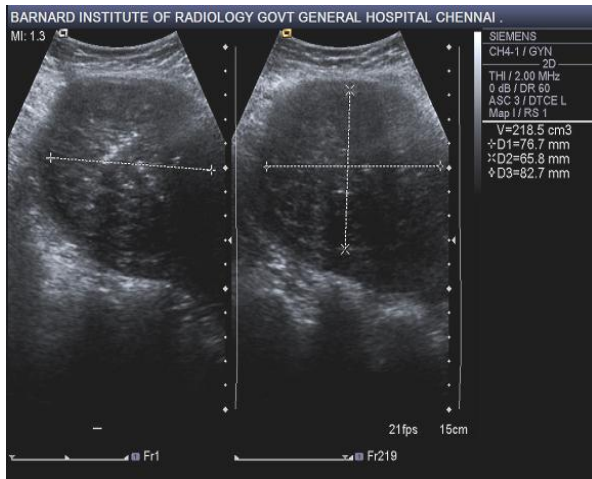


DURING GEL FOAM INJECTION OF RIGHT MAIN UTERINE ARTERY

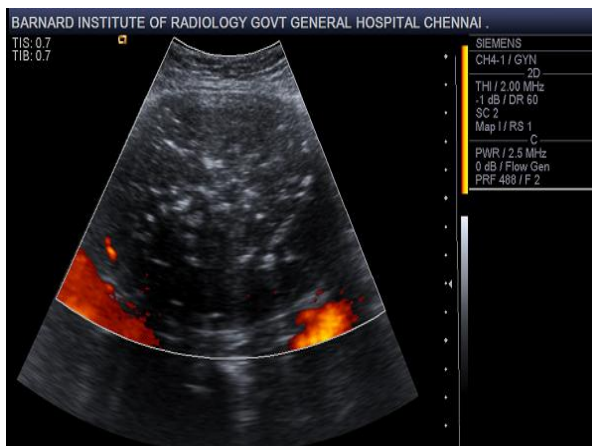


POST EMBOLISATION STANDING COLUMN OF CONTRAST

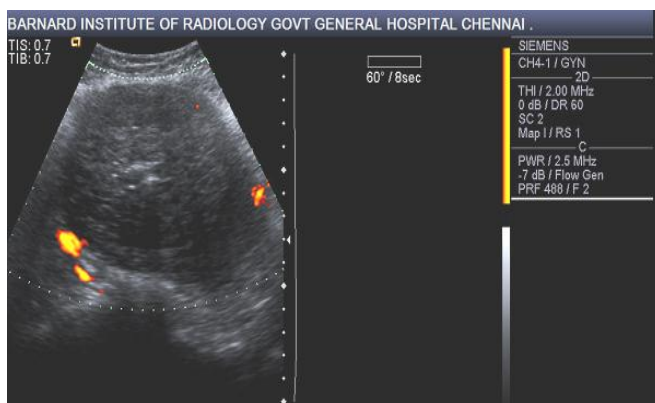
POST EMBOLISATION



