

National Institute for Clinical Excellence Interventional Procedures Programme

Systematic review of the efficacy and safety of
uterine artery embolisation in the treatment of
fibroids

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Host Department

The School for Health and Related Research hosts one of the two research groups that make up the 'Review Body' for the National Institute for Clinical Excellence (NICE) Interventional Procedures Programme. The other is based in the Health Services Research Unit at the University of Aberdeen.

Contributions of the ReBIP team to this review

Elizabeth Cross and Richard Wilson were involved in scoping the review, Appendix 1. Lynda Ayiku developed and ran the literature search strategies, obtained papers and formatted the references. Patricia Coleman (PC) screened the search results, developed inclusion and exclusion strategies, quality assessment, abstracted the data, and carried out the review. PC was the substantial author of the report. Jon Nicholl provided guidance and statistical advice throughout. Marc Chattle provided administrative support.

Conflicts of interest

None

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The views expressed are those of the author and not necessarily those of the funding body.

TABLE OF CONTENTS		Page
	EXECUTIVE SUMMARY	i-v
1.0	OBJECTIVE OF THE REVIEW	1
2.0	BACKGROUND	1
2.1	Description of the underlying health problem	1
2.1.1	Epidemiology	1
2.1.2	Aetiology	1
2.2	Current management and alternative procedures	2
2.3	Uterine Artery Embolisation	2
2.3.1	Description	2
2.3.2	Clinical indications/contraindications and putative impact	3
2.3.3	Personnel – skill/experience	3
2.3.4	Current use in UK	4
3.0	METHODS	5
3.1	Review	5
3.1.1	Literature search	5
3.1.2	Inclusion and exclusion criteria	6
3.1.3	UK literature	7
3.1.4	Results of filtering	12
3.1.5	Description of studies included	12
3.1.6	Quality assessment	14
3.1.7	Data abstraction	15
3.2	Data organisation	15
4.0	RESULTS	16
4.1	Summary of evidence	
4.1.1	Randomised controlled trials	16
4.1.2	The Ontario (Canada) Prospective UAE multi-centre series	16
4.1.3	Comparative studies	16
4.1.4	Case series	18
4.1.5	Patient survey	18
4.2	Study populations	18
4.2.1	Patients	18
4.2.2	Interventional Radiologists	18
4.3	Periods of follow up	19
5.0	EFFICACY AND SAFETY	19
5.1	Indicators of efficacy	18
5.1.1	Fibroid volume	19
5.1.2	Symptom improvement	20
5.2	Indicators of safety	23
5.3	Specific issues	24
5.3.1	Ovarian function and fertility	24
5.3.2	Pregnancy	25
5.4	Technological issues	25
5.5	Patients perspective/ satisfaction	25
5.6	Limitations of available evidence	33
6.0	DISCUSSION	34
7.0	CONCLUSION	36
8.0	REFERENCES	38

TABLES		Page
Table 1	Availability of UAE by UK Health Regions	4
UK Literature		
Table 2.1	Case series	8
Table 2.2	Reports	9
Table 2.3	Case reports	10
Table 2.4	Reviews/Editorials	11
Review process		
Table 3	Included studies	13
Table 4	Quality assessment of non-randomised case series	14
Summary results		
Table 5.1	Efficacy across a range of results	23
Table 5.2	Safety across a range of results	24
Table 6	Ontario multi-centre study	25
Table 7	Ovarian function and fertility/Pregnancy	26
Table 8	Technological issues	27
Table 9	Patients perspective/satisfaction	28
 FIGURES		
Figure 1	Numbers of potentially-relevant publications in file	6
Figure 2	% reductions in mean uterine volume at six months	20
Figure 3	% of patients whose symptoms improved/stabilised at six months	21
BOX 1	Reported measures of outcome	34
 APPENDICES		
Appendix 1	Scope of Review dated 12 August 2003	
Appendix 2	Literature search : databases and search terms	
Appendix 3	Non-English Language publications retrieved	
Appendix 4	Broad criteria of predictive quality of primary studies	
Appendix 5.1	Case Reports retrieved (except UK – see table 2.3)	
Appendix 5.2	References for case reports in Appendix 5.1	
Appendix 6	Quality checklists randomised controlled trials	
Appendix 7	Quality checklist for non-randomised studies	
Appendix 8	Separate summaries of 36 papers reviewed (alphabetic order of first author)	

GLOSSARY

Adenomyosis	Presence of endometrial glands and supporting tissues in the uterus where it would not occur normally
Adnexal	Parts accessory to an organ, especially the uterus
Amenorrhoea	Absence or abnormal cessation of menstruation
Anastomosis	A connection between two blood vessels or other tubular structures, occurring pathologically through disease or operatively
Angiography	Radiography of the vessels after injection of a contrast material usually requiring percutaneous insertion of a radiopaque catheter and positioning under fluoroscopic control
Arteriography	Visualization of an artery or arteries by x-ray imaging after injection of a contrast medium
Catheter	A flexible tubular instrument to allow passage of fluid from or into a blood vessel
Dysmenorrhea	Painful menstruation
Embolisation	Therapeutic introduction of various substances into the circulation either to arrest or prevent hemorrhaging or to devitalise a structure or organ by cutting off its blood supply
Fluoroscope	An apparatus for visualising the patterns of x-rays passing through a body under examination by interposing a glass plate coated with fluorescent materials
Histology	Science of the minute structure of the cells, tissues and organs in relation to their function
Hysteroscope	Instrument to enable visual inspection of the uterine cavity
Magnetic Resonance Imaging (MRI)	Diagnostic apparatus using radio-frequency pulses and signals permitting 3-dimensional localisation of the source of the signals
Menopause	Permanent cessation of menstruation; end of natural reproductive capacity
Menorrhagia	Excessive/heavy menstrual bleeding
Morphology	Science of the structure of animals and plants
Multiparous	Giving birth at least two times to an infant, (born live or not, weighing ≥ 500 grams, or having an estimated length of gestation of at least 20 weeks)
Myomectomy	Operative removal of fibroids
Necrosis	Pathologic death of one or more cells, or of a portion of tissue or organ
Nulliparous	Never have borne children
Percutaneous	Passage through the skin of needle puncture, including introduction of wires and catheters; denoting the passage of substances through unbroken skin
Peri-menopausal	A transitional stage in female reproductive capacity including physiological changes, mainly hormonal, occurring about 2 years before the menopause and ending one year later
Post-embolisation syndrome	Pain, nausea, fever, vomiting, following embolising procedures

EXECUTIVE SUMMARY

Uterine Artery Embolisation

A systematic review of the available evidence relating to the safety and efficacy of Uterine Artery Embolisation (UAE) was carried out.

Symptomatic fibroids are a common gynaecological condition. Typically they are managed by surgical intervention: hysterectomy or myomectomy. There is no long-term effective medical treatment. UAE is another treatment option. An interventional radiologist performs the procedure. The patient is sedated, and under local anaesthetic, a catheter is inserted into the femoral artery using a bilateral or unilateral technique. Using X-ray equipment to locate the blood vessels that are feeding the fibroids, fluid containing tiny particles is injected through the catheter into the small blood vessels. The particles silt up and block off the blood supply to the fibroids causing them to shrink. Some patients may expel tissue spontaneously over time, or require hysteroscopic assistance with its removal.

UAE is used in the management of other gynaecological conditions¹. Previously it was performed in preparation for surgical intervention for fibroids². Its use as a 'stand alone' procedure for fibroids was first reported in 1995³. Reliable estimates of the numbers of UAE procedures performed world-wide since then are not known. A survey in 2000⁴ reported that 8,500 had been undertaken in the USA. Approximately 2,050 have been performed to date in the UK, (Table 1).

Search and review process

Comprehensive searches of the relevant databases (Appendix 2) were undertaken during October and November 2003. The terms and the search strategies yielded 819 potentially relevant items. The titles and/or abstracts were scanned and 256/293 papers that contained the specific words 'Uterine Artery Embolisation' **and** 'Fibroids' (or equivalent terms) were obtained. The UK literature is summarised separately (Tables 2.1-2.4), and also included in the international review in the usual way. The indexing, filtering and quality check processes admitted thirty-nine primary papers (including 5 from the UK) for detailed review (Table 3). Three papers^{46,53,77} were removed subsequently.

Summary of review evidence

One randomised controlled trial (RCT), two comparative studies, one patient questionnaire survey, and 32 papers (one reporting baseline data only) from 25 case series of patients were reviewed. Most papers were from the USA (Table 3). The number of patients in the series ranged from 11^{20,76} to 555. The mean age of patients was 43 years (Tables 5-8). All the patients had symptomatic fibroids and were at the stage in their illness when some intervention was required. Beyond this, the criteria for inclusion in the UAE series varied between the studies.

Efficacy

Reductions in mean uterine volume and fibroid volume of 26-59% and 40%-75% respectively were reported in the first six months following UAE. Where longer follow up was available, the reductions continued over time in most patients (Figure 2). Greater reductions in fibroid volume were associated with larger fibroids and increased vascularity^{61,63,64}.

Reductions in fibroid volume has been found not to be associated with changes in symptoms^{20,64}. Improvements in the symptoms, most commonly for menorrhagia, were reported in 60% to more than 90% of patients irrespective of the numbers in the clinical series (Figure 3).

The extent of any improvement in symptoms achieved is unclear. Changes in pre-treatment scores ranged from 10% to 'complete resolution'⁵⁷ were reported from smaller series of patients (range, n=11 to n=80). The largest series (n=555) reported 'marked improvements' (as distinct from 'moderate' or 'slight') for between 34% and 58% of patients. These results were based on a follow-up period of 3-months, which may not be sufficient to detect all outcomes, and they cannot be compared with the other three large series of patients (range, n=167 to n=400)^{25,66,73} because differences in improvements in symptoms were not reported. Two used a simple 3-category model 'worsened', 'unchanged' 'improved'^{25,73}. The third defined 'clinical failure', 'stabilisation' and 'improvement', but did not report the results for patients

(88%) whose symptoms had 'stabilised' and those whose symptoms 'improved', separately.

There was evidence that patient satisfaction was linked to clinical improvement over time. The only indicator of outcomes for a period of three years or more following UAE is based on the responses to a questionnaire survey by 51 of 57 patients who underwent UAE between three and five years previously. This reported that 61% (n=31/51) were 'at least somewhat satisfied with their choice of procedure'

Safety

Complications were reported in between 5% and 73% of patients in the included series. This variation is likely to be affected by the size of the series, length of follow up, and how complications are defined. Pain was the most common immediate post-procedural complication. Post-embolisation syndrome (pain, nausea, fever and vomiting) is not uncommon. The main reasons for emergency surgical intervention were unremitting pain and infection post-UAE. One death was reported in an included series. Complications may occur several months after UAE usually related to late passage of fibroid tissue. The crude rates of complications in two of the larger series (>100 patients) were between 6% and 13.0%. The overall complication rates reported in the RCT for hysterectomy and UAE respectively, were 20% vs 32%. The readmission rates for the two procedures were the same (1/20 hysterectomy and 2/40 UAE); 25% of UAE patients compared to 20% of those who had hysterectomy had intra-procedural complications, and at 30 days post-procedure, 72% (29/40) of UAE patients had any complications vs. 45% (9/20) hysterectomy patients (p=0.05). The serious complication rate in the one series that defined and measured complications against an objective classification^{73,74} was 1.25% (95% CI 0.3%, 2.5%).

Most studies reported a small number of cases of ovarian dysfunction either transient or permanent. The underlying mechanism for this appears to be poorly understood. One explanation is that it occurs through non-target embolisation of the ovarian arteries^{56,66,70}. Several papers observed an association between permanent amenorrhoea and increasing age^{54,55, 71,78}.

Other issues

There were several reports of patients becoming pregnant after undergoing UAE, and delivering babies successfully^{24,25,56,59}. Where stated, any pregnancy complications were not considered to be more common than in other patients of similar age and medical history.

Radiation dose and fluoroscopic times were the main focus of one paper⁶⁸ and reported in the results of four others^{25,51,61,66}. Estimates of the radiation dose are reported to be higher than in other common fluoroscopic procedures, but compared to known risks associated with pelvic irradiation of other diseases, UAE was not considered by the authors to present greater risks.

Increased operator experience was associated with shorter procedure and fluoroscopic times.

Embolic particles have been found in histological examination of tissue excised from patients who have had UAE^{21,50}. The significance of this for those treated successfully is unknown.

Patient satisfaction

The limited satisfaction data available is generally favourable to UAE. Several studies^{54,55,76} specified the desire of some women to avoid surgery as an important factor in considering their treatment options. Two papers^{47,65}, referred to the respective patient groups as highly motivated for UAE.

A patient survey of the decision-making determinants in 84 US women seeking UAE, found that published literature (not the doctor) was the primary source of information about their illness and treatment options. The three reasons for seeking UAE reported most frequently were to AVOID: 1) recurrence of fibroid symptoms (n= 80/84 95%); 2) adverse effects of other surgical treatments (n=76/84 90%; 3) prolonged recovery associated with other treatments (n=70/84 83%).

Discussion

Fibroids are a significant public health issue and there is a lot of interest in UAE from provider and patient groups in what, compared with other treatment options, is a minimally invasive procedure. The numbers of UAE procedures carried out worldwide are unknown but the patterns of publication indicate that the expertise is concentrated in a relatively small number of centres in the USA, England and France. It is estimated that no more than 1000 procedures are performed annually in the USA. Approximately 2,050 UAE procedures have been carried out in the UK to date, mostly in one centre in London and the South East (Table 1).

There is consistent evidence that UAE causes the fibroids to shrink and improvements in symptoms are reported for most patients in the short term. The limitation of the evidence is that, with the exception of one small RCT of moderate quality comparing UAE with hysterectomy, it is mostly contained in uncontrolled case series of varying size. Case series are susceptible to population bias due to selection and loss to follow up. Only one paper based on a small UK series (n=21) reported using a validated outcomes questionnaire. No consistent definitions or uniform way of measuring clinical changes in symptoms following UAE were found. The resulting variation in how the clinical data were collected and reported obscures the extent of any improvements. It prevents reliable inferences as to how efficacious UAE is and the clinical importance of any improvements, from being made. Patient satisfaction was associated with the clinical changes in symptoms achieved.

Conclusion

UAE is efficacious in that it causes the fibroids to shrink and relieves or stabilises the symptoms in 60% and >90% of patients in the short-term. The extent of any improvements gained, their clinical importance and sustainability over time, was not available from the series included in the review. The limited amount of patient satisfaction data is favourable to UAE. These data are based on selected case series, and are subject to the same reservations about their reliability and generalisability.

In respect of safety, there is weak evidence from a small moderate quality RCT that the overall rate of complications within 30 days of the procedure is similar or greater than with hysterectomy. UAE may result in a small number of serious complications in the short term^{36,73,74}. The rate of serious complications following UAE available from one included series where complications were measured according to an objective system of classification, was 1.25% (95% CI 0.3%, 2.5%)^{73,74}.

Longer term, larger randomised controlled trials that compare UAE with other treatments for managing symptomatic fibroids in the UK population are required.

1.0 OBJECTIVE OF THE REVIEW

To systematically review the evidence for efficacy and safety of uterine artery embolisation (UAE) for the management of symptomatic fibroids.

2.0 BACKGROUND

2.1 Description of the underlying health problem

2.1.1 Epidemiology

Uterine fibroids are nodules of smooth muscle cells and fibrous connective tissue that develop within the wall of the uterus. Also known as uterine leiomyomas or uterine myomas, fibroids are benign tumours of the uterus. Fibroids are the commonest gynaecological problem in women in the UK. Asymptomatic fibroids require no treatment other than routine monitoring. Symptomatic fibroids may be associated with pelvic pain, pressure and heavy bleeding, abdominal distention and bulk-related symptoms (urinary frequency or urgency, constipation, sense of pressure). Fibroids are a causative factor in pregnancy loss⁵, and may be associated with sub-fertility.

Fibroids are classified into three types:

- Intramural (growths within the walls of the uterus);
- Subserosal or subserous (growths projecting into the uterine cavity), and
- Submucosal or submucous (projecting from the outer surface of the uterus).

2.1.2 Aetiology

The aetiology of fibroids is not known, but it is believed to be associated with estrogen and progesterone because fibroids coincide with the female reproductive years. Fibroids can occur in women of any age. They are associated with excess weight, are more common in nulliparous women, and in women of Afro-caribbean ethnic origin.

2.2 Current management and alternative procedures

Symptomatic fibroids are typically managed by hysterectomy or myomectomy. Fibroids are one of the most frequent reasons for a hysterectomy. Approximately 70,000 hysterectomy procedures are performed annually in the UK and around one third will be for fibroids. There is no known long-term effective pharmacological intervention. Gonadotrophin will inhibit the growth of fibroids during the time that it is being taken. The fibroids will grow again once the treatment stops.

2.3 Uterine Artery Embolisation

2.3.1 Description

Uterine Artery Embolisation (UAE) is an alternative procedure to manage symptomatic fibroids. UAE has been used in the management of gynaecological conditions other than fibroids for some years. Previously, it was performed preparatory to surgical interventions for fibroids. The first report of UAE as a 'stand alone' procedure for fibroids was published in 1995.

UAE is performed by Interventional Radiologists using established angiographic techniques and materials to locate and place catheters into the uterine arteries. The procedure is an extension of embolotherapy used to treat postpartum haemorrhage. A percutaneous catheter is introduced into an artery using either a bilateral or unilateral technique, and manipulated under fluoroscopic guidance into the uterine arteries. When the catheters are in place, embolic particles are injected into both uterine arteries to block the blood supply. The closure of the arteries is thought to be permanent. Deprived of the arterial blood supply, the fibroids begin to shrink.

UAE takes around one hour depending on the anatomy of the patient's pelvic arteries and technical difficulty in placing the catheters.

2.3.2 Clinical indications/contraindications and putative impact

The gynaecologist and radiologist decide in consultation with the patient on whether UAE is the appropriate treatment option. Patients who have any signs of pelvic infection are not suitable for UAE. The impact of the procedure on fertility has not been established and patients who wish to become pregnant may be advised to undergo myomectomy which is not associated with a risk of ovarian dysfunction. In the immediate period post-UAE patients may experience pain, a high temperature and symptoms of what is described as 'post embolisation syndrome'. The most frequent major complication is infection. Where this cannot be managed conservatively, patients may have to undergo emergency hysterectomy.

2.3.3 Personnel - skill/experience

The patient is referred to the interventional radiologist to assess suitability for UAE by a gynaecologist. Interventional radiologists are doctors who have undergone specialist training in this type of procedure and the use of radiation. Those who have not undergone specific UAE training usually attend a centre where UAE is performed before embarking on the procedure. The interventional radiologist must be capable of percutaneous arterial puncture, safe passage of a catheter into the aorta, subselective catheterisation from the aorta to the uterine artery, angiographic imaging, embolisation with standard arteriographic catheters and microcatheters, and the subsequent assessment of the angiographic result. During UAE patients are exposed intermittently to radiation, and this requires that close attention is paid to dose limitation measures, radiation physics and radiation safety.

The nursing input in the angiography suite involves patient monitoring, control and analgesia and anti-emetics.

The management of the patient is shared by the two specialties of gynaecology and radiology.

2.3.4 Current use in the UK

The National Institute for Clinical Excellence (NICE) guidance on UAE for fibroids⁶ is that there is uncertainty about the safety and efficacy of the procedure. The recommendation of a joint report published by the Royal Colleges of Radiologists, and of Obstetricians and Gynaecologists⁷, was that UAE should be carried out only within the context of a clinical trial. UAE is reported to be available at 48 NHS and three private hospitals in the UK. Most of the availability is in London and the South East of England (Table 1).

Out of an estimated total of 2,050* UAE procedures for fibroids performed in the UK to date, 200 (10%) were performed outside London or the South East. Of the 1850 carried out in London or the South East, 1000 have been reported as being undertaken at one centre.

Table 1 : Reported availability of UAE by UK Health Regions*

Health Regions	Centres where UAE is available
England	
North West	4
Northern and Yorkshire	4
West Midlands	2
Trent	3
Eastern	0
London	12 (including 3 private)
South East	14
South West	6
Scotland	5
Wales	1
Northern Ireland	0
United Kingdom	51

*Estimates of the numbers of UAE procedures performed in the UK to date and centres where the procedure is available have been provided by FEMISA, a patient group. The data have been collated from several sources but are believed by the UK radiologists consulted to be reasonably reliable.

3.0 METHODS

3.1 Review

3.1.1 Literature Search

The aim was identify all indexed references relating to the safety and efficacy of uterine artery embolisation in the treatment of uterine fibroids in line with the agreed Scope of this review (Appendix 1). After initial piloting and discussions in a ReBIP team workshop, the search strategy and terms were refined, and a comprehensive search was carried out during October and November 2003 as follows:

Sources - 17 electronic bibliographic databases were searched, covering biomedical, health-related, science, social science, and grey literature. Additionally, the reference lists of relevant articles were checked. Selected websites were also searched for eligible evidence-based reports.

Terms - A combination of free-text and thesaurus terms were used. The 'population' terms (e.g. uterine fibroids, uterine growths, uterine tumours, etc.) were combined with the 'intervention' terms (e.g. uterine artery embolisation, UAE, embolotherapy, etc.). Copies of the search strategies used in the major databases are included in (Appendix 2).

No date or language restrictions were applied to the search

The searches yielded 819 items. Titles and/or abstracts were screened for inclusion and 293 reports were identified as potentially relevant. Full papers were requested. Nineteen items were unavailable in the UK. Attempted retrieval from outside the UK was not pursued. The costs of doing so could not be justified as it was unlikely to yield information over and above that contained in the items that were obtained. For the same reasons a further fifteen papers that were not retrieved routinely in the time available were not pursued. Three items obtained were clearly not relevant. The remaining 256 papers and abstracts received were indexed by country and study design, and assessed independently for relevance to the UK setting and whether they reported safety and/or efficacy.

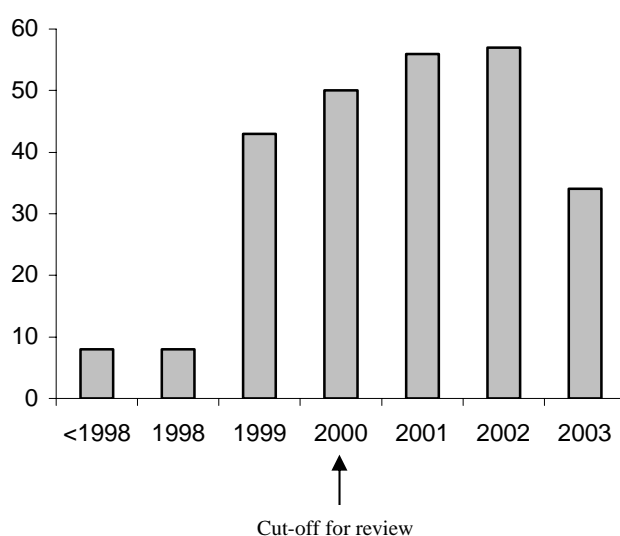
3.1.2 Inclusion and exclusion criteria

Three priorities were identified:

- 1) to capture the most recent evidence about safety and efficacy of UAE for fibroids;
- 2) to limit any bias due to duplication;
- 3) to manage the volume of literature efficiently.

The most effective way of achieving all three priorities was to use a publication cut-off date for the literature to be reviewed. Given the cumulative volume of literature it was decided that the threshold should be a publication date of 2000 or later (Figure 1).

Figure 1 Numbers of potentially-relevant publications in file (n=256)



Although there may be delays between date of study and date of publication, it was considered that as well as helping to eliminate bias that occurs when results are duplicated in multiple publications of the same data, a cut-off of 2000 would help remove any bias resulting from including results from early experiences when the technology was still developing. Potentially, adopting a ‘most recent’ focus would capture reports of longer-term outcomes available from revisiting treatments provided in the early stages of an ‘on-going’ series. It would also reduce the number of papers to one that was manageable within the time and resources available.

Multiple publications from the same patient series were only included if they reported different results, for example, clinical outcomes in one paper and quality of life indicators in another. A decision was taken not to obtain translations of 28 non-English language papers. These are listed but not otherwise considered, (Appendix 3). Five abstracts were also excluded.

The inclusion criteria used to filter the literature were:

- i) Primary papers reporting on safety and/efficacy
- ii) Published in 2000 or later
- iii) English language

The exclusion criteria were:

- i) Unavailable in the UK
- ii) Not retrieved in the time available
- iii) Publications of the same data reported in a later publication (and not reporting on different outcomes)
- iv) Abstracts.

3.1.3 UK Literature

To help locate the results of the review within the context of the UK literature, all the papers by UK authors that were retrieved (without filters) have been indexed and tabulated separately (Tables 2.1-2.4). Correspondence by UK authors has been referenced but is not tabulated^{8,9,10,11,12,13,14,15,16}.

Table 2.1 CASE SERIES – UK full papers – No filters

Author	Purpose	Numbers Treated	Numbers reported	Age (range)	Follow up:months	Summary results
Bradley ¹⁷	Pilot study of UAE for large symptomatic fibroids; 7 afro caribbean; 1 white	8	8	37 (31-48)	8 months	5/8 recommend UAE to others; mean uterine volume reductions; 5/8 improved symptoms; 1/8 pregnant.
Burn ¹⁸	MRI as a predictor of outcome	18 (subset of Vashisht ²⁴)	18	39 (28-53)	2 and 6 months	See Table 8
Burn ¹⁹	Measures of technical success	14 (subset of Vashisht)	14	39 (31-51)	2 and 6 months	
De Souza ²⁰	MRI as a predictor of outcome	11	11	40	1 and 4 months	See Table 8
McCluggage ²¹	Pathology of histological tissue (spontaneous expulsion or surgery) post-UAE from different institutions	10	10	42 (32-51)	<0.5 to 11 months	Necrosis; giant cell reaction; foreign material elsewhere in myometrium, the cervix or paraovarian region; myometrial necrosis beyond confines of leiomyomas
Mehta ²²	Complications post-UAE	42	7	42 (31-54)	<0.25 to 7	See Table 5
Nicholson ²³	Pathology post UAE and clinical outcomes	38	38	(32-52)	1,3,and 6 months	20/38 complete resolution of symptoms; development of peripheral hyperechoic rim likely end result of PVA in peripheral arteries
Vashisht ²⁴	Efficacy, safety and patient satisfaction	21	21	40 (29-52)	2 and 6	See Table 5
Walker ²⁵	Long-term efficacy	400		43	MRI scan: 6 Ques. 1-24	See Table 5
Walker ²⁶	MRI changes in fibroid volume post UAE and patient satisfaction	200 (subset of Walker)	88 MR 111 ques.	43	-do-	
Watson ²⁷	MRI changes in fibroid volume post UAE and patient satisfaction	114 (subset of Walker)	114	42	-do-	

Table 2.2 REPORTS – UK

Author	Purpose	Conclusion/Recommendation
Joint report of the Royal College of Radiologists and Royal College of Obstetricians and Gynaecologists	Expert Clinical Opinion; Literature review of best available evidence	Subject to symptoms, treatment protocols and patient choice UAE available within a controlled clinical trial registered with a primary research programme, and using appropriate scientific methods of collecting and reporting of data; Set up a national registry to monitor UAE for fibroids, routinely.
National Institute for Clinical Excellence	Rapid appraisal of evidence	Uncertainty about safety and efficacy – Refer to Review Body for Interventional Procedures (ReBIP)
Succinct and Timely Evaluated Evidence Review (STEER) ²⁸	Systematic review of effectiveness of UAE	Summary of findings: Insufficient evidence of effectiveness of UAE in selected outcomes compared with alternative interventions.

Table 2.3 CASE REPORTS – UK (no filters).

Author	Age of patient	Purpose of report	Reported outcome
D'Angelo ²⁹	29	Spontaneous twin-pregnancy 20 months post UAE	Uneventful
Davies ³⁰	37	UAE complicated by endometrial ablation and Asherman's syndrome	Potential implications for future fertility:
Ellis ³¹	37	Report short-term results of UAE for large uterine fibroid	Uneventful : 75% reduction in volume
Jones ³²	32-50	Six case reports: (subset of Walker)	Sequestration and extrusion of fibroid tissue post UAE patients between 20 days and 38 weeks x 6 cases: per vaginam or assisted hysteroscopic resection
Jones ³³	37	Uterine vascular supply originating from the contralateral external iliac and ovarian arteries as a cause of failure of UAE	Reason for failure of UAE
Laverge ³⁴	45	Spontaneous expulsion of 3 large fibroids over several months post UAE	Symptom resolution
Matson ³⁵	44 x 2 42 45	Four cases : 1 clinical failure 3 treatment failure	Clinical failure x 1 case: 44 years Anastomoses of the ovarian and uterine arteries x 3 cases: 42, 44, 45 years
Vashisht ³⁶	51	Outcome of post UAE infection (subset Vashisht)	Death : Multiparous woman (five children)
Vashisht ³⁷	29	Post-UAE pregnancy (subset Vashisht)	Uneventful pregnancy and elective caesarean delivery

Table 2.4 REVIEWS/EDITORIALS – UK (no filters)

Author	Purpose	Conclusion
Belli ³⁸	Evidence for safety and efficacy	UAE may widen treatment options for fibroids in some patients. Safety and efficacy needs to be established
Braude ³⁹	Clinical management	Insufficient evidence of safety and efficacy
Howatson-Jones ⁴⁰	Nursing role and standards	Nursing Care Plan based on holistic approach
Nott ⁴¹	Safety	No clear conclusions can be drawn
Reidy ⁴²	Safety	Short-term results encouraging – long term safety and efficacy required; routine monitoring through national registry
Walker ⁴³	Safety and efficacy	UAE may be viable alternative treatment for fibroids; comprehensive data in large trials required
Walker ⁴⁴	Current debate	Summarises current issues

3.1.4 Results of filtering

The 256 items retrieved were classified broadly into primary and secondary studies. The 121 secondary papers (reviews, education and debate, reports, and editorials) were excluded. One hundred and thirty-five **primary** studies formed the initial basis of the review. The methodological quality of these was ranked according to a hierarchy of criteria of general predictive quality by specific study design, (Appendix 4). 61 items were filtered out because of incompleteness of reporting, or a publication date of 1999 or earlier, published in a language other than English or abstract only.

Thirty-five of the 74 primary papers remaining were case reports. Case reports usually describe rare events or complications. In an emerging technology they contribute to the range of clinical experiences and outcomes that may be important in considering safety and efficacy. Case reports from centres in the UK (without filters) are summarised in Table 2.3. These are presented without comment. Case reports published in 2000 and later, from outside the UK, are appended (Appendix 5.1) and referenced separately (Appendix 5.2).

3.1.5 Description of studies included

The initial inclusion criteria admitted 39 full papers based on 32 series of patients for detailed abstraction: two randomised controlled trials^{45,46} (RCTs), five papers from one large multi-centre series in Canada^{47,48,49,50,51}, three comparative studies^{52,53,54}, two series in more than one centre^{55,56}, and 27 reports from 24 series in single institutions, five from the UK^{18,20,22,24,25}, five from other Europe^{57,58,59,60,61} thirteen from North America^{62,63,64,65,66,67,68,69,70,71,72,73,74}, and four from other countries^{75,76,77,78}, (Table 3).

Table 3 : Included studies

UK	Country	Design	Retrospective/ prospective
Pinto	Spain	RCT (UAE v hysterectomy)	prospective
**Keyoung	USA	RCT (post UAE pain control)	prospective
Broder	USA	comparative	retrospective
Razavi	USA	comparative	retrospective
**McLucas	USA	comparative	retrospective
Pron	Canada	multicentre case series	prospective
Pron ⁴⁸			
Pron			
Colgan	Canada		
Pron ⁵¹			
Chrisman ⁵⁵	USA	>one centre case series	prospective
McLucas ⁵⁶	USA	>one centre case series	retrospective
Ahmad	Kuwait	case series	prospective
**Bai	Korea	case series	retrospective
Banovac	USA	case series	retrospective
Bapuraj	India	case series	unclear
Burn	UK	case series	unclear
De Souza	UK	case series	prospective
Fleischer	USA	case series	unclear
Jha	USA	case series	unclear
Klein	USA	case series	prospective
McLucas		case series	prospective
Mehta	UK	case series	retrospective
Messina	Brazil	case series	prospective
Nikolic	USA	case series	prospective
Omary	USA	case series	prospective
Pelage	France	case series	prospective
Pelage		case series	prospective
Ravina	France	case series	prospective
Ryu	USA	case series	prospective
Ryu			
Spies	USA	case series	prospective
Spies ⁷³			
Spies			
Tranquart	France	case series	prospective
Vashisht	UK	case series	prospective
Walker	UK	case series	prospective
Zupi	Italy	case series	prospective
Nevadunsky	USA	questionnaire survey	prospective

**papers subsequently withdrawn. One bias associated with early termination of study, another contained patients who did not have fibroids, and another lacked sufficient detail.

3.1.6 Quality assessment

PC assessed the methodological quality of the 39 papers using two separate checklists that have been agreed by the Review Body to be used.

The two RCTs satisfied the 11-question checklist based on Delphi consensus methods by Verhagen⁷⁹ (Appendix 6). The 16-question checklist (Appendix 7) used to assess the quality of the remaining 37 papers was adapted from the NHS Centre for Reviews and Dissemination's guidance for those carrying out or commissioning reviews 2001⁸⁰.

The results of the quality check for the case series (n=30) which are the bases of the 37 observational papers, is contained in Table 4.

Table 4 Quality assessment of non-randomised case series (n=30)

Criteria	Yes	No	Unclear
1. (a) Where participants selected from a relevant patient population?	30	0	0
(b) Were they representative?	0	0	30
2. Were the inclusion/exclusion criteria of patients in the study clearly described?	29	1	0
3. Were participants entering the study at a similar point in their disease progression?	0	0	30
4. Was selection of patients consecutive?	12	2	16
5. Were all important prognostic factors identified?	0	0	30
6. Was data collection undertaken prospectively?	17	9	4
7. Was the recruitment period clearly stated?	16	14	0
8. Was the intervention that which is being considered in the review?	29	1	0
9. Was the Operator's experience described?	14	16	0
10. Was the place, and facilities where the patients were treated described?	19	3	8
11. Were objective (valid and reliable) outcome measures used?	29	0	1
12. Where clinical outcomes were reported?	22	8	0
13. Was the period of follow-up long enough to detect important effects on outcomes of interest?	26	2	2
14. Was information provided on all patients in the series initially?	19	7	4
15. If incomplete, were participants lost to follow-up likely to introduce bias?	0	0	11
16. Were the main findings clearly described?	25	5	0

3.1.7 Data extraction

PC was not blinded to the names of study authors, institutions, and publications. Three papers (one RCT, one comparative, and one case series) were removed following the quality check process. One RCT examined the effect of intra-arterial lidocaine for pain control following UAE. The placebo trial was predicated on an assumption that lidocaine (used for pain control in other embolising procedures) would be effective in reducing pain following UAE. The study was terminated after eighteen patients had been randomised. It was not considered further in the review. A comparative study was found to lack sufficient detail for it to be useful, and UAE in one case series was found not to have been performed exclusively for fibroids. Thirty-six papers were retained and the data were abstracted in detail.

3.2 Data organisation

The papers were separated broadly into three groups according to whether the focus was 1) 'general' i.e. reporting a range of results, or 2) 'specific' (i.e. addressing fertility issues which is a putative area of concern) or 3) relating to technological issues. Seventeen papers reported a range of results (Table 5), 7 papers addressed issues relating to fertility (Table 7), and nine papers reported technological issues (Table 8). One questionnaire survey of factors in patients' decision-making is summarised alongside patient satisfaction results available from the other studies (Table 9). One of the five papers from a Canadian study that was the largest series included ('Ontario'), reported baseline data only. All five papers Ontario papers appear in Table 6.

Individual summaries of each paper included in the review are contained in Appendix 8.

4.0 RESULTS

4.1 Summary of Evidence

4.1.1 Randomised controlled trials

The one randomised-controlled trial (RCT) compared UAE with hysterectomy. The study used a pre-consent design and was of moderate quality. Group 1 patients were randomised to be offered UAE if they agreed (n=37) or hysterectomy if they did not (n=1). Group 2 patients were intended to receive hysterectomy (n=19). Three Group 2 patients refused hysterectomy and had UAE. An intention to treat analysis was carried out to compare length of stay. However for safety and efficacy a ‘treatment received analysis’ was used. Forty patients received UAE. Three clinical failures converted to hysterectomy. One patient was not reported at the six months follow-up, so data were available for 36 UAE patients. Thirty-one reported clinical improvement on the primary outcome (cessation of bleeding), including six patients (17%) who had amenorrhoea. An overall success rate of 79% (n=31/39) was achieved. The reduction in the mean volume of the dominant fibroid was 46% (95% CI 27%,66%). No meaningful comparison between the efficacy of hysterectomy that has 100% effect on symptoms and fertility, and UAE, that does not, is possible.

With regard to overall safety, 32% (n=13/40) of patients made emergency department visits following UAE, predominantly for post-embolisation syndrome (n=6) or severe pelvic pain (n=3), compared to 20% (4/20) of the patients who had hysterectomy. Two/40 patients were re-admitted post UAE vs. 1/20 of the patients post hysterectomy.

25% (10/40) of the patients had intra-procedural complications during UAE vs. 20% (4/20) of the patients during hysterectomy. At 30 days post-procedure, 73% (29/40) of patients who had UAE had complications vs. 45% (9/20) of the patients who had a hysterectomy (p=0.05).

4.1.2 The Ontario (Canada) Prospective UAE multi-centre case series

Four of the five papers from a large study of 555 patients in eight centres^{47,48,49,50,51} were tabulated together to provide an overview of the short-term (3 months post-UAE) results. One paper reported baseline results only (Table 6). Efficacy and the effect on ovarian function in a subset of patients (n=526) who received bilateral UAE (n=538) was reported in one paper. Complications in eight patients resulting in hysterectomy were reported in another. A fourth paper reported technical results, and a fifth the results of histological examination of resected tissue from 18 patients who, underwent surgical intervention in the same 3-month period.

4.1.3 Comparative studies

Two comparative studies compared UAE and myomectomy^{52,54}. Both had reviewed patient notes retrospectively. The populations of treatment groups were not similar either for age, symptoms or previous treatment. One of the studies did not attempt any case-mix adjustment, but compared symptom improvement in sub-groups reporting the particular symptom before treatment. In UAE patients ‘significantly greater’ (p<0.05) improvement was found for menorrhagia (92% vs. 64%), less ‘significant improvement’ was found for symptoms of mass effect (76% vs. 91%), and no statistical difference (p>0.05) in improvement for pain (74% vs 54%). Case-mix differences weren’t taken into account in any other comparisons. The other study⁵⁴ used logistic regression to compare the need for further invasive procedures adjusting for differences in age and follow-up interval. After adjustment, the odds ratio for needing further invasive procedures in patients having UAE was 12.5 (95% CI: 1.4, 110.1). Case-mix adjustment was not used in other comparisons and the authors report that other differences could have led to bias, and that the: “...study design did not allow us to adjust statistically for those differences.” The differences between the patient groups in the two studies^{52,54} cannot therefore be discounted as a factor in explaining any differences in the outcomes reported. Consequently, the results for patients who received UAE have been reviewed but no further comparative data from these two studies^{52,54} have been considered.