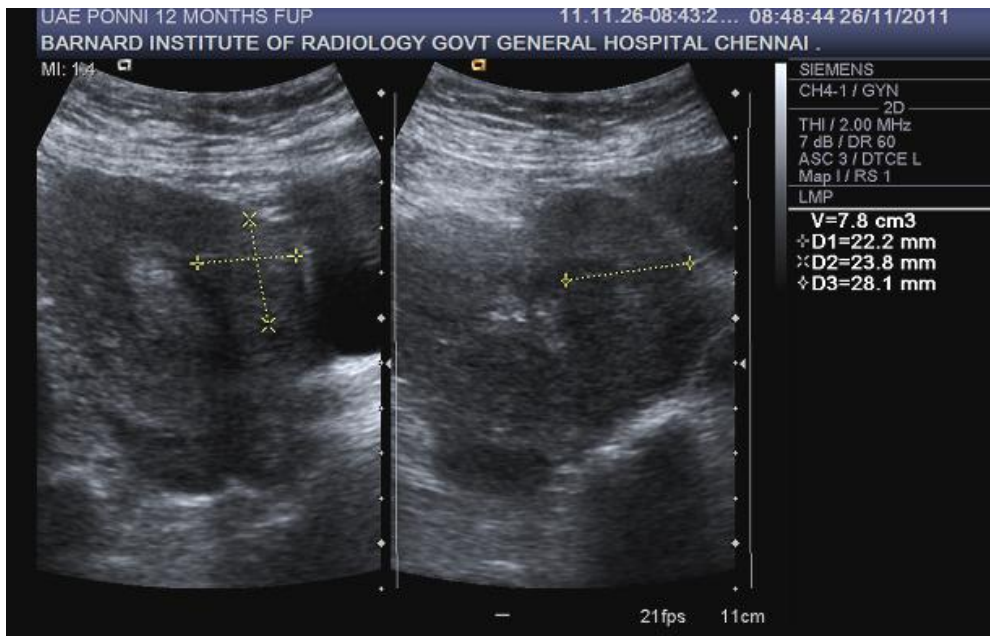
**IMMEDIATE POST
EMBOLISATION GREY SCALE
IMAGE - VOLUME
MEASURING 102 cu. cm**



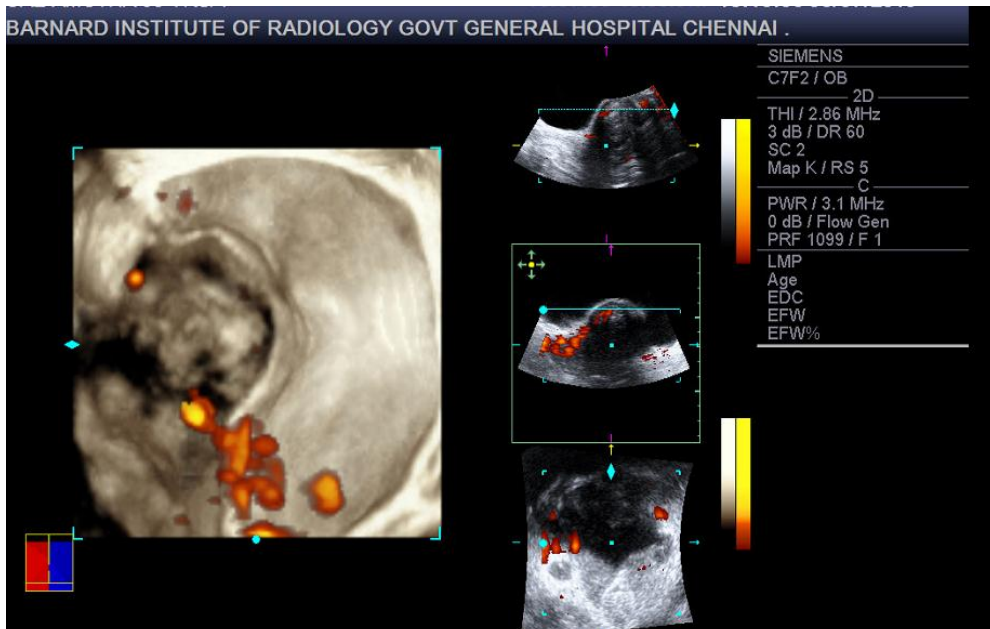
**POST EMBOLISATION
3 MONTHS FOLLOWUP
IMAGE - 38% VOLUME
REDUCTION AND
HYPOVASCULAR**