4.1.4 Case series

Thirty-two of the 36 papers reviewed were from observational case series of patients receiving UAE in one or more than one centre. One paper (Ontario series) reported baseline results only. Fifteen papers (including three from the Ontario series^{48,49,51}, (Table 6) reported results across a range of symptoms and outcomes (Table 5), seven addressed issues of fertility (Table 7) and nine (including one Ontario paper) addressed technical issues (Table 8).

4.1.5 Patient survey

The results of the one patient survey included are summarised alongside quality of life and/patient satisfaction data available in the other papers reviewed (Table 9).

4.2 Study populations

4.2.1 Patients

The number of patients in the series ranged from 11^{70,76} to 555. The symptoms in all patients included had reached the stage where some form of intervention was required. Some series were on-going over several years. The entry criteria for treatment by UAE varied between series. (Tables 5-8) (Appendix 8).

4.2.2 Interventional Radiologists

The focus of two studies^{51,69} was interventional radiologists. One technical paper examining the diagnostic usefulness of MRI reported changes in the intentions of five interventional radiologists to treat with UAE following magnetic resonance imaging (MRI): (n=8/57 were moved to surgery). A paper in the Ontario series conducted in eight different centres reported significant differences ($p < 0.001$) in both procedure and fluoroscopic times between eleven interventional radiologists with a minimum of 3-years post-fellowship experience (range 3-26 years), for successful and failed procedures (mean procedure time 61 vs 88 mins) (mean fluoroscopy time 19 vs 32 mins), and between the first 20 procedures and the next 20 procedures (mean procedure time 75 mins vs 55 mins) (mean fluoroscopy time 21 vs 61 mins).

4.3 Periods of follow-up

Diagnostic measures and clinical outcomes were reported from follow-up periods ranging from two months to more than two years. The most common period of follow up to be reported was six months. Five papers reported data in mean follow up periods of more than a year^{25,52,54,57,60}. In two series^{25,60}, the numbers of patients lost to follow-up increased with increasing length of follow-up. The longest period of follow up was contained in a report based on a retrospective notes review and follow up survey of patients who had undergone UAE between three and five years previously.

5.0 EFFICACY AND SAFETY

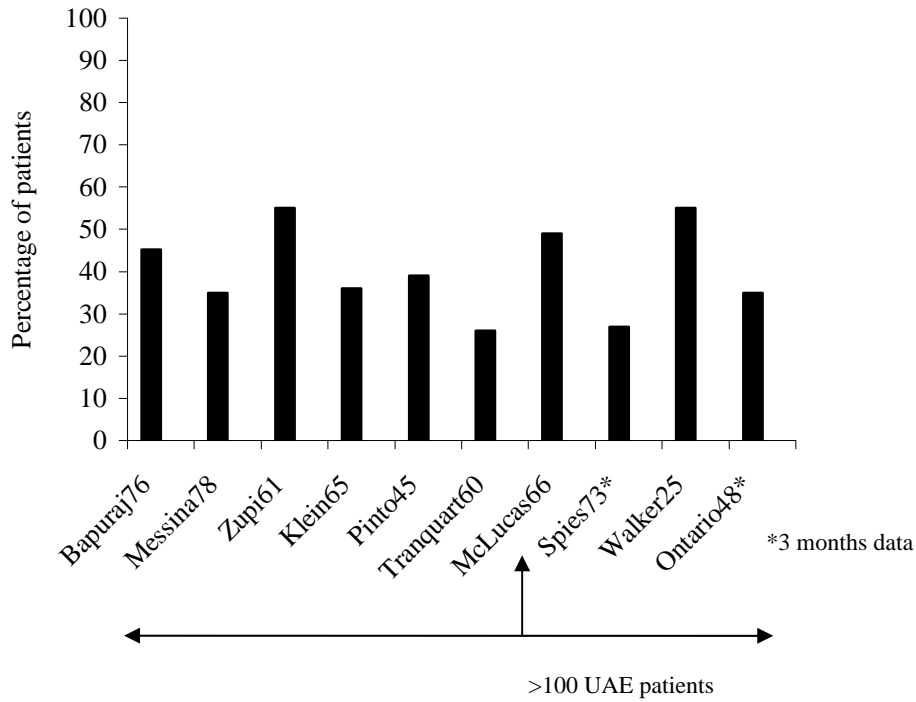
5.1 Indicators of efficacy

The measures of efficacy reported most consistently in the reviewed papers are changes to fibroid and uterine volume and impact on symptoms. The percentage reductions in mean uterine volume at six months ranged from 26% to 59%¹⁸ (Figure 2).

5.1.1 Fibroid Volume

The range of reduction in mean fibroid volume at 6 months was 40%⁶⁴ to 75%. Where results from more than one follow-up period were available, a continuing reduction in mean fibroid volume has been reported (mean 43% (range 6%-100%) at 2 months; and mean 59% (range 6%-100%) at 6 months). One study found larger reductions to be associated with larger fibroids at baseline⁴⁸ (>400 cm³ 49% (95% CI 44%-54%)). The reverse was found in another series i.e. larger reductions (60%) associated with smaller fibroids at pre-UAE assessment of 9-108 cm³ compared to 40% reduction in mean volume of fibroids 144-1383 cm³ at pre-UAE assessment.

Figure 2 % Reduction in mean uterine volume at 6 months



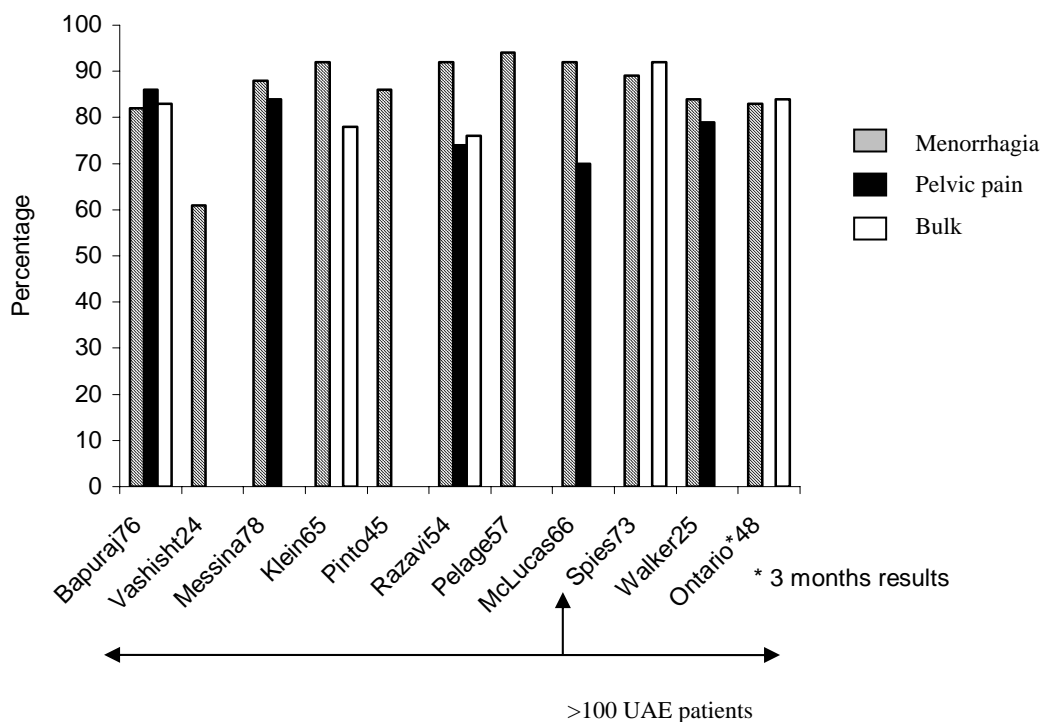
5.1.2 Symptom improvement

Short term

Seventeen of the papers reviewed reported changes in symptoms following UAE, occurring in 60% to >90% of patients^{20,24,25,45,48,52,54,57,58,60,61,64,65,66,73,76,78}. Eleven reported results for specific symptoms^{24,25,45,48,54,57,60,61,65,66,76}. ‘Improvements’ or ‘stabilisation’ of symptoms were reported most frequently for menorrhagia. (Figure 3).

No association was found between reductions in fibroid or uterine volume and clinical data^{20,64}.

Figure 3 % of patients with symptoms that improved/stabilised



Ten papers reported data on the amount of improvement in symptoms achieved^{20,24,45,48,54,57,60,61,66,76}. In a series of 26 patients, changes in symptoms were classified as ‘total regression, ‘mild reduction’ and ‘no variation’. Three patients had ‘no variation’ in symptoms. One paper from a UK series of 21 patients used a validated outcomes questionnaire⁸¹. Based on 14 responses, six out of eight patients with menorrhagia (75%), and two of five patients with abdominal distention (40%) were reported as ‘much better’. Seven patients were lost to follow up. Improvements over pre-treatment symptom scores in ten patients in a UK series of eleven patients, ranged from 10%-56%. Papers from two series^{57,76} used the same five-point scale. For menorrhagia, one paper (n=80) reported ‘complete resolution’ in 72 patients and ‘marked improvements’ in 3 patients (the symptoms in 5 patients were unchanged). The other paper, based on a series of 11 patients reported ‘complete resolution’ in four patients and ‘marked improvements’ in five. The results at 3-months from a prospective case series of 58 patients using a 4-point scale, reported that symptoms were unchanged in 10% (n=6), improved in 76% (n=44)

and symptom-free in 14% (n=8). A retrospective review of the case notes and follow up question in 62 patients used a six-point scale. Clinical success was defined as ‘complete resolution’ or ‘significant improvement’ and successful outcomes for menorrhagia, pain and mass was reported in 92% (n=48/52), 74% (n=25/34) and 76% (n=28/37) of patients respectively. The main outcome measure in the RCT reviewed was cessation of bleeding. Success was reported for 31/39 patients. Twenty achieved ‘full recovery’ (56%), five ‘partial recovery’ (14%), and six ‘amenorrhoea’ (17%).

The largest prospective series of patients reviewed (n=555) reported changes in symptoms in a subset of 538 patients receiving bilateral UAE at three-month follow up based on an ‘untested’ 8-point scale from ‘much improved’ through ‘no change’ to ‘much worse’. The symptoms of 58% of patients with menorrhagia (n=249/429), 53% with dysmenorrhea (n=170/322), 34% with bulk symptoms (n=160/464) and 53% with urinary urgency/frequency (n=163/306) were reported as ‘much improved’. Three months may not be sufficient time to capture all the outcomes of interest, and data to compare these results are not available from the three other series with more than 100 patients^{25,66,73} in the review. One used a simple 3-category model ‘improved’, ‘unchanged’, ‘worsened’. Another collected data using an 11-point scale from minus 5 (markedly worse) through unchanged to plus 5 (markedly improved), but after remodelling into an ordinal scale, the outcomes were reported as ‘improved’, ‘unchanged’ or ‘worse’. This paper concluded that UAE ‘...controls the symptoms caused by leiomyomata in most patients’. ‘Clinical failure’, ‘improvement’ and ‘stabilisation’ were defined in the third paper. Seven/150 patients followed up at 5 months were in the ‘failure group’ but results for symptoms that had ‘improved’ and those that had ‘stabilised’ were not reported separately. Although not reported expressly, one small series also implied a difference between ‘stabilisation’ and ‘improvement’. Symptoms of menorrhagia were reported to be ‘controlled’ in 88% (n=21/24) of patients and symptoms of pelvic pain ‘improved’ in 84.2% (n=16/19).

Long-term

One paper reported ‘improved’ symptoms at 3 months, 6 months and >12 months follow-up in a series of n=200 women. The improvements at 3 months (heavy menstrual bleeding 87%; bulk symptoms 93%; satisfaction 93% (n=181)) were sustained at more than 12 months (90%, 91% and 92% respectively (n=167)). Two papers based on a

prospective series of more than 50 patients^{57,60}, reported data for different levels of improvement in follow-ups of 24 months. One reported complete resolution of symptoms in 72/80 (90%) of patients in the original series. The second reported complete resolution of symptoms in 19 of 58 patients available to follow up at 24 months. The numbers lost to follow up in this series (66%) may affect the reliability of this result.

The longest period of follow up available was a retrospective study which conducted a questionnaire survey of 51 of 57 patients who underwent UAE between 3 and 5 years previously. The only indicator of long-term efficacy reported was that 61% (n=31/51) were 'at least somewhat satisfied with their choice'.

5.2 Indicators of safety

It was not always clear whether patients had more than one complication or if the reporting of adverse effects was complete. However, the evidence reviewed indicates that crude overall rates of complications in the short-term ranged between 5% and 73%.

In the short-term post-procedure pain was commonly reported and infection was the main reason leading to emergency presentation and in some cases, emergency surgical intervention. There was one death in a UK series.

Rates of conversion post-UAE to hysterectomy couldn't be determined reliably in all the series, but on the evidence available, range between 1.3% and 11.5%. Where hysterectomy was reported and reasons were provided, three cases were related to the existence of underlying pelvic disease (other than fibroids)^{66,78} which were noted before UAE. One paper reported that clinical failure of UAE was associated with previous pelvic disease or pelvic surgery.

The overall complication rates for hysterectomy and UAE respectively, reported in the RCT were 20% vs 32%. The readmission rates were the same (1/20 hysterectomy and 2/40 UAE); 25% of UAE patients compared to 20% of those who had hysterectomy had intra-procedural complications, and at 30 days post-procedure, 73% (29/40) of UAE

patients had complications vs. 45% (9/20) hysterectomy patients (p=0.05). The crossover that occurred confounds the comparative rates for complications in the two groups.

Longer term

Late passage of fibroid tissue was reported as occurring up to a year or longer after UAE^{25,74}. The results of a questionnaire survey based on the responses of 51 of 57 patients undergoing UAE between 3 and 5 years previously reported that 29% (15/51) had undergone further surgical intervention. The study defined a clinical failure group as 'the need for additional invasive treatment for myomas', 'no improvement in overall symptom score' or self-rated 'dissatisfied or very dissatisfied'(Box 1). Twenty/51(39%) met these criteria.

5.3 Specific issues

5.3.1 Ovarian function and fertility post UAE

Seven papers focussed specifically on the effect of UAE on ovarian function, (Table 7). These studies are few in number and are based on series of varying size. An outcome of hysterectomy has obvious implications for fertility, and may arise following a failure of UAE, underlying disease other than myomata or unrelated to UAE. The preliminary indications in respect to otherwise successful UAE, is that incidental ovarian artery collateral embolisation during UAE may occur, and patients are counselled to the possibility of this effect.

There is evidence that ovarian dysfunction is more likely in women aged over 45 years^{55,72}. The early results from the Ontario Study (excluding patients who were menopausal at baseline) also report a strong inverse association between increasing age and delay in resuming menses post UAE, (Table 6). The mechanism by which ovarian dysfunction occurs is poorly understood. Increased vascularity in older women and over-aggressive embolisation are potential explanations considered in the literature^{56,62,66}.

5.3.2 Pregnancy

Fibroids are not necessarily a cause of infertility but predispose to complications during pregnancy leading to spontaneous abortion and breach presentation. Occurrences of pregnancies in the period following UAE were reported^{24,25,56,59}. Two series^{56,59} reported a total of 29 pregnancies in 23 women, (Table 7). The complications during the pregnancies reported in the women who conceived after they had undergone UAE were not considered by the authors to be greater than in those of the same age sharing a similar disease profile and medical history generally.

5.4 Technical issues

Nine papers (including one from the Ontario trial) reported on technological aspects of the UAE including the ability of magnetic resonance imaging to predict the outcome of UAE, the effect of varying the size of the embolic particles^{58, 62}, and the optimum endpoint of the procedure, and operator effect (Table 8).

One paper (Ontario trial) reported the results of histological investigation of re-sected tissue in 17 of 18 patients undergoing surgery 8.2 months (median) post UAE, undertaken without knowledge of the indication of surgery or time elapsed since UAE, (Table 6). The findings were not dissimilar to those reported previously in a UK study. Embolising particles were found in the tissue. The implications of the morphologic changes observed in those experiencing post-UAE complications for those treated successfully are uncertain.

Radiation dose and fluoroscopic times were the main focus of one paper and reported in four others^{25,51,61,66}. Estimates of the radiation dose are reported to be higher than in other common fluoroscopic procedures, but compared to known risks associated with pelvic irradiation of other diseases, UAE was not considered to present greater risks. Exposure time is related to procedure and fluoroscopy times.

5.5 Patients perspective/satisfaction

Nine papers reported limited data on patient satisfaction (Table 9). One paper from the USA reported factors influencing patient choice obtained in a questionnaire survey of patients previously undergoing UAE. The women believed themselves to be well-

informed about their disease and the treatment options available. Printed literature (not the doctor) was the primary source of information about UAE in 40% of the sample.

The Ontario study reported that 85% (n 414/487) were willing to undergo another UAE procedure if necessary. The figures assume that the responders are typical of the 555 recruited into the study. The proportion reduces to 65% if those who would do so only conditionally (n=93) are taken into account.

Table 5.1 Papers reporting a range of results – efficacy

Series	Country	Size	Patient descriptions	Mean Age (range)	Follow Up Months	Numbers reported	Changes in mean volume and/or symptoms
Bapuraj	India	11	Strong desire to avoid surgery	32 (28-52)	<1,2,6 months	11	2 months -10/11 clinical improvement 1-3 Pelage scale:
Vashisht	UK	21	Symptomatic fibroids	40 (29-52)	2, 6	14	Fibroid: 32.6% 2 months: 75.2% 6 months: 8/13 improved menorrhagia; 61% 2/7 improved abdominal distension.
Messina	Brazil	26	Pre-menopausal; refused surgery	42 (33-49)	3,6,12	26	Menorrhagia: controlled 87.5%; Pain improved 84.2%
Zupi	Italy	26	Single or large myoma; intramural location; fertile age	39 (32-54)	1,3,6,12	26	Uterine: 64% 6 months; 83% 12 months; Most reduction high vascularity; Symptom improvements 12/21 menorrhagia; 7/9 pain; 8/12 urinary disturbance; 18/18 abdominal weight
Klein	USA	35	Highly motivated for UAE	46 (32-56)	<2,6	30	Dominant fibroid 49% (1%,92%) 6 months
Pinto	Spain	40/57 ⁱ	Suitable for hysterectomy; no desire for future pregnancy; fibroids <10 cm dia.	43 (18-59)	6	40	Dominant fibroid 56% (27%,66%) 6 months Improved bleeding in 31/39 patients
Mehta	UK	42	Mostly multiple myoma; 86% afro-caribbean; 9% white; 5% asian	42 (31-54)	4-16 median 12	7	No efficacy results reported
Tranquart	France	58	Symptomatic fibroids	44 (33-65)	3	58	Symptoms 10% u/changed; 76 improved; 14% resolved
Broder	USA	59/97 ⁱⁱ	Previous myoma surgery; 45% white; 55% non-white;	44	37-59	51	31/51 patients some symptom improvement 61%
Razavi	USA	67/111 ⁱⁱ	Strong desire to avoid hysterectomy	44	14	62/67	Symptom improvement 92% menorrhagia; 74% pain; 76% improved mass.
Pelage	France	80	Failure of hormonal treatment; menorrhagia; no desire for future pregnancy	45 (30-54)	2,6,12, 24	80	Symptom improvement 72/80 complete resolution; 90% 3/80 marked improvement; 5/80 no improvement.
McLucas	USA	167	Menorrhagia predominantly	43 (29-63)	6	150	Uterine: 23% <2months; 31% 6 months; 33% 12 months. Symptom improvement/stabilisation 87% patients n=131/150. Optimum results uterus height <16 cms; slow-growing myoma without history of pelvic disease and no adnexal findings pre UAE u/sound and pelvic examination.
Spies	USA	200 (subset of	No strong desire for future pregnancy; Not pedunculated submucosal; uterus <24 weeks. 45% white; 55% non-white	43 (27-57)	12 months	158	Improved: menstrual bleeding 89%; bulk 92% at 6 months
Walker	UK	400	5/400 post menopausal; avoid difficult multiple myomectomy or hysterectomy	43(20>50)	mean 17 months	321	Latest follow up for each woman Symptom improvements 73%-90%
Ontario ^{47,48,49}	Canada	555	See table 6	43 (18-59)	3		See Table 6

Table 5.2 Papers reporting a range of results – safety

Series	Country	Size	Patient descriptions	Mean Age (range)	Follow Up Months	Numbers reported	Complications/events	Rate
Bapuraj	India	11	Strong desire to avoid surgery	32 (28-52)	<1,2,6	11	1 post-embolisation syndrome	10%
Vashisht	UK	21	Symptomatic fibroids	40 (29-52)	2, 6	Unclear	Pain; 1 death; 1 readmission 6 weeks for opioid analgesia	10%
Messina	Brazil	26	Pre-menopausal; refused surgery	42 (33-49)	3,6,12	26	3 hysterectomy; 3 x Ovarian failure: (1 aged <45: 2>45 years)	23%
Zupi	Italy	26	Single or large myoma; intramural location; fertile age	39 (32-54)	1,3,6,12	26	19 fever; 26 pain; 3 scanty bleeding 3 months; 2 myoma debris	
Klein	USA	35	Highly motivated for UAE	46 (32-56)	<2,6	30	1 repeat UAE; 3 surgery 4 x amenorrhoea	27%
Pinto	Spain	40/57 ⁱ	Suitable for hysterectomy; no desire for future pregnancy; fibroids <10 cm dia.	43 (18-59)	6	40	20 moderate/major complications (excluding 6 amenorrhoea) 3 x hysterectomy.	72%
Mehta	UK	42	Mostly multiple myoma; 86% afro-caribbean; 9% white; 5% asian	42 (31-54)	4-16 median 12	7	Readmission 1-29 weeks mainly infection. 1 hysterectomy	17%
Tranquart	France	58	Symptomatic fibroids	44 (33-65)	3	58	6 unchanged	10%
Broder	USA	59/97 ⁱⁱ	Previous myoma surgery; 45% white; 55% non-white;	44	37-59	51	6 hysterectomy; 8 myomectomy; 1 repeat UAE; 20/51 clinical failure	39%
Razavi	USA	67/111 ⁱⁱ	Strong desire to avoid hysterectomy	44	14	62/67	1 x Pelvic pain; menopause 4 >46 years; 1 x transient numbness of groin; hysterectomy N/R	9%
Pelage	France	80	Failure of hormonal treatment; menorrhagia; no desire for future pregnancy	45 (30-54)	2,6,12, 24	80	85% intense pelvic pain; 6 amenorrhoea; 4 expulsion myoma debris; 1 hysterectomy	14%
McLucas	USA	167	Menorrhagia predominantly	43 (29-63)	6,12	150: 6 months 46 : 12 months	21 'failures' (box 1) – previous pelvic surgery or other pelvic disease. Lower success (50%) presence of adenomyosis (alone or fibroid-related);	13%
Spies	USA	400	No strong desire for future pregnancy; Not pedunculated submucosal; uterus <24 weeks. 43% white; 57% non-white	43 (27-57)	3 , 12	250 questionnaires	42 patients 47 complications ;37 x 30 days of UAE; 4 x 31-90 days; 6 .>3 months	10.5%
Walker	UK	400	5/400 post menopausal; avoid difficult multiple myomectomy or hysterectomy	43 (20 >50)	mean 17	321	23 clinical failures; 26 amenorrhoea	6.0%
Ontario ^{47,48,49}	Canada	555	See table 6	43 (18-59)	3		See Table 6	

i RCT, ii Comparative

Table 6 The Ontario (Canada) prospective uterine fibroid embolisation (UAE) multi-centre series

Author	Purpose	Numbers	Numbers reported	Summary results
Pron ⁴⁷	Baseline characteristics of consecutive UAE patients in 8 university and community hospitals in Canada	555	555	
Pron	3-months (ultra-sound and telephone follow up) i) clinical outcomes and ii) patient satisfaction	555	i) 526 ii) 487	Mean volume reductions in uterine and dominant fibroid of 27%-33%; fibroids >400 cm ³ 50%; 83% improvements in menorrhagia, 77%; dysmenorrhea, bulk 86%. Significant improvements on impact on life scores – 72% reduced to 13% - associated with symptom relief not reductions in uterine volume. Post-UAE amenorrhoea strongly dependent increasing age.
Pron	3-months results : post-UAE complications resulting in hysterectomy	555	8	i) infection; ii) post-embolisation pain; iii) vaginal bleeding; iv) prolapsed leiomyoma.
Colgan	3-months : Pathologic examination of tissue in patients undergoing hysterectomy or myomectomy following technical failure of UAE (n=10) or post UAE hysterectomy (n=8)	555	18	PVA particles in resected tissue
Pron	Effect on time of increasing numbers of UAE performed in trial. 8/11IRs at 8 centres min. 40 procedures each in trial. Performance indicator: 'Early' v 'Later' : (cut-off 20 procedures).	555 patients 11 IRs	570 procedures	Significant difference in procedure and fluoroscopic times between : interventional radiologists technical success and failure; and first 20 procedures and next 20 procedures.

Study period November 1998-November 2000

Follow up period 3-months

Patient characteristics (n=539) Mostly white (66%), 33% <30 years old; highly educated (68% graduates or postgraduate); mostly working outside homes; most used Internet; 50% no children; fertility an issue for 31%; 23% previous treatment for gynae.probs; 80% pre-menopausal; 35% overweight; 17% obese.

Symptom profile: 66% intramural fibroids; 70% multiple fibroids; average fibroid volume 293 cm³; length 1-24 cm; average uterine volume 680 cm³; heavy bleeding; pelvic pain; symptoms differed by age and race; non-white women more likely to have multiple fibroids; av. duration of symptoms 5-7 years.

Health status: self rated health status lower than other women of their age; 5% increased surgical risk; 19% other major health problems.

Operator characteristics: 11 interventional radiologists (IRs) in eight centres; 3-26 years post fellowship experience. 8/11 completed a minimum of 40 procedures each in trial

Table 7 Ovarian function and fertility post UAE

Series	Country	Size	Patient descriptions	Mean Age (range)	Follow Up Months	Methods	Outcome
Ryu	USA	23	1) Pre-menopausal	43 (35-51)	Baseline	Doppler ultra-sonography; Ambulatory visit; telephone survey.	In 15/17 cases evidence of incidental ovarian artery collateral embolisation during UAE (p<0.0001)
Ryu		6	2) Complete loss of ovarian arterial perfusion post UAE	40 (35-51)	6-7	Standardised questions	4/6 re-established ovarian arterial perfusion 1/6 had not but resumed normal menses; 1/6 (>45) developed menopausal symptoms
Ahmad	Kuwait	32	30 Pre-menopausal; 2 Peri-menopausal; no desire for future pregnancy	34 (26-45)	<1,<2,3, 6	FSH assay	Transient ovarian dysfunction in 2 peri-menopausal patients; Resumed 8-10 months post-UAE
Spies	USA	63	No strong desire for future pregnancy; Not pedunculated submucosal; Uterus size <24 weeks. 53% black; 43% white; 4% other	43 (33-50)	3,6	FSH assay; questionnaire: agegroups 30-39; 40-44; 45-50	15% risk of increased FSH levels in >45 years. Mechanism not understood.
Chrisman	USA	66	Pre-menopausal; poor candidates for surgery	(30-55)	5 <1,3,6,12	2-centre study FSH assay, Standardised questions	Ovarian failure <45 years : Nil >45 years (9/21) 43%
McLucas	USA	400		41 (26-67)	Not reported	4-centre study	Ovarian dysfunction 4 <45 premature menopause; results for >45 not reported.
Ravina	France	9*/184	Post UAE pregnancies	36*	Not reported		12 pregnancies in 9 women 4-23 months post UAE: 7 live births 3 vaginal; 4 caesarean
McLucas	USA	14/400	Post UAE pregnancies	41 (26-67)	Not reported	4-centre study	17 pregnancies in 14 women post UAE.

Table 8 Technological issues

Series	Country	Size	Participant descriptions	Mean Age (range)	Technology	
de Souza	UK	11	Menorrhagia	40 (29-48)	Correlation between volume changes and clinical outcomes	Reduction in volume on MRI does not predict clinical response changes in symptom scores
Burn	UK	18	Otherwise considered for surgical resection	39 (28-53)	-do-	MRI can predict response to UAE
Pelage	France	20	Menorrhagia; pre-menopausal; Pelvic pain; no desire for future pregnancy 15 white; 5 non-white	43 (36-53)	Effect of embolising agent on post UAE pain and non-target embolisation	Results of tris-acryl encouraging. Controlled trials required.
Fleischer	USA	20	Symptoms 6 months to one year duration	43 (38-57)	3-d color Doppler sonography to identify fibroids of different size and vascularity	Reductions in volume preceded by reduced vascularity. Hypervascular fibroids greater reduction than isovascular or hypovascular.
Nikolic	USA	20	N/R	44 (30-53)	Radiation effects	Mean UAE dose >common fluoroscopic procedures. Compared to known risks associated with level used in irradiation of other pelvic disease unlikely to result in radiation injury or genetic risk to future children.
Banovac	USA	23	Multiple fibroids	42 (28-52)	MRI and Tris-acryl Gelatin Microspheres	Endpoint: resistance before stasis – ‘pruned branch appearance’ Confirms previous findings ⁸² - agent appears safe and efficacious. Controlled trials needed
Jha	USA	31	N/R	45 (31-54)	MRI as a predictor of outcome	Useful for quantifying signal intensity and morphologic changes pre and post UAE
Omary	USA	60 5	Patients Interventional Radiologists	44 (31-54)	MRI to improve diagnostic confidence	MRI significantly altered diagnoses and treatment plans of IRs evaluating patients with presumed symptomatic fibroids
Ontario ⁵¹	Canada	555	See table 6	43 (18-59)	Effect of operator experience in trial for UAE procedure times	See Table 6

Table 9 Patient views/satisfaction

Series	Country	Size	Measure of satisfaction	Mean Age (range)	Follow Up Months	Numbers Reported	Results
Vashisht	UK	21	Would you recommend UAE to a friend?	40 (29-52)	6	14	7 definitely; 2 probably; 4 unsure; 1 No
Klein	USA	35	'subjective satisfaction (not otherwise reported) and not seeking further therapy'	46 (32-56)	6	30	26 very satisfied : 4 unreported
Pinto	Spain	40/57 ⁱ	Would you undergo the same treatment again?	43 (18-59)	6	36	28 yes; 5 no; 3 maybe
Broder	USA	59/97 ⁱⁱ	Not reported	44	37-59	51	31 at least somewhat satisfied (61%)
Nevadunsky	USA	84	Questionnaire survey of factors in decision in women undergoing UAE; all candidates for surgery; 71% white; 70% college degree or higher; 70% household income >\$50,000 - (socio-demographic atypical of New Jersey population).	44 (27-56)	Unclear	84	Fibroids significant impact on lifestyle; Literature primary source of information about UAE. Decision determinants in >50% of responders; 1) avoid recurrence of symptoms; 2) avoid adverse effects of alternatives; 3) avoid prolonged surgical recovery; 4) avoid surgery
McLucas	USA	167	Would you recommend UAE to others?	43 (29-63)	6	150	87% (n=130) yes
Spies	USA	200	Linked to categories of clinical outcomes	43 (27-57)	3 , 12	158	6 months (n=158) 'satisfied' 93%
Walker	UK	400	Would you choose UAE again? Would you recommend UAE to others?	43 (20 >50)	24	131	97% (n=127) yes
Ontario	Canada	555	Satisfaction scale: willingness to undergo another UAE and overall satisfaction verbal score 1-6 (greatly; moderately; mildly [dissatisfied]; mildly; moderately; greatly [satisfied].	43 (18-59)	3	487	91% satisfied (mildly; moderately; greatly) 85% (414) willing to undergo UAE again, (93/414) only conditionally so.

i RCT

ii Comparative

5.6 Limitations of available evidence

An important limitation of the evidence reviewed is that, apart from a small RCT of moderate quality, it is contained in uncontrolled case series that are susceptible to population bias. Additionally, changes in symptoms are based on self-reported changes assessed on ordinal scales ranging from 3 to 11 points⁷³ (Box 1), that have not been tested. Reference was found to a new symptom-specific and quality of life instrument for fibroids⁸³. This was not used in any of the studies reviewed. Only one paper reported using a validated outcomes questionnaire. This reported improvements in menorrhagia for a lesser proportion of patients than other studies (61% vs. $\geq 82\%$) (Figure 3) and the reliability of these data are affected both by the small size of the series (n=21) and patients lost to follow up (n=7/21).

Ten series ranging in number from 11^{20,76} to 80⁵⁷ reported on the amount of improvement in symptoms. There was substantial variation in the amount of improvement in symptoms that were quantified (improved score of 10% to 'complete resolution'). The differences in the amount of improvement for patients whose symptoms had 'improved', and those that had 'stabilised'⁶⁶, or were controlled was unclear, as was the clinical importance of any changes in symptoms.

Reliable long term data are not available, either because these have not yet been reported^{47,48,49} or patients are lost to follow-up^{25,66,73}.

The overall complication rate observed ranged between 5% and 73%. The rates available in papers from the larger series reviewed are within this range, (6%²⁵ and 13%). The wide variations in the smaller series will be due to the size of the series, and differences in how complications are defined and reported. The overall rate of complications in two papers from a series that used objective standardised measures to classify complications within the first 30 days following UAE^{73,74} was 10.5%. The rate for major complications was 1.5%.

Comparison of results will be affected by different lengths of follow up. The largest series (n=555) and one of the smallest series (n=11) reported clinical results obtained in follow-ups of 3 months or less. This is unlikely to be sufficient to capture all the changes in symptoms or adverse effects that may occur.

The results reported also assume that patients lost to follow-up are the same as those still available^{52,60}, and this assumption may not be valid.

Patient satisfaction data were limited. Those linked to clinical outcomes are subject to the same reservations as to their reliability and generalisability

Box 1 : Outcome measures

Broder⁵² 7 point scale of clinical improvement and 4 point scale for patient satisfaction from very satisfied to very dissatisfied; (inclusive) Clinical failure: need for additional invasive treatment for myomas or no improvement in overall symptom score or self-rated dissatisfied or very dissatisfied.

McLucas 3-point Pre-UAE symptom scale: severe, moderate, mild. Post UAE 'improvement' moving from severe to moderate; 'stabilisation' moderate or mild. 'Failure group': 1) hysterectomy or 2) <10% shrinkage of myoma at 6 months; or worsening symptoms.

Pelage^{58,76} scale: 5 point scale: 1) complete resolution to 5) worsening;

Razavi 6-point scale: 6) complete resolution to 1) significantly worse. 'clinical success' = 5 or 6.

Spies collected on 11-point scale 'minus 5 markedly worse thru 0 to plus 5 'markedly improved' reported as improved; unchanged; worsened. Patient satisfaction data were collected and reported in the same way.

Spies standard measures of complications based on service use developed by Society of Cardiovascular and Interventional Radiology Complication Class (SCVIR); and criteria of the American College of Obstetricians and Gynaecologists (ACOG).

Vashisht validated Menorrhagia Outcomes Scale

Walker pain score: 8 levels: no pain to worst pain ever felt;

3 level symptom scale: improved-unchanged-worsened;

Patient satisfaction indicator: recommend UAE to others.

Ontario^{47,48,49} (rating scale was not tested)

1) life impact score;

2) 'willingness to undergo another UAE if necessary'; and

3) 6 point scale satisfaction scale

6.0 DISCUSSION

Fibroids are a significant public health issue and there is a lot of interest in the UAE from provider and patient groups in what is, compared to the alternatives available, a minimally invasive procedure. UAE widens the treatment options for suitable patients who wish to avoid major surgery or are poor surgical risks. The numbers of procedures carried out world-wide are unknown but, the published literature indicates that the expertise is concentrated in a relatively small number of centres in the USA, England and

France. A survey in 2000⁴ reported that 8,500 had been performed in the USA. It is estimated that 2,050 procedures have been carried out in the UK to date, mostly in one centre in London and the South East (Table 1).

In the short- term there is evidence to show that UAE reduces the size and volume of fibroids in most patients. Greater reductions are associated with larger fibroids and those with increased vascularity. The reductions in volume achieved have been found not to correspond with improvements in symptoms. Short-term improvements in the symptoms (most frequently menorrhagia) in most patients are reported. The extent of these improvements could not be determined from the papers reviewed. Two papers from series of less than 100 patients reported complete resolution of symptoms in 90% to 100%.⁶⁰ of patients. 'Marked improvements' (as distinct from 'moderate' or 'slight' were reported as occurring in 34% to 58% of patients in the largest series. These results cannot be compared with those based on the other large series of patients. Differences in the amount of improvement^{25,73} or improvement or stabilisation were not reported, and no uniform or consistent criteria to evaluate results or uniform definitions that would allow comparisons to be made was found.

In respect of safety, there was wide variation in the rate (5% to 73%). Almost certainly these proportions will be affected by differences in the size of the case series and in how complications are defined. The rates in the larger studies, (with follow up at six months), of between 6% -13% are within the range of the overall complication rate 10.5% reported in the one study that used standardised criteria for complications.

Pain and post-embolisation syndrome are not uncommon. A number of other events – some life-threatening - have been reported. Based on the available data, rates of conversion to hysterectomy were between 1.3%⁵⁷ and 11.5%. Late passage of fibroid tissue is reported as occurring more than a year following UAE^{25,74}. The impact on fertility appears to be small but there are uncertainties about the mechanism by which UAE ovarian dysfunction occurs. Permanent ovarian dysfunction is reported in a small number of cases, and this possibility raises issues for women who desire future pregnancy.

The implications of morphologic changes found in excised post-UAE tissue^{21,50} are uncertain.

The optimum protocol is still being developed. Operator confidence and competence are relevant safety issues and the sharing of care between the two specialties raises questions about the optimum care of patients in the immediate and delayed post-UAE period.

The limitations of the available evidence are that there is only one small RCT⁴⁵ (n = 38 vs n=19) comparing UAE with hysterectomy and this is of moderate quality. The comparative results remain reasonably robust, although the small size of the trial means that the results are not precise. The study provides weak evidence that the rate of any complication within 30 days of the procedure was higher in the UAE group (73%) than in the hysterectomy group (45%), but the crossover confounded comparison of the rates between the groups. The design of the comparative studies^{52,54} did not permit valid comparisons to be made between patients who had UAE and those who had myomectomy. Predominantly therefore, the evidence is contained in uncontrolled case series of varying size. All the patients are a selected to highly selected group. How representative they are of the relevant UK patient population is uncertain. The results reported will be affected by selection bias and patients lost to follow up. Other limitations are variations in reporting, and the use of unvalidated outcome measures that make it difficult to assess the clinical importance of the improvements reported. As these are linked to patient satisfaction meaningful comparisons between studies cannot be made. The evidence reviewed permits only tentative conclusions about the safety and efficacy of UAE to be drawn.

7.0 CONCLUSION

There is evidence of short-term improvements in the symptoms in between 60% and $\geq 90\%$ of patients treated with the UAE, particularly for those presenting with symptoms of menorrhagia. The extent and durability of any improvement is unclear.