**POST EMBOLISATION 6
MONTHS FOLLOWUP
IMAGE – 65.7% VOLUME
REDUCTION AND
HYPOVASCULAR**

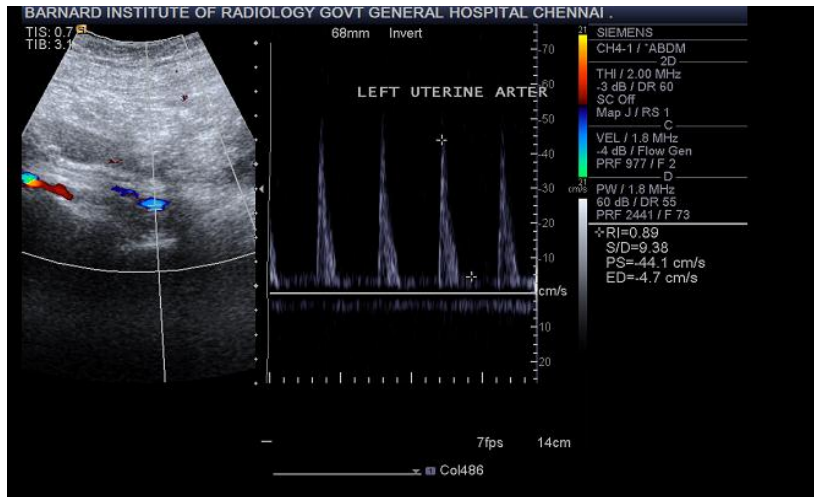


**POST EMBOLISATION 12 MONTHS 3D CDS SONOGRAPHIC IMAGE –
 80 %VOLUME REDUCTION AND HYPOVASCULAR**

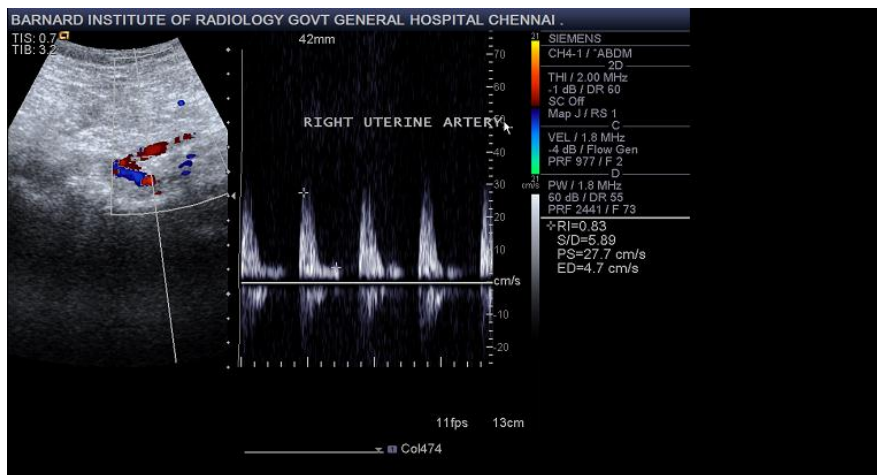


**POST EMBOLISATION 12 MONTHS 3D COLOR DOPPLER IMAGE
 SHOWING MARKED REDUCTION IN VASCULARITY**