In respect of safety, UAE results in a small number of serious complications in the short term^{36,73,74}. No reliable data comparing complication rates with other interventions was available in the papers reviewed.

The important factors that distinguish UAE from other treatment options, (subject to clinical suitability for treatment), are patient choice and fertility.

Longer term, larger randomised controlled trials comparing UAE with other treatments for managing the symptoms of fibroids in the UK population are required.

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APPENDICES

Systematic review of the efficacy and safety of uterine artery embolisation in the treatment of fibroids

NATIONAL INSTITUTE FOR CLINICAL EXCELLENCE
REVIEW BODY FOR INTERVENTIONAL PROCEDURES

Uterine Artery Embolisation for Fibroids

Scope
12th August 2003

Objective

To systematically review the evidence for efficacy and safety of Uterine Artery Embolisation (UAE) for fibroids.

Intervention

Uterine artery embolisation is one of the newer minimal access procedures for fibroids. Others include laparoscopic and hysteroscopic myomectomy. The aim of minimal access procedures is to reduce the recovery time and operative risks compared with conventional techniques.

UAE involves injecting embolising material to block the blood supply to the fibroids. A catheter inserted into a femoral artery under local anaesthetic is fed into uterine arteries under x-ray control. Both uterine arteries are blocked with these particles. The normal muscle of the uterus takes a new blood supply from other vessels that supply it. However, usually, the fibroids do not revascularise. Consequently, the fibroids shrink, and evidence to date suggests there is no adverse effect on the normal muscle of the uterus. Pain can be severe for up to 8 hours post-procedure and opiate analgesia is usually required. Patients are usually in hospital for 24-36 hours because of the pain relief they require, and are advised to rest for 1-2 weeks. Fibroid embolisations are performed by an interventional radiologist.

Background

Uterine fibroids, also known as uterine leiomyomas or uterine myomas, are benign tumours of the uterus. Fibroids are the commonest gynaecological problem of women in the UK and are one of the most frequent reason for a hysterectomy. Symptoms include pain, pelvic pressure, and excessive bleeding. In addition fibroids may be associated with sub-fertility.

UAE is likely to be seen as an alternative to hysterectomy or myomectomy, and is particularly attractive to women wanting to avoid surgery. It probably necessitates a shorter hospital stay and recovery time, and results in fewer major complications. Most imaging studies focus on volume reduction. It is known that there is a small recurrence rate or that some fibroids fail to degenerate.

Sepsis following necrosis of the fibroid is the most serious and most common adverse event. If severe it can lead to death (two cases in the worldwide literature) and a variable incidence of unwanted and often difficult hysterectomy (1:50 – 1:200). However, current observational trials have demonstrated a very high efficacy of the procedure with a morbidity and mortality rate lower than surgery. Many thousands of women have had the procedure, the majority with apparent success. Although a total of four women are known to have died after UAE (two from septicaemia and two from pulmonary emboli), the alternative surgical procedures of hysterectomy and myomectomy are also associated with a small but significant mortality rate and significant morbidity. Advice in the UK is not to perform UAE for fibroids in patients with a history of pelvic infection¹.

There are also issues about the place of UAE and its safety in large fibroids, especially in relation to infertility. Infertility following the procedure due to premature ovarian failure or intra-cavity adhesions is poorly quantified. Conversely, there are multiple papers in the literature describing successful pregnancies after UAE for a variety of pathologies, but only limited clinical data are available on this. Some specialists recommend that patients desiring future pregnancies explore other treatment possibilities such as myomectomy before considering UAE.

¹ Royal College of Radiologists and Royal College of Obstetricians and Gynaecologists (2000) *Clinical Recommendations on the Use of Uterine Artery Embolisation in the Management of Fibroids: Report of a joint working party* London: Royal College of Obstetricians and Gynaecologists.

Population

Fibroids occur in women from 15-90 years of age, and are more common in Afro-Caribbean women.

Current forms of management for patients who might be considered for UAE for fibroids

1. Traditionally, women were offered hysterectomy or myomectomy.
2. There is no medical treatment for uterine fibroids. GnRH agonists can be administered but this is a temporary treatment, normally used to shrink the fibroids prior to surgery, and generally cannot be used for more than six months.

Efficacy issues

The efficacy of UAE for fibroids will be assessed using subjective and objective measures of outcome including reduced fibroid bulk, symptom relief (menorrhagia, pressure and pain symptoms), pregnancy rates, quality of life and patient satisfaction. It is important to note that there may be different end points depending on whether UAE for fibroids is an alternative to myomectomy or hysterectomy.

Safety issues

Potential adverse events include: amenorrhoea in younger women, uterine infection, premature ovarian failure, fibroid expulsion (no sequelae), persistent discharge (up to three months), failure of a technically successful procedure leading to hysterectomy, sepsis following necrosis of the fibroid, and infertility. Concerns exist about radiologists who perform this procedure without first securing the advice and support of a gynaecologist and about 'lone' radiologists who only invite gynaecological assistance when significant complications have already occurred.

Data gathering strategy

Evidence on efficacy and safety will be identified using a number of strategies: electronic searches, searching of grey literature (such as conference proceedings), population databases, experts' opinions and reference lists of identified studies. For evidence on patient satisfaction outcomes the strategy employed will utilise searches of electronic databases, grey literature and referenced lists of identified studies. Experts' opinions may also be canvassed where relevant.

Analysis strategy

Evidence will be considered if possible in order of design quality, the hierarchy of designs depending on the parameter being considered. Data will be abstracted independently, by two assessors using standard abstraction forms, and tabulated. Where possible, results will be summarised using standard statistical methods.

Other considerations

Other considerations which may have to be taken into account during this review relate to the training and experience of radiologists who wish to undertake this procedure and the division of patient management responsibilities between radiologists and gynaecologists.

APPENDIX 2

LITERATURE SEARCH

DATABASES and SEARCH TERMS

Electronic Bibliographic Databases Searched

1. BIOSIS
2. Cinahl
3. Cochrane Library (CENTRAL, DARE, Cochrane Database of Systematic Reviews, Cochrane Controlled Trials Register, NHS EED, HTA)
4. CRD Databases (DARE, NHS EED, HTA)
5. Current Controlled Trials
6. Dissertation Abstracts
7. Embase
8. HTA Projects and Publications Database
9. Index to Thesis
10. ISI Conference Proceeding
11. Medical Research Council (MRC) Clinical Trials Register
12. Medline
13. National Research Register
14. PreMedline
15. Research Findings Register (ReFeR)
16. Tripdatabase
17. Web of Science (Science Citation Index and Social Science Citation Index)

Search Strategies Used in the Major Electronic Bibliographic Databases

BIOSIS

1985-2003

SilverPlatter WebSPIRS

Search undertaken October 2003

- #1 uter* fibroid*
- #2 myofibro*
- #3 myom*
- #4 leiomyom*
- #5 benign tumo?r*
- #6 benign near5 tumo?r*
- #7 uter* neoplasm*
- #8 uter* cancer*
- #9 uter* tumo?r*
- #10 uter* growth*
- #11 or/ #1 – #10
- #12 uter* arter* emboli?ation*
- #13 emboli?ation*
- #14 uae
- #15 embolotherap*
- #16 or/ #12 - #15
- #17 #11 and #16

Cinahl

1966-2003

Ovid

Search undertaken October 2003

- #1 uter\$ fibro\$.tw.
- #2 myofibro\$.tw.
- #3 myom\$.tw.
- #4 leiomyoma/
- #5 leiomyom\$.tw.
- #6 benign adj10 tumo?r\$.tw.
- #7 uterine Neoplasms/
- #8 (uter\$ adj10 neoplasm\$.tw.
- #9 uter\$ cancer\$.tw.
- #10 uter\$ growth\$.tw.
- #11 uter\$ tumo?r\$.tw.
- #12 or/ #1 - #11
- #13 Embolization, Therapeutic/
- #14 emboli?ation\$.tw.
- #15 uter\$ arter\$ emboli?ation\$.tw.
- #16 uae.tw.
- #17 embolotherap\$.tw.
- #18 or/ #13 - #17
- #19 #12 and #18

Cochrane Library
The Cochrane Library, Update Software (Online version)
Search undertaken October 2003

- #1 (uter* next fibroid*)
- #2 MYOFIBROMATOSIS single term (MeSH)
- #3 myofibro*
- #4 MYOMA explode tree 1 (MeSH)
- #5 myom*
- #6 LEIOMYOM explode tree 1 (MeSH)
- #7 leiomyom*
- #8 (benign next tumor*)
- #9 (benign next tumour*)
- #10 UTERINE NEOPLASMS explode tree 1 (MeSH)
- #11 (uter* next neoplasm*)
- #12 (uter* next cancer*)
- #13 (uter* next growth*)
- #14 (uter* next tumor*)
- #15 (uter* next tumour*)
- #16 or/ #1 - #15
- #17 (uter* next arter* next embolization*)
- #18 (uter* next arter* next embolisation*)
- #19 EMBOLIZATION THERAPEUTIC explode tree 1 (MeSH)
- #20 embolisation*
- #21 embolization*
- #22 uae
- #23 embolotherap*
- #24 or/ #17 - #23
- #25 #16 and #24

CRD Databases (NHS DARE, EED, HTA)

CRD website. Complete databases
Search undertaken October 2003

- #1 uterine artery embolisation
- #2 uterine artery embolization
- #3 uae
- #4 embolotherapy
- #5 or/ #1 - #4

Embase**1980-2003****SilverPlatter WebSPIRS****Search undertaken October 2003**

- #1 explode 'uterus-myoma' / all subheadings
- #2 explode 'myoma-' / all subheadings
- #3 myom*
- #4 explode 'myofibrosis-' / all subheadings
- #5 myofibro*
- #6 explode 'leiomyoma-' / all subheadings
- #7 leiomyom*
- #8 uter* near10 fibro*
- #9 uter* near5 benign near3 tumo?r*
- #10 explode 'uterus-cancer' / all subheadings
- #11 uter* near10 cancer*
- #12 uter* near5 neoplasm*
- #13 explode 'uterus-growth' / all subheadings
- #14 uter* near5 growth*
- #15 explode 'uterus-tumor' / all subheadings
- #16 uter* near5 tumo?r*
- #17 or/ #1 – #16
- #18 explode 'uterine-artery-embolization' / all subheadings
- #19 uter* near5 arter* near5 emboli?ation*
- #20 uae
- #21 explode 'artificial-embolism' / all subheadings
- #22 artificial embolism*
- #23 emboli?ation*
- #24 embolotherap*
- #25 or/#18- #24
- #26 #17 and #25

Medline**1966-2003****Ovid****Search undertaken October 2003**

- #1 (uter\$ adj10 fibro\$.)tw.
- #2 myofibro\$.tw.
- #3 exp Myoma/
- #4 myom\$.tw.
- #5 exp Leiomyoma/
- #6 leiomyom\$.tw.
- #7 (uter\$ adj5 benign adj3 tumo?r\$.)tw.
- #8 Uterine Neoplasms/
- #9 (uter\$ adj5 neoplasm\$.)tw.
- #10 (uter\$ adj5 cancer\$.)tw.
- #11 (uter\$ adj5 growth\$.)tw.
- #12 or/ #1 - #11
- #13 EMBOLIZATION, THERAPEUTIC/
- #14 emboli?ation\$.tw.
- #15 (uter\$ adj5 arter\$ adj5 emboli?ation\$.)tw.)
- #16 uae.tw.
- #17 embolotherap\$.tw.
- #18 or/ #13 - #17
- #19 #12 and #18

Medline In Process

October 3rd 2003

Ovid

- #1 uter\$ fibroid\$.tw.
- #2 myofibro\$.tw.
- #3 myom\$.tw.
- #4 leiomyom\$.tw.
- #5 benign tumo?r\$.tw.
- #6 uter\$ neoplasm\$.tw.
- #7 uter\$ cancer\$.tw.
- #8 uter\$ growth\$.tw.
- #9 uter\$ tumo?r\$.tw
- #10 or/ #1 - #9
- #11 uter\$ arter\$ emboli?ation\$.tw.
- #12 emboli?ation\$.tw.
- #13 uae.tw.
- #14 embolotherap\$.tw.
- #15 or/ #11 - #14
- #16 #10 and #15

Web of Science

1981-2003

MIMAS

Search undertaken October 2003

- #1 uter* arter* embolization*
- #2 uter* arter* embolisation*
- #3 uae
- #4 embolotherap*
- #5 or/ #1 – #4
- #6 uter* fibroid*
- #7 myofibro*
- #8 myom*
- #9 leiomyom*
- #10 benign tumor*
- #11 benign tumour*
- #12 uter* neoplasm*
- #13 uter* growth*
- #14 uter* cancer*
- #15 uter* tumor*
- #16 uter* tumour*
- #17 or/ #6 – #16
- #18 #5 and #17

APPENDIX 3

List of Non-English Language publications No translations obtained

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APPENDIX 4

Review of the Safety and Efficacy of Uterine Artery Embolization

Criteria for inclusion based on the predicted quality of study design

Distinguished:		Description/Justification
Primary		
✓✓✓	Randomised Controlled Trials	Randomised allocation of patients to UAE treatment group and other treatment group. Dispassionate observance of outcomes.
✓✓✓	Comparative studies	Compare patients in intervention with patients (matched) receiving different treatment
✓✓✓ ✓	Multi-centre prospective single arm clinical treatment trial	Systematic prospective cases series of patients treated in >one clinical setting – potential to reduce bias from concentration of expertise or facilities associated with single centre trials.
✓✓✓	Prospective longitudinal study	Prospective case series followed over a specified time – potentially longer term outcomes
✓✓	Before and After	Express reporting of measures pre and post procedure potentially higher than retrospective or unqualified prospective
✓	Observational clinical study	Prospective or retrospective case series
✓	Prospective case series	Higher than retrospective in reducing potential bias from differences between patients or procedures
✓	Retrospective	Low - most opportunity for bias

APPENDIX 5.1

**CASE REPORT summaries – published 2000 or later,
(Other than UK - see Table 1.3).**

Author	Country	Age	Reported outcome
Ambekar	USA	52	Aberrant uterine artery as a cause of UAE treatment failure
Andrews	USA	34	Results non-selective pelvic arteriogram to identify and treat collateral arteries
Bouffard	USA	40	Resolution of symptoms
Common	Canada	49	Near fatality due to unrecognised underlying leiomyosarcoma.
DeBlok	The Netherlands	42	Fatality from septic shock
De Laco	Italy	54	Uterine wall defect 14 months post UAE
Felemban	Canada	43	Expulsion of myomas vaginally 21-35 days post UAE; symptomatic improvement
Garcia	USA	54, 35	Two x cases. symptom improvement
Godfrey	USA	45	Diffuse uterine necrosis - Laparotomy, total hysterectomy and left salpingoophorectomy
Goldberg	USA	42	Complicated pregnancy and subsequent hysterectomy
Hagspiel	USA	37: 51	Pilot to demonstrate feasibility of perfusion-weighted EST magnetic resonance imaging.
Hameed	USA	53	Diagnosed post UAE squamous mataplasia; progestational therapy; hysterectomy
Has	Turkey	36	15 days post UAE. Surgical evacuation of pregnancy. Potentially, future fertility preserved; 11 months amenorrhoea observed
Huang	Taiwan	41	Incomplete vaginal expulsion of pyoadenomyoma with sepsis and focal bladder necrosis
Kido	Japan	31	Symptomatic improvement of diffuse leiomyomatosis
Kovacs	USA	35	Post UAE laparotomy and myomectomy; transient ovarian failure: successful conception
Kroencke	Germany	48	Improvement and shrinkage of fibroids : uneventful expulsion of infarcted tissue 7 months post-UAE
Onder	Turkey	22	Uterine fibroid with menorrhagia and pelvic pressure managed successfully with UAE
Payne	USA	39; 47	Serious complications post UAE– delayed detection of sarcoma : emergency hysterectomy
Pollard	USA	40	Large cervical myoma prolapse; abdominal hysterectomy
Shashoua	USA	44	Ischemic uterine rupture 3 months post UAE: hysterectomy
Stringer	USA	45	Ovarian failure 4 weeks post UAE
Stringer	USA	53	Rare myoma: Laparoscopic myometomy post UAE
Sultana	USA	43	Extrusion of degenerating leiomyoma into bladder: hysterectomy and partial cystectomy

Vitale	USA	37; 49	Two-cases short-term symptom improvements; Sonographic and colour-flow Doppler findings pre and post and 3 months post-UFE
Yeagley	USA	38	Labial necrosis as possible complication of UAE

**References to Case Reports 2000 (Appendix 5.1) and later
(except UK – see Table 1.3)**

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APPENDIX 6

Quality assessment tool for randomised controlled trials

Criteria	Yes	No	Unclear
1. Was the assignment to the treatment groups really random?			
2. Was the treatment allocation concealed?			
3. Were the groups similar at baseline in terms of prognostic factors?			
4. Were the eligibility criteria specified?			
5. Were the groups treated in the same way apart from the intervention received?			
6. Was the outcome assessor blinded to the treatment allocation?			
7. Was the care provider blinded?			
8. Were the patients blinded?			
9. Were the point estimates and measures of variability presented for the primary outcome measures?			
10. Was the withdrawal/drop-out rate likely to cause bias?			
11. Did the analyses include an intention-to-treat analysis?			

APPENDIX 7

Quality assessment for non-randomised case series	Yes	No	Unclear
Criteria			
1. (a) Where participants selected from a relevant patient population? (b) Were they representative?			
2. Were the inclusion/exclusion criteria of patients in the study clearly described?			
3. Were participants entering the study at a similar point in their disease progression?			
4. Was selection of patients consecutive?			
5. Were all important prognostic factors identified?			
6. Was data collection undertaken prospectively?			
7. Was the recruitment period clearly stated?			
8. Was the intervention that which is being considered in the review?			
9. Was the Operator's experience described?			
10. Was the place, and facilities where the patients were treated described?			
11. Were objective (valid and reliable) outcome measures used?			
12. What clinical outcomes were reported?			
13. What was the period of follow-up?			
14. Was information provided on all patients in the series initially?			
15. Were participants lost to follow-up likely to introduce bias?			
16. Were the main findings clearly described?			

APPENDIX 8

**Separate summaries of 35 papers reviewed
(alphabetic order of first author)**

Study	Design/Patients/Participants	Inclusion/Exclusion	Procedure/materials	Outcome measures	Results
Ahmed 2002 ⁷⁵ Kuwait One centre Date October 1997 March 2001 Funding: None declared	<p>case series prospective</p> <p>Patients: 32</p> <p>Mean age: 34 (26-45)</p> <p>Refused surgical intervention; Poor candidates for myomectomy. Did not desire future fertility; or option other than UAE hysterectomy only.</p> <p>4/32 previous myomectomy 7/32 previous cesarean sections 1/32 left ovarian resection</p> <p>Pre-UAE – Ultrasound Clinical and biochemical tests</p> <p>Post-UAE Follow up 1 and 6 weeks, 3 and 6 months</p>	<p>Included: Patients referred following gynaecological examination. and diagnosis of symptomatic fibroids pre or peri-menopausal <u>and</u> no desire for future pregnancy</p> <p>Excessive menstrual bleeding; pelvic pain or press or both. 9/32 anaemia</p> <p>30 normal baseline ovarian function. 2 peri-menopausal</p>	<p>32 bilateral</p> <p>Same interventional radiologist</p> <p>Embolizing materials 500-700 <i>um</i> dia Polyvinyl alcohol foam particles</p> <p>Endpoint Cessation of antegrade blood flow in uterine artery</p> <p>Procedure time Mean 90 (range, 45-120) minutes</p>	<p>Reduction in fibroid and uterine volume</p> <p>Effect on ovarian function</p>	<p>Efficacy At least 30% reduction in fibroid size.</p> <p>Safety Fertility 30/32 patients resumed normal menses 2-3 months post procedure. FSH level 3 months 6.99 IU/L \pm 1.67 6 months 6.7 IU/L \pm 1.18</p> <p>2/32 (peri-menopausal at baseline) irregular menses. FSH level Pre;UAE 30 IU/L and 22 IU/L Post UAE 3 months 48 IU/L and 40 IU/L 6 months 26 IU/L and 27 IU/L Normal menses resumed 8 and 10 months post UAE respectively.</p> <p>Evidence of transient ovarian dysfunction in peri-menopausal patients.</p>

Study	Design/Patients/Participants	Inclusion/Exclusion	Procedure/materials	Outcome measures	Results												
<p>Banovac 2002⁶²</p> <p>USA</p> <p>Single-centre</p> <p>Date Not reported</p> <p>Funding: Co-author Research grants from Biosphere Medical</p>	<p>Before and After UAE Retrospective notes review of MR images.</p> <p>Patients: 23</p> <p>Mean age: 42 (28-52)</p> <p>61 fibroids in total – 35/61 intramural 15/61 serosal 11/61 broad-based submucosal or pedunculated submucosal or pedunculated serosal.</p> <p>Pre-UAE MR Imaging</p> <p>Post-UAE Review of pre and post MRI images: 3 months by two experienced IR (other than operating IR)</p>	<p>Included: Pre UAE MR images undertaken at operating institution; Symptomatic fibroids - bleeding or pelvic pain.</p>	<p>23 bilateral</p> <p>Experienced interventional radiologist (IR)</p> <p>Embolizing material: 21/23 Tris-acryl gelatin microspheres:500-700 μm or 700-900 μm dia. or combinations.</p> <p>1/23 300-500 μm dia. or combinations</p> <p>1/23 700-900 and combination of 900-1200 μm dia.</p> <p>Variation : operator choice</p> <p>Endpoint Slow in flow in uterine arteries sufficient for contrast material to remain visible in the main ascending uterine artery for at least 5 cardiac beats but cleared in several seconds. Angiographic endpoint central vasculature of leiomyomata occluded proximal portions of feeding vessels remaining patent without significant forward flow ‘pruned branch appearance’</p>	<p>Median reduction in: fibroid volume; dominant fibroid volume; uterine volume</p> <p>No clinical outcomes</p>	<p>Efficacy Median volume reduction at 3 months</p> <table> <tr> <td>% Change</td> <td></td> <td><u>95% CI</u></td> </tr> <tr> <td>All Fibroids (61*)</td> <td>52%</td> <td>(41%,63%)</td> </tr> <tr> <td>Dominant (21*/23)</td> <td>52%</td> <td>(40%,69%)</td> </tr> <tr> <td>Uterine</td> <td>32%</td> <td>(23%,43%)</td> </tr> </table> <p>2*/61 fibroids not found</p> <p>1/61 fibroid no reduction</p> <p>Safety No complications reported</p>	% Change		<u>95% CI</u>	All Fibroids (61*)	52%	(41%,63%)	Dominant (21*/23)	52%	(40%,69%)	Uterine	32%	(23%,43%)
% Change		<u>95% CI</u>															
All Fibroids (61*)	52%	(41%,63%)															
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Study	Design/Patients/Participants	Inclusion/Exclusion	Procedure/materials	Outcome measures	Results									
Bapuraj 2002 ⁷⁶ India Single-centre Date March 2000- March 2001 Funding: None declared	Case series Patients: 11 Mean age: 31.6 (22-50) Pre-UAE – Ultrasound one day before UAE Post-UAE Clinical follow up 15 days Ultrasound 2 and 6 months	Included: Diagnosis of fibroids confirmed by ultrasound and examination by experienced gynaecologist 11/11 Menorrhagia 7/11 pelvic pain 6/11 bulk symptoms 5/11 chronic anaemia 11/11 strong desire to avoid surgery 11/11 hypervascular uterus No other gynaecologic or medical problems; No contraindications to arteriography;	Inpatient 11/11 bilateral Experienced interventional radiologist Embolizing material: 350-500 <i>um</i> polyvinyl alcohol particles gelatin sponge slurry End-point: Complete cessation of flow or reflux of contrast material into anterior division of internal iliac artery	Diagnostic Mean reduction in: dominant fibroid volume; uterine volume. Clinical Pelage ⁵⁷ 5-point scale: 1 Complete resolution 2 Marked improvement 3 Slight improvement 4 No improvement 5 Worsening of symptoms	Efficacy Mean reduction volume: <table border="1"> <thead> <tr> <th></th> <th>2 months</th> <th>6 months*</th> </tr> </thead> <tbody> <tr> <td>Dominant fibroid</td> <td>38.76</td> <td>56.34</td> </tr> <tr> <td>Uterine</td> <td>27.48</td> <td>45.34</td> </tr> </tbody> </table> <i>*6 patients</i> Safety 1/11 severe pain 1/11 post-embolization syndrome 6/11 hospital stay >24 hours Mean hospital stay 1.9 days Clinical 10/11 Improvement 1-3 Pelage scale 1/11 No improvement : Menorrhaggia		2 months	6 months*	Dominant fibroid	38.76	56.34	Uterine	27.48	45.34
	2 months	6 months*												
Dominant fibroid	38.76	56.34												
Uterine	27.48	45.34												

Study	Design/Patients/Participants	Inclusion/Exclusion	Procedure/materials	Outcome measures	Results
Broder 2002 ⁵²	Comparative case series Retrospective notes review	Included	Inpatient	Changes in symptoms: Symptom scale 1-5	Long-term efficacy *51 patients
USA	Patients: 59/97 (UAE/all)	Multiple symptoms Most had previous surgical procedures for fibroids**	Not described	Clinical improvement scale 1-7	29% (n=15) further invasive therapy 6 hysterectomies 8 myomectomies 1 repeat UAE
Single-centre	July 1996-August 1997			Patient satisfaction 1-4 (very satisfied to very dissatisfied)	
Date December 2000	Ethnicity *51 patients White 23 Non-white 28	** performed preoperatively by clinical protocol in many UAE patients at this instituiton – practice discontinued		Criteria for Failure 1. Need for additional invasive treatment for myomas; 2. No improvement or worsening in overall symptom score; 3. Self-rated dissatisfied or very dissatisfied.	20/51 ‘clinical failure’ rate 39%
Funding: In part by UCLA Building Interdisciplinary Research Careers in Women’s Health Program	Mean age: 44 (31-56) Post UAE Notes review and Telephone survey mean follow up 46 (41-59) months			Any one = clinical failure	31/61 ‘at least somewhat satisfied’ 61%

Study	Design/Patients/Participants	Inclusion/Exclusion	Procedure/materials	Outcome measures	Results
Burn 2000 ¹⁸ UK Single-centre Date Not reported Funding: None declared	Before and After Patients: 18 Mean age: 39 (28-53) 32 fibroids in total - Volume mean 340 cm ³ (15-1383 cm ³) 16 larger (144-1383 cm ³) 16 smaller (9-108 cm ³) Pre-UAE – MRI one day before UAE Post-UAE MRI images: 2 and 6 months reviewed by two experienced IRs (other than operating IR)	Included: Consecutive patients with diagnosis of fibroids confirmed by ultrasound and gynaecological examination Menorrhagia or abdominal distension or discomfort; Otherwise candidates for surgical resection	16/18 bilateral 2/18 unilateral Experienced interventional radiologist	Mean reduction in: fibroid volume; No clinical outcomes	Pre-UAE MRI high signal intensity T1-weighted images predictive of poor response; high signal intensity T2-weighted images predictive of good response. Efficacy Mean reduction fibroid volume <u>95% CI</u> 2 month 43% (6%, 100%) 6 months 59% (6%, 100%) 2 months larger 40% (24%, 52%) smaller 60% (28%, 78%) No complications reported

Study	Design/Patients/Participants	Inclusion/Exclusion	Procedure/materials	Outcome measures	Results
<p>Chrisman 2000⁵⁵</p> <p>USA</p> <p>Two-centres: 1 community hospital; 1 major tertiary care university medical centre</p> <p>Date April 1998 Sept 1999</p> <p>Funding: None declared</p>	<p>>one centre case series prospective</p> <p>Patients: 66</p> <p>Mean age: 44 (30-55)</p> <p>Refused surgical intervention; Poor candidates for myomectomy. Did not desire future fertility; or option other than UAE hysterectomy only.</p> <p>Pre-UAE – Clinical and biochemical tests</p> <p>Post-UAE Follow up 2 weeks, 3,6 and 12 months Repeat tests</p>	<p>Included: Patients with diagnosis of symptomatic fibroids confirmed by gynaecological examination; clinical consultation with interventional radiologist and nurse practitioner.</p> <p>Menorrhagia; progressive or abdominal distension or discomfort; Otherwise candidates for surgical resection</p> <p>Excluded- Peri-menopausal symptoms defined by >20 IU/L FSH irregular menses; hot flushes or night sweats.</p>	<p>66 Bilateral</p> <p>355-700 <i>um</i> dia Polyvinyl alcohol foam particles</p>	<p>Standard questions</p> <p>Effect on ovarian function by two age groups: n= 45 Less than 45 years n= 21 45 years and older</p> <p>Statistical differences chi² test</p>	<p>Mean follow up 11 months (range, 6-17 months)</p> <p>Efficacy 56/66 resumed regular menses Mean 3.5 (range, 1-8) weeks</p> <p>Safety 10/66 did not resume regular menses.</p> <p>9/10 findings consistent with ovarian failure 1/10 Surgical gelatin pledget embolization only; amenorrhoea FSH (<20 IU/L)</p> <p>9/21 aged 45 years and older; 0/45 aged under 45 years</p> <p>No differences between those who did and did not resume regular menses for presenting symptoms; fibroid size; amount of PVA used.</p> <p>Post UAE ovarian failure significantly more likely to occur in patients aged 45 and over than in younger patients.</p> <p>No results by different centres reported.</p> <p>No other safety or efficacy data reported.</p>

Study	Design/Patients	Inclusion/Exclusion	Procedure/materials	Outcome measures	Results
Colgan 2003 ⁵⁰ Canada Multi-centre 8 settings: University and community hospitals Date Not reported Funding: None declared	<p>Case series Prospective Consecutive patients</p> <p>Patients: 555</p> <p>Mean age: 43 (18-59)</p> <p>66% Caucasian 23% Black 11% Other ethnic origin</p> <p>31% <40 years old 68% university educated 85% working outside home</p> <p>Black women significantly -- younger (40.7 years vs. 44.0 years); - more likely to have multiple fibroids.</p> <p>Mean fibroid volume 293 (95% CI 259-327 cm³) Length 8 (range, 1-24 cm)</p> <p>Mean uterine volume 680 (95% CI 626-734 cm³) Length 14 (range, 5-30 cm)</p> <p>No differences in uterine/fibroid size for age or ethnicity. 268/537 no children; 164/537 Fertility an issue</p> <p>Pre UAE Ultra-sound Questionnaires Gynaecological examination</p>	<p>Included: 355/539 multiple fibroids</p> <p>80 Pre-menopausal</p> <p>Symptomatic fibroids sufficiently severe for hysterectomy. Average 5 years duration 3 previous consultations with gynaecologists, 10 physicians</p> <p>80% heavy menstrual bleeding; 73% urinary urgency/frequency 41% pain during intercourse 40% work absences</p> <p>439 fibroid impact on life score 4 or higher. 101 previous treatment for fibroids.</p> <p>19% other major health problems. 5% increased surgical risk. Younger women – poorer self- perceived health status; 35% overweight; 17% obese</p> <p>Excluded Pelvic inflammatory disease Undiagnosed pelvic mass Endometrial carcinoma Pregnancy; renal insufficiency</p>	<p>538 Bilateral 14 Unilateral</p> <p>11 interventional radiologists</p> <p>Primary Embolising material Polyvinyl alcohol particles 355-500 μm dia. Gelfoam used by 4 InterventionalRadiologists in 57% of their cases</p> <p>Average procedure time: 61 mins</p> <p>Endpoint Standing column of contrast or contrast refluxed toward uterine artery or into internal iliac artery</p>	<p>3 months follow-up; median 8.1 months</p> <p>Blinded to indications for surgery or time elapsed since UAE.</p> <p>Histologic review of excised tissue.</p>	<p>Selected results – see Pron⁴⁸, Pron⁴⁹ and Pron⁵¹</p> <p>Safety</p> <p>Treatment failure or clinical failure 17/ 18 women: (2 myomectomy; 16 hysterectomies)</p> <p>PVA emboli in post UAE specimens from 17/18 cases</p> <p>1/18 case without embolic material identified in histological review was a large viable cervical rather than uterine body leiomyoma –</p> <p>Clinical history indicated that location of fibroid was not appreciated before UAE</p>

Study	Design/Patients/Participants	Inclusion/Exclusion	Procedure/materials	Outcome measures	Results
De Souza 2002 ²⁰ UK Single-centre Date N/R Funding: None declared	<p>Before and After Prospective case series</p> <p>Patients: 11</p> <p>Mean age: 40 (29-48)</p> <p>45 fibroids in total - Volume mean 89.9 cm³ (0.6-434) median 41.2 cm³</p> <p>34 myometrial location; 7 submucous; 3 subserosal 1 cervical</p> <p>Pre-UAE – MRI Postal questionnaire FSH tests</p> <p>Post-UAE MRI images: 1 day; 1 and 4 months; FSH tests 4 months Postal questionnaire 12 months</p>	<p>Included: Consecutive patients with diagnosis of fibroids</p> <p>11/11 Menorrhagia; 8/11 Abdominal distension/feeling of mass</p>	<p>11/11 bilateral</p> <p>Embolizing material: 355-500 <i>um</i> dia. Polyvinyl alcohol particles</p> <p>Post-op care 9/11 intravenous analgesia for pain</p>	<p>Mean reduction in: fibroid volume; dominant fibroid volume; uterine volume</p> <p>FSH level</p> <p>Postal questionnaire symptom scores before and after UAE. Each symptom scored 1-3 to produce final total of 9.</p> <p>Formula to assess change in clinical score at 12 months follow up: Difference in follow upscore/ Preembolisation score x 100.</p>	<p>Efficacy Mean reduction fibroid volume 4 months 38.2% ± 25.2%</p> <p>Mean reduction volume dominant fibroid 1 day 6% ± 8.1% 1 month 22.3% ± 17.5% 4 months 36.7% ± 26.5%</p> <p>Mean reduction uterine volume 4 months 20.1% ± 22.6%</p> <p>FSH levels: Stable Pre-UAE: 4.9 IU/L ± 2.2 4 months: 5.1 IU/L ± 1.6</p> <p>Improvements in symptom scores at 12 months: 4/11 56% 4/11 33%-44% 1/11 22% 1/11 11% 1/11 0%</p> <p>Immediate volume reduction in dominant fibroid correlates with improvements/changes in clinical scores at 12 months. Reductions in fibroid volume at 4 months do not.</p> <p>No safety data reported</p>

Study	Design/Patients/Participants	Inclusion/Exclusion	Procedure/materials	Outcome measures	Results
<p>Fleischer 2000⁶⁵</p> <p>USA</p> <p>Single-centre</p> <p>Date N/R</p> <p>Funding: None declared</p>	<p>Before and After</p> <p>Patients: 20</p> <p>Mean age: 43 (38-57)</p> <p>4/20 previous transfusions for chronic anaemia</p> <p>31 fibroids > 2 cm 17 intramural 9 subserosal 4 submucosal 1 cervical</p> <p>Pre-UAE – 3D color-doppler sonography one hour before UAE</p> <p>Post-UAE 3D color-doppler sonography 1 day, 3 and 6 months</p>	<p>Included: Patients referred for UAE Symptomatic fibroids 6 months to one year duration including: Abnormal uterine bleeding; Abdominal discomfort; Urinary frequency – bulk-related symptoms</p>	<p>20 unilateral (both right and left uterine arteries)</p> <p>Embolizing material: 355-500 <i>um</i> dia polyvinyl alcohol particles</p> <p>Endpoint: stasis</p> <p>Secondary embolizing agent: Selective gelfoam pledgets.</p>	<p>Mean reduction in: fibroid volume;</p> <p>Changes in vascularity;</p>	<p>Efficacy Mean changes:</p> <p>One day post UAE: Reduced vascularity 46% ± 17% 10/12 hypervascular fibroids 50% 4/10 isovascular 50% 2/9 hypovascular fibroids 50%</p> <p>3-6 months: Increased vascularity 12% ± 14%</p> <p>Reductions in fibroid volume 3 months 22% 6 months 47%</p> <p>Hypervascular fibroids on pre-UAE reduced in size more than other fibroids.</p> <p>19/20 ‘marked reductions’ in symptoms 95%</p> <p>Safety 1/20 elected hysterectomy excessive pain 5%</p>

Study	Design/Patients/Participants	Inclusion/Exclusion	Procedure/materials	Outcome measures	Results
<p>Jha 2000⁶⁴</p> <p>USA</p> <p>Single-centre</p> <p>Date N/R</p> <p>Funding: Grants from Siemens Medical Systems and Berlex Laboratories</p>	<p>Before and After</p> <p>Patients: 31</p> <p>Mean age: 45.2 (31-53.8)</p> <p>125 fibroids in total</p> <p>Pre-UAE – MR <one month before UAE</p> <p>Post-UAE MR images: 3 and 12 months (assessed by 3 readers other than operating IR)</p> <p>Symptom questionnaire 3 months</p>	<p>Included: Consecutive patients with symptomatic fibroids:</p> <p>18 bleeding and pelvic pain; 11 bleeding; 2 pain</p> <p>Failed medical treatment 4 previous myomectomy.</p> <p>Excluded: Patients for whom a myomectomy was a simple therapeutic option; wished to maintain fertility</p>	<p>16/18 bilateral 2/18 unilateral</p> <p>Experienced interventional radiologist</p> <p>500-710 <i>um</i> dia. polyvinyl alcohol particles</p>	<p>Mean reduction in: fibroid volume; vascularity;</p> <p>Symptom relief measures: (pelvic pain or bleeding): 1 Better 2 No Change 3 Worse</p>	<p>Pre-UAE MRI high signal intensity T1-weighted images predictive of poor response; high signal intensity T2-weighted images predictive of good response.</p> <p>Strong predictor of good response:</p> <ul style="list-style-type: none"> • Submucosal location. • Hypervascular fibroids <p>Predictor of poor response:</p> <ul style="list-style-type: none"> • Increasing age • Increasing pre-treatment uterine volume <p>Efficacy Mean reduction 3 months</p> <p>uterine 33.5% ± 16.1% (SD) p<0.001 fibroid 40.4% ± 35.8%(p<0.001)</p> <p>Mean reduction one year (5 patients only) fibroid 64.06% ± 30.30%</p> <p>26/31 improvement 84%</p> <p>4/31 no improvement in one or more symptoms: 1/4 adenomyosis; 13% 1/31 worsening 3%</p> <p>Safety 2/31 hysterectomy 6%</p>