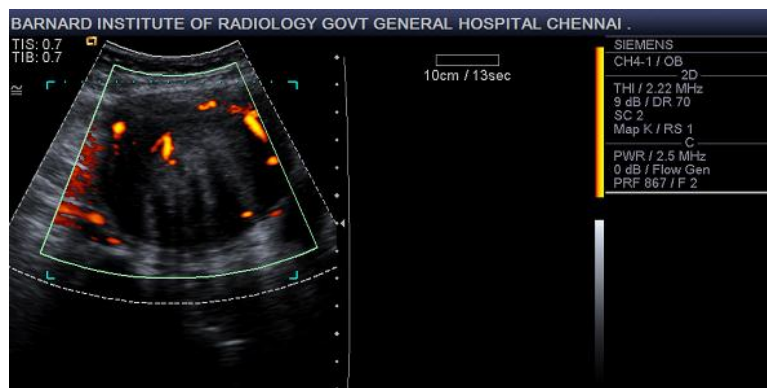
CASE - 4



PRE EMBOLISATION LEFT UTERINE ARTERY PSV – 44.1 cm/s

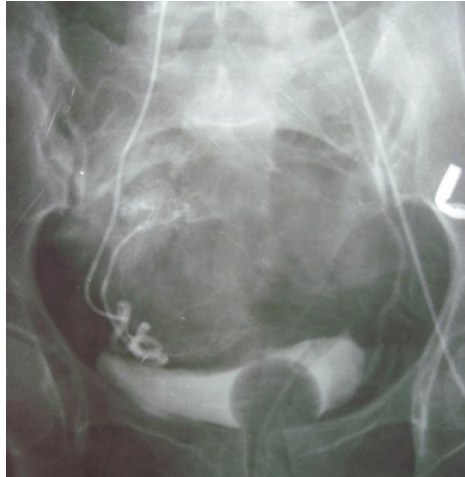


PRE EMBOLISATION RIGHT UTERINE ARTERY PSV – 27.7 cm/s

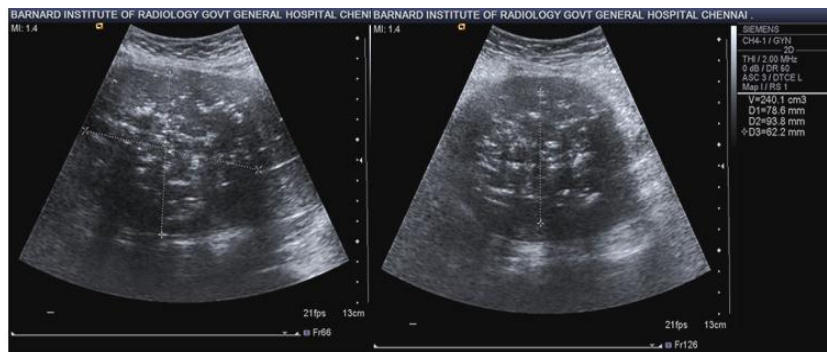


PRE EMBOLISATION 3D COLOR DOPPLER IMAGE

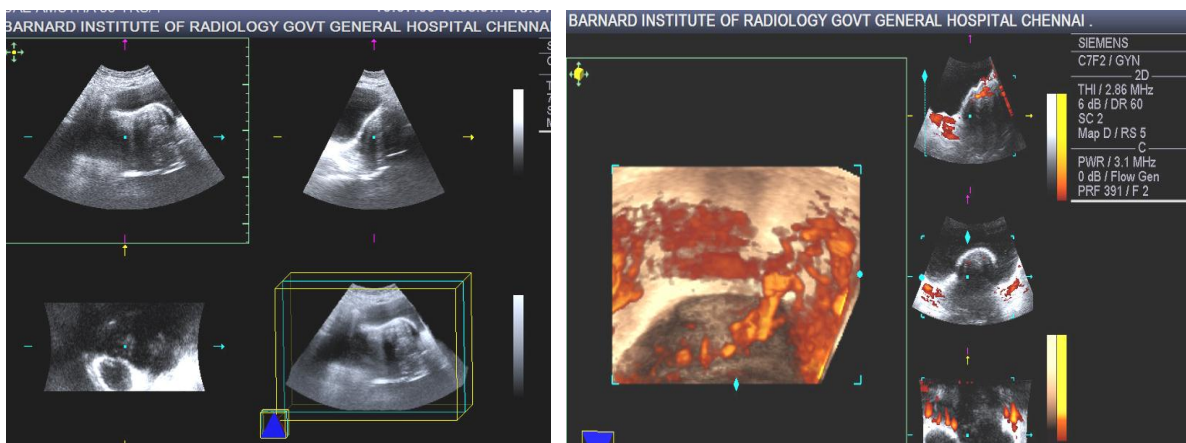