Study	Design/Patients	Inclusion/Exclusion	Procedure/materials	Outcome measures	Results
<p>Klein 2001⁶⁵</p> <p>USA</p> <p>Single-centre</p> <p>Date July 1998-ongoing at date of publication</p> <p>Funding: Northwest Kaiser Permanente (a closed-panel health maintenance organisation >400,000 members)</p>	<p>Case series Prospective</p> <p>Patients: 35</p> <p>Highly motivated. Mostly specific request for UAE</p> <p>Mean age: 46 (32-56)</p> <p>13 nulliparous; 8 primiparous 14 multiparous</p> <p>Pre-UAE: Laboratory tests MRI</p> <p>Follow-up: Telephone interviews 6 weeks and 6 months; U/sound 8 weeks and 6 months</p>	<p>Included Symptomatic fibroids assessed by MRI and gynaecological examination in accord with protocols.</p> <p>Significant symptoms heavy bleeding, pelvic pressure, urinary frequency.</p> <p>Excluded Pelvic pain only Desire for future fertility <u>and</u> only one or two myomas</p>	<p>Outpatient ambulatory care unit</p> <p>Embolizing material 350-500 <i>um</i> dia. polyvinyl particles mixed with saline and iodinated x-ray contrast</p> <p>Secondary embolising agent: Selective Gelfoam pledgets</p> <p>Post-UAE care: 29/35 discharged 6.9 hours (5-10 hours) 6/35 not discharged 3/35 admitted within 1 week post UAE</p>	<p>Reductions in uterine and fibroid volume</p> <p>Symptoms Subjective satisfaction expressed by patients</p>	<p>Efficacy reduction 6 months* <i>24 patients</i></p> <p>Mean Uterine 36% (11%-30%) Dominant fibroid 49% (1%-92%) Statistically significant changes</p> <p>Patient satisfaction 6 months* <i>30 patients</i></p> <p>26/30 Very satisfied 87%</p> <p>4/30 Unsatisfactory 13% 2 no improvement; 1 subsequent surgery 1 technical failure and repeat UAE</p> <p>Safety Pain 21/29 Intravenous analgesia</p> <p>Ovarian function 4/30 (aged 43-51 years) amenorrhoea and elevated FSH 6 months post UAE</p> <p>Figures reported do not take 5 patients lost to follow up into account</p>

Study	Design/Patients/Participants	Inclusion/Exclusion	Procedure/materials	Outcome measures	Results
<p>McLucas 2001⁵⁶</p> <p>USA</p> <p>>one centre</p> <p>Date 1996 December 1999</p> <p>Funding: None declared.</p>	<p>case series observational clinical study overlaps with McLucas⁶⁶</p> <p>Patients: 14*/400</p> <p>Mean age: 41 (26-67) years</p> <p>Average dia. largest myoma 7.5 cm(1.2-19 cm) Average uterine volume 1389 ml (117-8804 ml)</p> <p>139/400 identified fertility as a goal after UAE</p> <p>Pre-UAE FSH levels Clinical assessment</p> <p>During radiation exposure</p> <p>Post-UAE 6 months FSH Clinical assessment Request to be notified of subsequent pregnancy or procedures or surgeries</p>	<p>Included Patients with symptomatic fibroids: menorrhagia or postmenopausal bleeding secondary to uterine myomata. No size restriction on individual myoma or uterine.</p> <p>No treatment on the basis of infertility as a symptom</p>	<p>Not described</p>	<p>Pregnancy and delivery following UAE</p> <p>Effect on ovarian function measured by change in FSH levels and menopausal symptoms</p>	<p>Safety 17 pregnancies reported in 14 women 5 spontaneous abortions 10 normal deliveries; 2 pregnant at time of publication. 1/10 premature labour, placenta previous and abruptio placenta, delivered at 32 weeks gestation. 9/10 full term without complications</p> <p>Ovarian function 4/6 women <45 years experienced premature menopause. Normal FSH levels before UAE experienced amenorrhoea and hot flushes post-UAE.</p> <p>Operator competence observed as a potential factor in non-target embolization of ovarian arteries.</p> <p>2/400 hysterectomy as a result of infection. 1/2 pathology report revealed chronic salpingitis. 1/2 pre-UAE uterine volume of 7932 cm³ requiring 10.75 vials of 300-500 polyvinyl alcohol particles (PVA) to occlude the uterine arteries (average uterine volume 620.17 cm³ and 3.62 vials of PVA), did not respond to anti-biotic therapy after abscess was noted on MRI.</p> <p>Radiation exposure – reported McLucas⁶⁵</p> <p>No results reported by different centres.</p> <p>No efficacy data reported</p>

Study	Design/Patients	Inclusion/Exclusion	Procedure/materials	Outcome measures	Results
McLucas 2001 ⁶⁶ USA Single-centre Date April 1997 August 1999 Funding: None declared	Case series Prospective Patients: 167 Mean age: 43 (29-63) 2 menopausal 51 previous pelvic surgeries Pre-UAE: Ultrasonography Laboratory tests Symptom scores (patient) Bleeding Pain Pressure Post-UAE: Ultrasonography (mostly same observer and equipment) <2, 6 and 12 months FSH Interviews 5 months	Included: Symptomatic fibroids – predominantly menorrhagia	Community hospital 163 bilateral 4 unilateral Embolizing material: Polyvinyl alcohol particles 108 procedures 500 μ m dia. 60 -do- 300 μ m dia Endpoint 1. Statis – elevated FSH levels noted in some patients. Thereafter 2. Resistance. Wait. Repeat contrast injection – No further FSH change noted Post-op care: Bed rest 6 hours	Reductions in uterine volume Symptom scores Mild Moderate Severe Definitions: Improvement going from severe to moderate; Stabilization remaining moderate or mild 'Failure group' Subsequent hysterectomy, or <10% shrinkage in myoma at 6 months, or worsening symptoms at 6 months; Overlapping groups counted as 'one'. Success = Not failure Radiation exposure Subset of 50 consecutive patients Patient numbers at follow up < 2 months 125 6 months 98 12 months 46	Efficacy Volume uterine reduction Follow up n % < 2 months 125 23 6 months 98* 31 12 months 46 37 131/150 improvement or stabilisation of symptoms. 88% 21/167 treatment 'failures' 12% Safety 119 Pain; observed overnight 12 Fever; 8/12 contacted physician; 3 readmitted; 6 Hysterectomy; 1/6 sepsis; 4 pelvic pathology noted pre-UAE; 1/6 unknown 8 Expelled necrotic submucous myomas 2-12 months post UAE; 5/8 spontaneously; 3/8 vaginal myomectomy to complete passage Radiation 0.9 to 1.1 rads per minute, mean radiation exposure 14 (6.4 - 45.8) minutes. Compare barium enema 6-rad; hysterosalpingogram 2-rad. Proficiency of radiologist important Fertility Ovarian function 4/98* menopause >45 years old 2 successful pregnancies and deliveries post UAE Results reported to not take account of increasing numbers of patients lost to follow up

Study	Design/Patients/Participants	Inclusion/Exclusion	Procedure/materials	Outcome measures	Results
<p>Mehta 2002²²</p> <p>UK</p> <p>Single-centre</p> <p>Date June 1998- April2000</p> <p>Funding: None declared</p>	<p>Case series Retrospective notes review</p> <p>Patients: 7/42</p> <p>Mean age: 42 (31-54)</p> <p>36 Afro-Caribbean 4 Caucasian; 2 Asian.</p> <p>38 multiple fibroids 4 single fibroids</p> <p>max dia. 5-22 cm</p> <p>Pre-UAE Ultrasound Laboratory tests FSH level Ultrasonography</p> <p>Post-UAE Ultrasound and clinical follow up 6 weeks, 6 and 12 months routinely. Otherwise at Gynaecologist's discretion</p>	<p>Included Diagnosis of fibroids referred by gynaecologist</p> <p>main symptom 76% menorrhagia or dysmenorrhoea; 24% uterine bulk, urinary frequency</p> <p>Excluded Concurrent pelvic infection</p>	<p>Inpatient</p> <p>41 bilateral 1 unilateral</p> <p>Embolizing material: 300-500 <i>um</i> polyvinyl alcohol particles</p> <p>End-point Statis</p> <p>Post-op care Anaesthetist-led pain control team;</p> <p>All discharged within 48 hours post-UAE</p>	<p>Rates of readmission post UAE</p>	<p>Safety 7 readmissions; median time 3 weeks post UAE (range 1-29 weeks);</p> <p>All emergency presentations to A&E – fever and pain. Additionally, 5 had vaginal discharge, and one was unable to pass urine</p> <p>2/7 admitted twice; 3/7 improved on antibiotic therapy; 3/7 also required manual removal of extruding fibroid; 1/7 total hysterectomy for pyometritis.</p> <p>Mean inpatient stay 12.6 days (range 4-21 days);</p> <p>1/7 subsequent normal full-term pregnancy 1/7 ovarian failure not considered related to UAE</p> <p>Complications rate 7/42 17%</p> <p>No efficacy results reported</p>

Study	Design/Patients/Participants	Inclusion/Exclusion	Procedure/materials	Outcome measures	Results
Messina 2002 ⁷⁸ Brazil Single-centre Date March 2000- January 2001 Funding: None declared	Case series Prospective Patients: 26 Mean age: 43 (33-49) Pre-UAE FSH level Ultrasonography Post-UAE Clinical follow up 1 week; 3 and 12 months Ultrasonography	Included Diagnosis of fibroids confirmed by ultrasonography and gynaecological examination Heavy menstrual bleeding Pelvic pain or pressure Refused surgical treatment Pre-menopausal Excluded FSH level 30 IU/l and clinical indications of menopause	Inpatient 24/26 bilateral 2/26 unilateral Embolizing material: 500-710 μ m polyvinyl alcohol particles End-point Complete vascular occlusion	Laboratory Mean reduction in: uterine volume; Clinical improvement Effectiveness by standard questions Hemoglobin levels FSH level Pain visual analogue scale	Efficacy % reduction uterine volume: Median Mean Range 3 months 27.9 29.4 11-65 1 year 45.4 41.1 2-91 All changes p<0.001 21/24 menorrhagia and anaemia controlled; Hemoglobin : 2.6 g/dl 1 year post UAE 88% 16/19 pelvic pain/pressure improved 84% 1/26 technical failure 4% Safety 3/26 treatment failures requiring hysterectomies: 12% 1 unremitting pelvic pain, vaginal bleeding – adenomyosis noted; 1 fever, pain, elevated white blood cell count, vaginal discharge and expulsion of infected uterine fibroid – 3 months post-UAE;. 1 submucosal fibroid – persistent heavy bleeding. Fertility 3/26 ovarian failure 1 <45: 2 >45 years

Study	Design/Patients/Participants	Inclusion/Exclusion	Procedure/materials	Outcome measures	Results
Nevadunsky 2001 ⁶⁷ USA Single-centre Date August 1998 August 1999 Funding: None declared	Patient survey Prospective Consecutive patients Patients: 84 Mean age: 44 (27-56) 60/84 Caucasian (71%) 59/84 College or postgraduate degree (70%) 57/84 Household income > \$50,000 (68%) 49/84 Household income > \$75,000 (58%)	Included: Presenting for UAE for symptomatic fibroids Excessive bleeding (61) anaemia (41) pelvic pain (29) Pressure (21) bulk related symptoms 24 Otherwise candidates for surgical resection	N/A	Ranking of priorities in decision to seek UAE by numbers of responses Source of information Impact on quality of life Decision-making determinants	Symptoms significant impact on quality of life. Information 56/84 used Internet 34/84 Literature primary source of information about UAE Knowledge of fibroids 79/84 well-informed Knowledge of treatment options 82/84 well-informed Impact of fibroids on quality if life Worries about health; daily discomfort; anxiety; limits daily activities; limits sexual activity; cause of sadness or depression; limits social activity Decision-making determinants in >50% of sample: Avoid recurrence of fibroid symptoms Avoid adverse effects of alternatives Avoid prolonged surgical recovery Avoid any surgical intervention No safety or efficacy data

Study	Design/Patients/Participants	Inclusion/Exclusion	Procedure/materials	Outcome measures	Results
<p>Nikolic 2000⁶⁸</p> <p>USA</p> <p>Single-centre</p> <p>Date N/R</p> <p>Funding: None declared</p>	<p>Case series Prospective</p> <p>Patients: 20/23</p> <p>Mean age: 43.7 (30-53)</p> <p>Estimating risks of radiation dose during UAE with known risks from other sources</p> <p>Data collected during UAE</p>	<p>Included:</p> <p>Patients undergoing UAE</p> <p>Excluded:</p> <p>Unreliable data showing inconsistent vaginal and skin dose measurements (ie lower than average yet higher exposure numbers and long fluoroscopic times)</p>	<p>2 unilateral 21 bilateral</p> <p>Embolizing material: 500-700 μm dia polyvinyl alcohol particles</p> <p>Endpoint: stasis and slight antegrade flow still present in uterine artery</p>	<p>Estimate of genetic risk from radiation dose.</p> <p>Fluoroscopic times; Radiation absorbed by skin; Radiation absorbed by ovaries; Population estimates based on numbers of patients who undergo hysterectomy for fibroids in US annually; numbers of women of child-bearing age, and average numbers of children.</p>	<p>Safety <u>Mean times/dose:</u> Fluoroscopic time 21.89 minutes (range 8-52.5); Radiation dose 2.9 R/min (0.75 mC/kg/min) to 4.4 R/min (1.13 mC/kg/min); Numbers of exposures 44 (range, 21–62); Ovarian dose 22.34 cGy (range 4.25-65.08 cGy); Skin dose 162.32 cGy (range 66.01-303.89 cGy); Genetically significant dose 0.005 mSv</p> <p>Population estimates and comparison with known risks of radiation from <u>other sources:</u></p> <p>Genetically significant dose 0.23 mSv (23 mrem)</p> <p>Contribution of UAE 2.2% to genetically significant dose from medical applications.</p> <p>Contribution of UAE to total genetically significant dose 0.4%</p> <p>Fluoroscopy times and numbers of exposures reduced with numbers of UAE performed.</p> <p>UAE not likely to result in radiation-induced skin effects, or substantial increased risk to future children.</p> <p>Fertility Effects on ovarian function uncertain. 1/23 repeat UAE</p>

Study	Design/Patients/Participants	Inclusion/Exclusion	Procedure/materials	Outcome measures	Results
<p>Omary 2002⁶⁹</p> <p>USA</p> <p>Single-centre</p> <p>Date Feb-Jun 2001</p> <p>Funding: RSNA Bracco Diagnostics Award and NIH; RSNA research and education fund medical student</p>	<p>Before and After MRI Prospective</p> <p>Patients: 60 Radiologists: 5</p> <p>Mean age: 44 (31-54) (patients)</p> <p>Pre-UAE: (physician) 1) Pre-MRI scan questionnaire with diagnostic options: uterine fibroids; adenomyosis; endometrial masses; adnexal masses; cervical masses; other (specify); multifactorial; normal.</p> <p>Post-MRI: 1) Review of diagnosis and anticipated treatment plan by IR and MR imaging specialists 2) Post-MRI questionnaire</p>	<p>Included: (patients) Previous diagnosis of fibroids; significant uterine bleeding; bulk-related symptoms; and/or pain.</p> <p>Excluded: Disinterested in UAE; Strong desire for future fertility; History of severe reactions to iodinated contrast agents; Currently pregnant.</p>	<p>Inpatient university-affiliated tertiary care medical centre</p> <p>Procedure not reported</p>	<p>Pre UAE : Changes in planned treatment and actual treatment as measure of diagnostic confidence</p>	<p>Safety and efficacy Pre- MRI 57/60 intended for UAE;</p> <p>Post-MRI 10/57 assigned to different treatment plan; 8/10 from UAE to surgery. 17.5%</p> <p>No UAE treatment outcomes data reported</p>

Study	Design/Patients	Inclusion/Exclusion	Procedure/materials	Outcome measures	Results
Pelage 2000 ⁵⁷ France Single-centre Date June 1991- December 1996 Funding: None declared	Case series Prospective Patients: 80 Mean age: 44.7 (30-54) 63 intramural location mean dia. largest fibroid 58 (range 21-100) mm 15 previous myomectomy Pre-UAE: Ultrasonography Post-UAE: 1, 6,12 and 24 months; annually thereafter. Ultrasonography Gynaecologic examination 4- 7 weeks and regularly thereafter 5-point Symptom scale (complete resolution to worsening)	Included: Failed medical treatment; Otherwise planned hysterectomy or myomectomy. Main criterion for UAE: refractory vaginal bleeding; Most frequent symptom pelvic pain; anaemia.	Inpatient 76 Bilateral 4 Unilateral 5 vascular radiologists procedure time 45-90 minutes Embolizing material: Polyvinyl alcohol particles 150-300 <i>um</i> Endpoint: 1 no residual hypervascularisation visible; 2 statis – distal; 3 reduced flow – proximal. Secondary embolising agent: None Post-op care: Obs & Gynae Ward Post embolization pain protocols; patient-controlled pump. Discharge 1-2 days	Reductions in fibroid volume Change in symptoms Symptom scale: 5-category scale (bleeding and pelvic pain): 1 complete resolution 2 significant improvement 3 slight improvement 4 unchanged 5 worsened	Efficacy Volume reduction dominant fibroid 2 months 6 months Mean 20% 52% Latest follow up 72/80 complete resolution 90% 3*/80 marked improvement 4% 5*/80 no improvement 6% <i>*1/3 and 3/5 unilateral procedures</i> 74 – normal menstruation first cycle Safety 68/80 intense pain 6/80 post embolization syndrome 4/80 expelled necrotic fragments of a pedunculated submucosal myoma <1 month UAE. Fertility 4/80 transient amenorrhoea 2/80 permanent amenorrhoea

Study	Design/Patients	Inclusion/Exclusion	Procedure/materials	Outcome measures	Results
Pelage 2003 ⁵⁸ France Single-centre Date >48 months before publication Funding: Post study Research grants Biospher Medical	Case series Prospective Patients: 20 15 white; 5 black 12/20 intramural fibroids 8/20 mixed fibroids Mean age: 43.1 (36-53) Pre-UAE: 20/20 Ultrasound <u>and</u> 9/20 MRI Follow-up: 1, 6,12 and 24 months; annually thereafter. Telephone interviews	Included: Failed medical treatment; No desire for future pregnancy <u>unless</u> only surgical option hysterectomy; Pre-menopausal; Heavy menstrual bleeding 20/20; Iron deficiency 11/20 Pelvic pain/pressure 9/20 Excluded: Single submuscosal or pedunculated subserosal fibroids	Inpatient Bilateral Embolizing material: calibrated microspheres 700-900 μ m dia. Endpoint: 4 no residual hypervascularisation visible; 5 statis – distal; 6 reduced flow – proximal. Secondary embolising agent: None Post-op care: Admission to Obs & Gynae Ward Post embolization pain protocols Discharge 1-2 days	Symptom scale: 5-category scale (bleeding and pelvic pain): 1. complete resolution 2. significant improvement 3. slight improvement 4. unchanged 5. worsened Major complications: Menstrual irregularity/amenorrhoea Pelvic infection Expulsion necrotic fragments Minor complications: Allergy to contrast medium adverse drug reaction groin haematoma dissection of uterine artery	Efficacy 6 months : Volume reduction Uterine Dominant Median 36 81 Mean 34 43 Latest follow-up (bleeding): 17/20 Complete resolution 85 % 1/20 Significant Improvement 5 1/20 No change 5 1/20 Worsened 5 1/20 Repeat UAE Safety 5/20 No pain 11/20 Moderate pain; 1/11 delayed intense pain 3 days post UAE readmission intravenous pain control; 4/20 Intense pain; 1/20 Expulsion necrotic fragments two and seven months post-UAE; Fertility 1/20 Pregnancy and delivery (53 years) menstrual irregularity - 9 months post UAE; 1/20