EMBOLISATION OF RIGHT SIDE UTERINE ARTERY VIA LEFT TRANSFEMORAL APPROACH



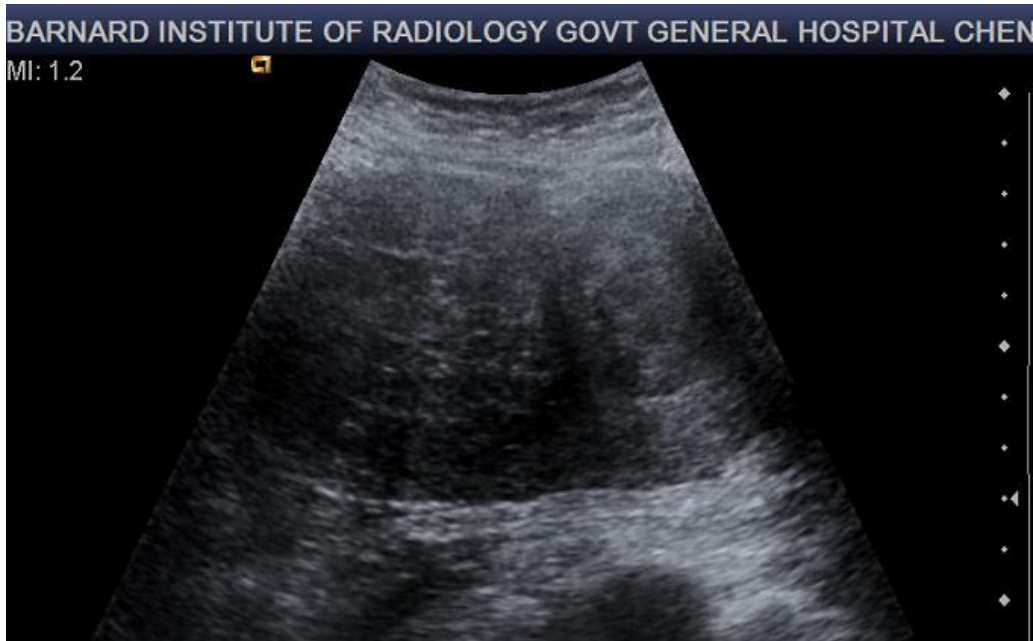
IMMEDIATE POST EMBOLISATION GREY SCALE IMAGE



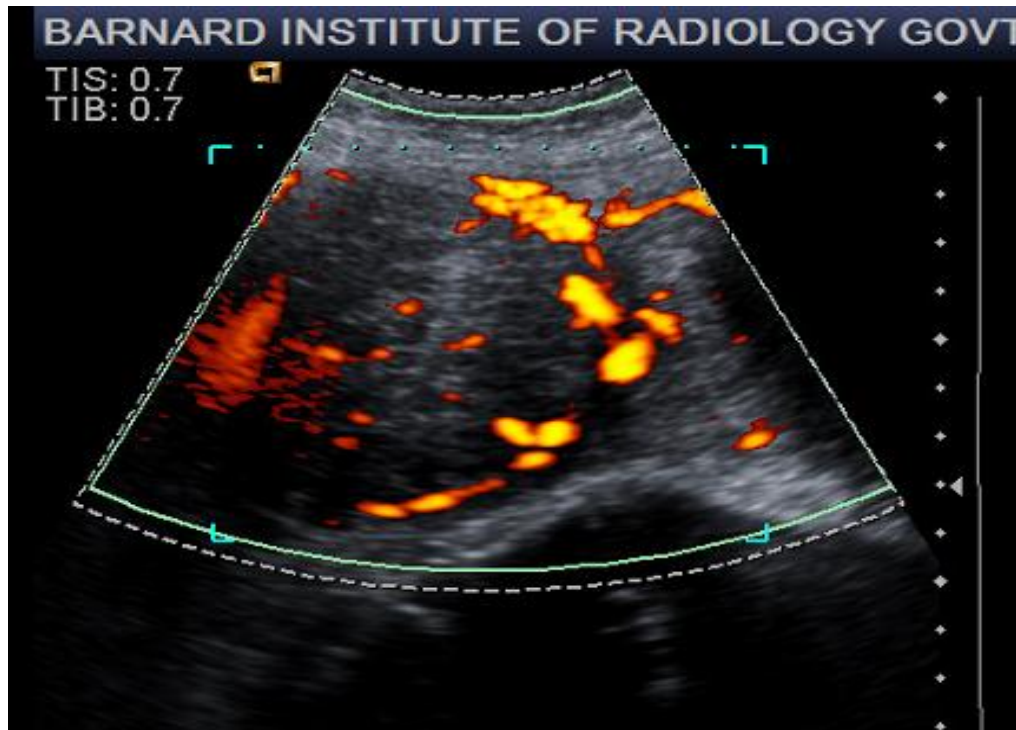
POST EMBOLISATION 12 MONTHS FOLLOW UP GREY SCALE IMAGE - 78% VOLUME REDUCTION DETECTED AND HYPOVASCULAR FIBROID



CASE - 5

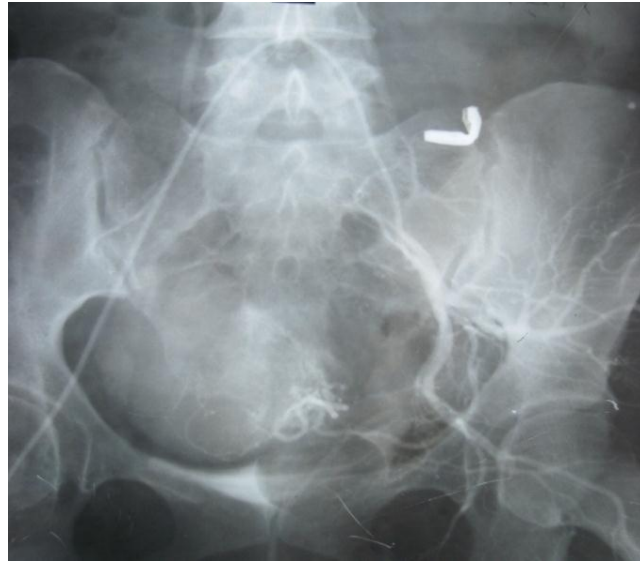


2D FIBROID DETECTION

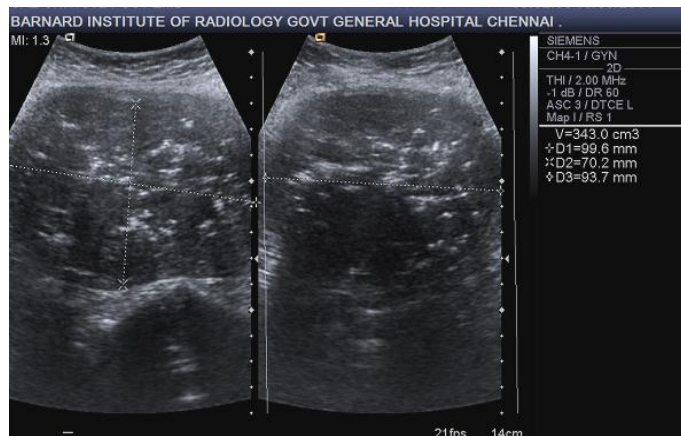


**PRE EMBOLISATION 3D COLOR DOPPLER –
VOLUME MEASURES 109.23 cu.cm AND HYPERVASCULAR FIBROID**

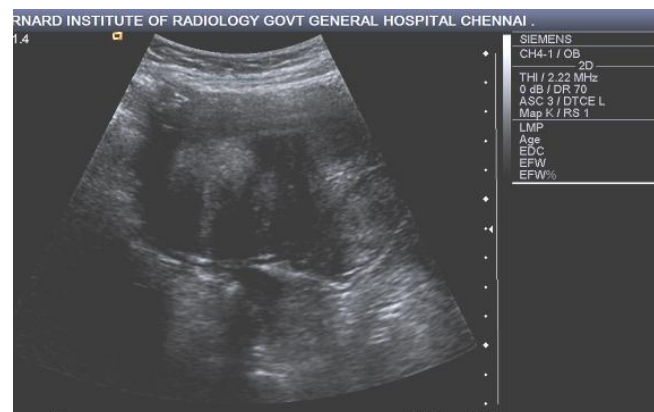
UTERINE ARTERY EMBOLISATION



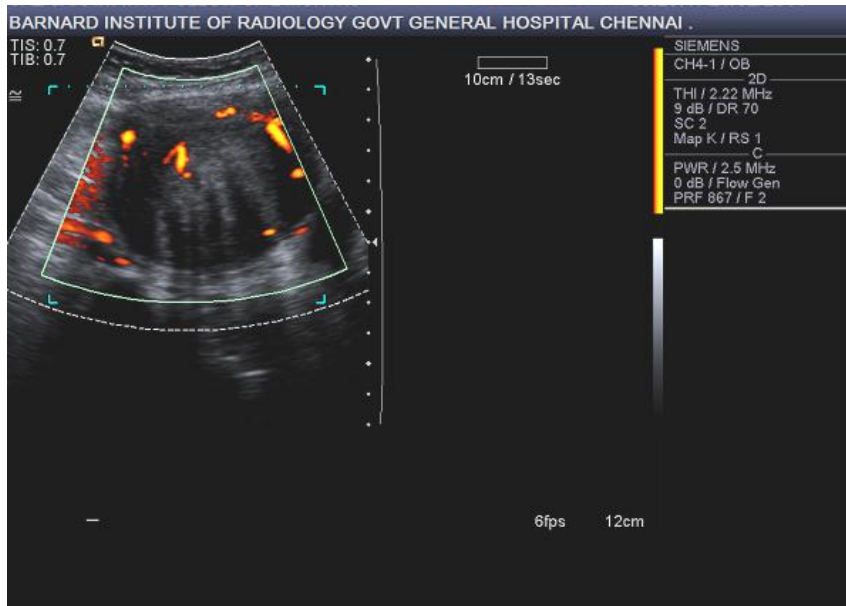
POST EMBOLISATION LEFT PELVIC ANGIOGRAM WITH STANDING COLUMN OF CONTRAST



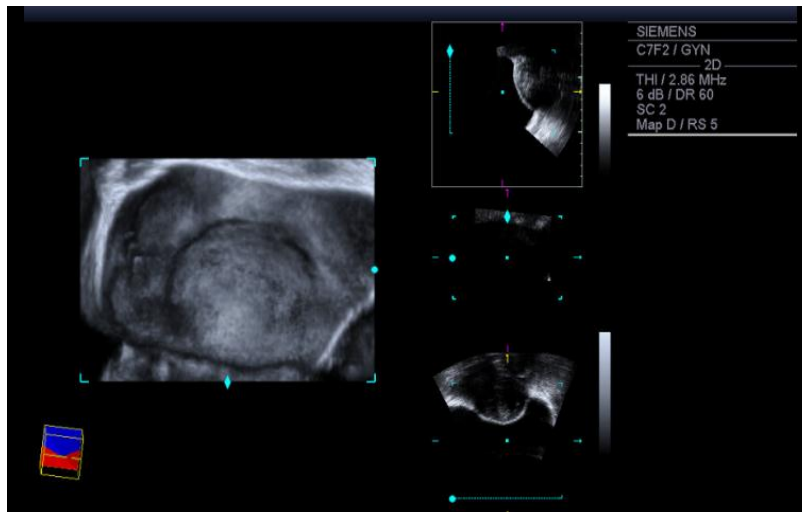
IMMEDIATE POST EMBOLISATION – GREY SCALE IMAGE SHOWING HYPERECHOIC EMBOLIC AGENTS



POST EMBOLISATION FOLLOW UP 3 MONTHS GREY SCALE IMAGE SHOWING 40% VOLUME REDUCTION



**POST EMBOLISATION 6 MONTHS 3D COLOR DOPPLER FOLLOWUP
63% VOLUME REDUCTION AND HYPO VASCULAR FIBROID**



**POST EMBOLISATION 12 MONTHS FOLLOW UP
81% VOLUME REDUCTION AND HYPO VASCULAR FIBROID**

Sl.No.	patient no	Age / Sex	Indication	Pressure	Approach	Uni/Bi	Particles Used	Vol_bef	Vol_3m	Vol_6m	Vol_12m
1	1	35/f	previous surgery	NO	Right TFA	unilateral	gelfoam	164.75	98.68	17.50	10.50
2	2	40/F	OPTED	NO	Right TFA	unilateral	gelfoam	136.66	102.00	76.04	33.04
3	3	38/f	OPTED	yes	Right TFA	unilateral	gelfoam	51.78	37.07	33.47	28.50
4	4	40/f	OPTED	NO	Right TFA	unilateral	gelfoam	51.40	30.95	21.97	16.50
5	5	35/f	OPTED	NO	Right TFA	unilateral	gelfoam	149.14	79.88	75.50	56.90
6	6	35/f	OPTED	yes	Right TFA	Unilateral	Gelfoam	60.00	32.00	18.36	10.90
7	7	40/f	ANEMIA	NO	Right TFA	Unilateral	PVA+ Gelfoam	38.23	22.00	10.81	
8	8	40/F	OPTED	NO	Right TFA	bilateral	PVA+ Gelfoam	94.87	32.62	20.00	12.00
9	9	39/f	OPTED	NO	Right TFA	Unilateral	PVA+ Gelfoam	162.75	89.88	32.48	26.90
10	10	30/f	OPTED	yes	Right TFA	Bilateral	PVA+ Gelfoam	109.23	65.93	30.23	10.07
11	11	40/f	ANEMIA	NO	Right TFA	Unilateral	Gelfoam	94.87	42.00	31.16	20.70
12	12	40/f	OPTED	NO	Right TFA	Bilateral	Gelfoam	44.55	18.00	5.88	3.90
13	13	40/f	OBESE	NO	Right TFA	Bilateral	Gelfoam	60.00	40.00	9.91	
14	14	40/f	OPTED	NO	Right TFA	Bilateral	Gelfoam	66.25	37.66	13.48	6.30

15	15	40/f	ANEMIA	NO	Right TFA	Unilateral	PVA	68.75	30.01	23.06	13.40
16	16	40/f	OPTED	NO	Left TFA	Bilateral	PVA+ Gelfoam	147.00	58.00	28.86	14.20
17	17	38/f	ANEMIA	NO	Right TFA	Bilateral	Gelfoam	52.30	37.66	18.36	13.20
18	18	34/f	OPTED	NO	B/1 TFA	Bilateral	Gelfoam	50.00	30.00	12.04	4.04
19	19	35/f	heart disease	NO	B/1 TFA	Bilateral	Gelfoam	122.38	92.02	25.19	12.60
20	20	38/f	OPTED	yes	B/1 TFA	unilateral	PVA+ Gelfoam	206.08	138.88	51.30	38.90
21	21	40/f	previous surgery	yes	B/1 TFA	unilateral	PVA+ Gelfoam	102.00	53.20	11.10	6.90
22	22	40/f	previous surgery	NO	B/1 TFA	unilateral	PVA+ Gelfoam	67.85	27.04	9.85	5.90
23	23	37/f	OPTED	no	B/1 TFA	unilateral	PVA+ Gelfoam	190.08	103.73	73.23	18.04
24	24	38/f	anaemic	yes	B/1 TFA	unilateral	PVA+ Gelfoam	128.76	71.74	27.55	20.30
25	25	40/f	OPTED	no	B/1 TFA	unilateral	PVA+ Gelfoam	156.87	94.79	22.59	15.30
26	26	39/F	OPTED	NO	B/1 TFA	unilateral	PVA+ Gelfoam	131.95	56.09	22.46	16.30
27	27	40/F	OBESE	NO	B/1 TFA	unilateral	PVA+ Gelfoam	150.50	74.88	34.03	13.07
28	28	37/F	OPTED	NO	B/1 TFA	unilateral	PVA+ Gelfoam	132.24	71.73	42.06	24.05
29	29	35/F	OPTED	NO	B/1 TFA	unilateral	PVA+ Gelfoam	199.68	101.75	58.30	
30	30	40/F	OPTED	NO	B/1 TFA	unilateral	PVA+ Gelfoam	220.32	125.59	78.02	31.03