Study	Design/Patients/Participants	Inclusion/Exclusion	Procedure/materials	Outcome measures	Results															
Pinto 2003 ⁴⁵ Spain Single-centre Date April 1999 – June 2001 Funding: None declared	Prospective Randomised Controlled Trial using Zelen's pre-consent design Interventions: Group 1 UAE or hysterectomy Group 2 hysterectomy only Safety and efficacy results were reported for n=40 patients who had UAE Mean age 43 (18-59) Pre-UAE Laboratory tests MRI Post-UAE MRI Patient-reported clinical change Patient satisfaction 2-year follow up	Included Patients with bleeding fibroids who were candidates for surgical resection Excluded Desire to maintain fertility Fibroids >10 cm dia. Contraindications for surgery Sensitivity to iodine-based contrast material	Inpatient – 450-bed teaching hospital 35 bilateral 5 unilateral All procedures same two InterventionalRadiologists Embolizing material 400-600 <i>um</i> dia polyvinyl alcohol particles	Bleeding cessation; Length of hospital stay; Complications Recovery – 4 pt. scale Full – cessation of menorrhagia or metrorrhagia or either if one only; Partial – Reduced menorrhagia; No improvement – no change; Worsening Complications Minor - no consequences for patient except nominal treatment; Moderate - non-life threatening additional treatment without sequelae for patient (post embolization syndrome, urinary infection); Major - death or life-threatening. Satisfaction Would you undergo UAE again?	Efficacy UAE Clinical success (improved bleeding) 31/39 Mean volume reduction at 6 months in Dominant fibroid 46% (27%,66%) Safety <u>UAE</u> 29/40 complications <30 days 73% >one complication x 9 patients 2 readmitted to hospital – post embolization syndrome; severe pelvic pain. major complication x 1 patient <u>Hysterectomy</u> 9/20 complications <30 days; 45% >one complication in 3 patients; 1 patient readmitted for transfusion. major complications ≥4 patients Satisfaction <table border="0"> <tr> <td>UAE</td> <td></td> <td>Hysterectomy</td> </tr> <tr> <td>28</td> <td>Yes</td> <td>15</td> </tr> <tr> <td>3</td> <td>Maybe</td> <td></td> </tr> <tr> <td>5</td> <td>No</td> <td>2</td> </tr> <tr> <td>4</td> <td>Not reported</td> <td>3</td> </tr> </table>	UAE		Hysterectomy	28	Yes	15	3	Maybe		5	No	2	4	Not reported	3
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Study	Design/Patients	Inclusion/Exclusion	Procedure/materials	Outcome measures	Results
Pron 2003 ⁴⁷ Canada Multi-centre 8 settings: University and community hospitals Date Not reported Funding: None declared	Case series Prospective Consecutive patients Patients: 555 Mean age: 43 (18-59) 66% Caucasian 23% Black 11% Other ethnic origin 31% <40 years old 68% university educated 85% working outside home Black women significantly -- younger (40.7 years vs. 44.0 years); - more likely to have multiple fibroids. Mean fibroid volume 293 (95% CI 259-327 cm ³) Length 8 (range, 1-24 cm) Mean uterine volume 680 (95% CI 626-734 cm ³) Length 14 (range, 5-30 cm) No differences in uterine/fibroid size for age or ethnicity. 268/537 no children; 164/537 Fertility an issue	Included: 355/539 multiple fibroids 80 Pre-menopausal Symptomatic fibroids sufficiently severe for hysterectomy. Average 5 years duration 3 previous consultations with gynaecologists, 10 physicians 80% heavy menstrual bleeding; 73% urinary urgency/frequency 41% pain during intercourse 40% work absences 439 fibroid impact on life score 4 or higher. 101 previous treatment for fibroids. 19% other major health problems. 5% increased surgical risk. Younger women – poorer self- perceived health status; 35% overweight; 17% obese Excluded Pelvic inflammatory disease Undiagnosed pelvic mass Endometrial carcinoma Pregnancy; renal insufficiency	Pre-UAE Baseline questionnaires; Ultrasound examination	No clinical outcomes reported	539/555 completed questionnaires. Description of Patient population

Study	Design/Patients	Inclusion/Exclusion	Procedure/materials	Outcome measures	Results
Pron 2003 ⁴⁸ Canada Multi-centre 8 settings: University and community hospitals Date Not reported Funding: In part Boston Scientific Corporation	Case series Prospective Consecutive patients Patients: 555 Mean age: 43 (18-59) 66% Caucasian 23% Black 11% Other ethnic origin Date Not reported Funding: In part Boston Scientific Corporation	Included: 355/539 multiple fibroids 80 Pre-menopausal Symptomatic fibroids sufficiently severe for hysterectomy. Average 5 years duration 3 previous consultations with gynaecologists, 10 physicians 80% heavy menstrual bleeding; 73% urinary urgency/frequency 41% pain during intercourse 40% work absences 439 fibroid impact on life score 4 or higher. 101 previous treatment for fibroids. 19% other major health problems. 5% increased surgical risk. Younger women – poorer self- perceived health status; 35% overweight; 17% obese Excluded Pelvic inflammatory disease Undiagnosed pelvic mass Endometrial carcinoma Pregnancy; renal insufficiency	538 Bilateral 14 Unilateral 11 InterventionalRadiologists Primary Embolising material Polyvinyl alcohol particles 355-500 μ m dia. Gelfoam used by 4 InterventionalRadiologists in 57% of their cases Average procedure time: 61 mins Endpoint Standing column of contrast or contrast refluxed toward uterine artery or into internal iliac artery	3 months follow-up Changes in volume : Uterine/Dominant fibroid Clinical outcomes 7-point Symptom score (much worse – much improved) the rating scale was not tested 10-point Life impact score (1 minimal-10 maximum) Menstrual flow and days Patient satisfaction Willingness to undergo UAE if necessary; 6-point scale Overall satisfaction; (greatly dissatisfied – greatly satisfied).	Selected results – see Pron ⁴⁹ , Colgan ⁵⁰ and Pron ⁵¹ 526/538 bilateral UAE patients. Efficacy Volume change Median Mean Dominant fib. 42% 33% (95% CI 28-38) Uterine 35% 27% (95% CI 23-32) Pre-treatment size Larger fibroids – mean reduction >400 cm ³ Smaller fibroids – mean reduction \leq 200 cm ³ (p <0.0001) Symptom improvement Mean 95% CI Menorrhagia 83% (80-87) Dysmenorrhea 77% (72-82) Bulk symptoms 84% (80-87) Urinary urgency 86 (82-90) Life impact Pre-UAE 72% score of > 7; Post-UAE 11% - strong association with improvements in menstrual bleeding but not reductions in uterine volume Safety Selected complications reported – see Pron ⁴⁹ ;Colgan ⁵⁰ and Pron ⁵¹ Amenorrhoea – age dependent <40 years 3% (95% CI 1-7) 40-49 years unreported \geq 50 41% (95% CI 26-58) Patient satisfaction 91% satisfied (95% CI 89-94) 85% (n=414) willing to undergo UAE again if necessary; 93/414 only conditionally so. Efficacy rates reported for sub-set of 526/538 patients Adverse events see Pron ⁴⁹ and Pron ⁵¹

Study	Design/Patients	Inclusion/Exclusion	Procedure/materials	Outcome measures	Results
Pron 2003 ⁴⁹ Canada Multi-centre 8 settings: University and community hospitals Date Not reported Funding: In part Boston Scientific Corporation	Case series Prospective Consecutive patients Patients: 555 Mean age: 43 (18-59) 66% Caucasian 23% Black 11% Other ethnic origin 31% <40 years old 68% university educated 85% working outside home Black women significantly -- younger (40.7 years vs. 44.0 years); - more likely to have multiple fibroids. Mean fibroid volume 293 (95% CI 259-327 cm ³) Length 8 (range, 1-24 cm) Mean uterine volume 680 (95% CI 626-734 cm ³) Length 14 (range, 5-30 cm) No differences in uterine/fibroid size for age or ethnicity. 268/537 no children; 164/537 Fertility an issue Pre UAE Ultra-sound Questionnaires Gynaecological examination	Included: 355/539 multiple fibroids 80 Pre-menopausal Symptomatic fibroids sufficiently severe for hysterectomy. Average 5 years duration 3 previous consultations with gynaecologists, 10 physicians 80% heavy menstrual bleeding; 73% urinary urgency/frequency 41% pain during intercourse 40% work absences 439 fibroid impact on life score 4 or higher. 101 previous treatment for fibroids. 19% other major health problems. 5% increased surgical risk. Younger women – poorer self- perceived health status; 35% overweight; 17% obese Excluded Pelvic inflammatory disease Undiagnosed pelvic mass Endometrial carcinoma Pregnancy; renal insufficiency	538 Bilateral 14 Unilateral 11 interventional radiologists Primary Embolising material Polyvinyl alcohol particles 355-500 μ m dia. Gelfoam used by 4 InterventionalRadiologists in 57% of their cases Average procedure time: 61 mins Endpoint Standing column of contrast or contrast refluxed toward uterine artery or into internal iliac artery	2 weeks; 3 months follow- up; median 8.1 months Complications resulting in hysterectomy Histopathology reports on excised tissue	Selected results – see Pron ⁴⁸ , Colgan ⁵⁰ and Pron ⁵¹ Safety 8 hysterectomies following complications (3 within one month; 5 within three months); 6 total hysterectomies; 2 sub-total hysterectomies. 2 Emergencies following infection; 4 Pain; 1 prolapsed myoma; 1 persistent vaginal bleeding. 8/8 fibroids intramural location and also 4/8 subsrosal. 4/8 performed at institutions other than UAE study institutions. PVA found in excised tissue.

Study	Design/Patients	Inclusion/Exclusion	Procedure/materials	Outcome measures	Results															
Pron 2003 ³¹ Canada Multi-centre 8 settings: University and community hospitals Date November 1998 and November 2000 Funding: None declared	Case series Prospective Consecutive patients Patients: 555 Mean age: 43 (18-59) 66% Caucasian 23% Black 11% Other ethnic origin 31% <40 years old 68% university educated 85% working outside home Black women significantly -- younger (40.7 years vs. 44.0 years); - more likely to have multiple fibroids. Mean fibroid volume 293 (95% CI 259-327 cm ³) Length 8 (range, 1-24 cm) Mean uterine volume 680 (95% CI 626-734 cm ³) Length 14 (range, 5-30 cm) No differences in uterine/fibroid size for age or ethnicity. 268/537 no children; 164/537 Fertility an issue Pre UAE Ultra-sound Questionnaires Gynaecological examination	Included: 355/539 multiple fibroids 80 Pre-menopausal Symptomatic fibroids sufficiently severe for hysterectomy. Average 5 years duration 3 previous consultations with gynaecologists, 10 physicians 80% heavy menstrual bleeding; 73% urinary urgency/frequency 41% pain during intercourse 40% work absences 439 fibroid impact on life score 4 or higher. 101 previous treatment for fibroids. 19% other major health problems. 5% increased surgical risk. Younger women – poorer self- perceived health status; 35% overweight; 17% obese Excluded Pelvic inflammatory disease Undiagnosed pelvic mass Endometrial carcinoma Pregnancy; renal insufficiency	538 Bilateral 14 Unilateral 11 interventional radiologists Primary Embolising material Polyvinyl alcohol particles 355-500 μ m dia. Gelfoam used by 4 interventional radiologists in 57% of their cases Average procedure time: 61 mins Endpoint Standing column of contrast or contrast refluxed toward uterine artery or into internal iliac artery	Technical success: All fellowship-trained in vascular and interventional radiology and at least 3 years experience in peripheral angiography and embolisation techniques. 2/11 dedicated interventional practice.	Selected results – see Pron ⁴⁷ , Pron ⁴⁸ , Colgan ⁵⁰ and Pron ⁵¹ Efficacy 570 UAE procedures in 555 patients. 97% technical success bilaterally.(538 patients) Main reason for technical failure : variant anatomy Safety 30 adverse events (30/555) Complication rate 5.3% (95% CI 3.6-7.4) 3 major complications: (1 multiple seizures; 2 serious allergic reactions) 4 perforations; 10 minor Significant variation between: - Interventional radiologists in both times (p <0.001); - Successes and failures, and - First 20 and next 20 procedures <table border="1"> <thead> <tr> <th></th> <th>Mins/Procedure 95% CI</th> <th>Mins/Fluoroscopy 95% CI</th> </tr> </thead> <tbody> <tr> <td>Successes</td> <td>61.0 (58-63)</td> <td>18.9 (18-19.8)</td> </tr> <tr> <td>Failures</td> <td>88 (75-100)</td> <td>31.5 (24.3-38.6)</td> </tr> <tr> <td>First 20 procedures</td> <td>75 (95% CI 70-80)</td> <td>21.3 (19.4-23.3)</td> </tr> <tr> <td>Next 20 procedures</td> <td>55 (95% CI 52-59)</td> <td>16.2 (14.8-17.5)</td> </tr> </tbody> </table> Adverse events rate 5.3% 30/555 Efficacy rates ⁴⁸ reported for sub-set of 526/538 patients		Mins/Procedure 95% CI	Mins/Fluoroscopy 95% CI	Successes	61.0 (58-63)	18.9 (18-19.8)	Failures	88 (75-100)	31.5 (24.3-38.6)	First 20 procedures	75 (95% CI 70-80)	21.3 (19.4-23.3)	Next 20 procedures	55 (95% CI 52-59)	16.2 (14.8-17.5)
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Study	Design/Patients/Participants	Inclusion/Exclusion	Procedure/materials	Outcome measures	Results
Ravina 2000 ⁵⁹ France One centre Date 1988 December 1997 Funding: None declared	case series prospective observational clinical study Patients: 9*/184 Mean age: 36* (22-41) median 40* 3/9 one large myoma 6/9 3 or more dia. range 40 to 100 mm	Included: Patients becoming pregnant following UAE for symptomatic fibroids	Highly selective and bilateral Embolizing materials 150/300 to 300/600 μ m dia Polyvinyl alcohol foam particles	Pregnancy course and delivery following UAE Delay to pregnancy Maternal blood pressure Fetal growth Possible recurrences of myoma Sonographic exam/monthly Fetomaternal vascularization Age and term of pregnancy Miscarriages Premature birth Delivery mode Birth weight and post-partum course	Safety 12 pregnancies in 9 women 5 early miscarriages in 3 women 8 infants delivered in 7 pregnancies 1 patient died severe AIDS and streptococcal septicaemia at 28 weeks. Infant died subsequently. Delay to pregnancy 13 (range, 4 to 23) months Age at delivery 38 (range, 23 to 43) years Miscarriages 5 in 3 patients >40 (40-42 years) Infants 8 in 7 patients (one twin) Term 4 full term; 3 premature Delivery 3 vaginal 4 cesarean sections Recurrence of myoma None

Study	Design/Patients/Participants	Inclusion/Exclusion	Procedure/materials	Outcome measures	Results
Razavi 2002 ³⁴ USA Single-centre Date July 1998- December 2000 Funding: None declared	Comparative Case series Retrospective notes review Patients: 67/111 (UAE/all) Strong desire to avoid hysterectomy Mean age: 44 (31-56) Pre-UAE Gynaecological examination Routine history Laboratory tests Pelvic imaging – sonography or MRI Post-UAE Mean follow up 14.3 months. Telephone questionnaire Review of medical records	Included Menorrhagia, pain, pressure, pelvic discomfort, mass effect causing abdominal distension or urinary tract symptoms 52 bleeding 34 pelvic pain 37 mass effect	Inpatient 66 bilateral 1 unilateral Embolizing material: 300-500 <i>um</i> polyvinyl alcohol particles or 500-700 <i>um</i> Trisacryl gelatin microsphere End-point Statis	Changes in symptoms: Menorrhagia, pain, mass effect assessed on 6-point scale: 6 Complete resolution 5 Significant resolution 4 Moderate 3 No change 2 Moderately worse 1 Significantly worse Time to resumption of daily activities Pain control Major complications leading to death, additional procedures; prolonged hospital stay; undesirable outcome or clinic visits within 30 days; bleeding leading to transfusion	Efficacy Significant or complete resolution of symptoms achieved* 62 patients 48/52 menorrhagia; 92% 25/34 pain 73% 28/37 mass 76% 5 further interventions- 3 myomectomies; 2 hysterectomies Mean time to resume normal activities 8 days (range 1-49 days); Pain control 5.1 days (range 1-21 days) Safety 7 complications – 11% 1 readmission for endometritis; 1 readmission for pelvic pain; 1 transient numbness in groin access site; Fertility 4 menopause >46 years old

Study	Design/Patients/Participants	Inclusion/Exclusion	Procedure/materials	Outcome measures	Results
<p>Ryu 2001⁷⁰</p> <p>USA</p> <p>one centre</p> <p>Date May 2000 December 2000</p> <p>Funding: Cardiovascular and Interventional Radiology Research and Education Foundation (CIRREF).</p>	<p>case series Prospective</p> <p>Patients: 23</p> <p>Mean age: 42.6 (35-51) years</p> <p>Pre-UAE Gray-scale and color Doppler US</p> <p>Post-UAE Gray-scale and color Doppler US Clinical visit Telephone contact <i>17 completed study</i></p>	<p>Included Consecutive patients with symptomatic fibroids: menorrhagia and/or bulk-related symptoms.</p> <p>Excluded Menopausal and post menopausal symptoms specifically hot flashes or night sweats.</p>	<p>Bilateral selective</p> <p>Embolizing materials Polyvinyl alcohol particles 355-500 μm dia. in 19 patients 500-700 μm dia. 2 patients. Embosphere 500-700 μm dia. 2 patients</p> <p>Endpoint Statis in the spiral uterine artery branches with antegrade flow in main uterine artery.</p>	<p>Changes in ovarian function as measured by increased vascular impedance by arterial signal or increase in RI and PI.</p> <p>Resistive Index = PSV-EDV/PSV Pulsatility Index = (PSV – EDV/mean</p> <p>Menopausal symptoms on questionnaire – hot flushes, mood swings, vaginal dryness, post-coital bleeding, weight gain, and bleeding >once every 3 weeks.</p> <p>Statistical significance p 0.05 or less.</p>	<p>Safety Fertility Significant increase in vascular impedance 15/17 patients (p<0.001) immediately post-UAE 9/17 complete loss of Doppler arterial signal in the ovary after UAE. 6/8 remaining (n=17) RI and PI values increased. 2/8 RI and PI values decreased.</p> <p>Evidence of significant vascular derangement in ovarian arterial circulation immediately after UAE. Mechanism unknown – inadvertent embolization not ruled out.</p> <p>See Ryu⁷¹</p>

Study	Design/Patients/Participants	Inclusion/Exclusion	Procedure/materials	Outcome measures	Results
<p>Ryu 2003⁷¹</p> <p>USA</p> <p>one centre</p> <p>Date May 2000 December 2000</p> <p>Funding: Cardiovascular and Interventional Radiology Research and Education Foundation (CIRREF).</p>	<p>case series Prospective</p> <p>Patients: subset of 6/23 (see Ryu⁷⁰)</p> <p>Mean age: 40 (35-51) years</p> <p>Pre-UAE Gray-scale and color Doppler US</p> <p>Post-UAE Gray-scale and color Doppler US Clinical visit Telephone contact Mean follow up 28 (range, 18-42 weeks)</p>	<p>Included Complete loss of ovarian function post UAE as measured by increases in RI and PI values and arterial signal in a previous study to assess ovarian arterial perfusion⁶⁹.</p>	<p>Bilateral selective</p> <p>Embolizing materials Polyvinyl alcohol particles 350-500 μm dia. in 3 patients 500-700 μm dia. 2 patients. Embosphere 500-700 μm dia. 1 patients</p> <p>Endpoint Stasis in the spiral uterine artery branches with antegrade flow in main uterine artery.</p>	<p>Changes in ovarian arterial perfusion at follow up measured by increased vascular impedance by arterial signal or increase in RI and PI.</p> <p>Resistive Index = PSV-EDV/PSV Pulsatility Index = (PSV – EDV/mean</p> <p>Menopausal symptoms on questionnaire – hot flushes, mood swings, vaginal dryness, post-coital bleeding, weight gain, and bleeding >once every 3 weeks.</p> <p>Statistical significance p 0.05 or less.</p>	<p>Safety Fertility 4/6 re-established arterial perfusion. All 4 decreased RI and PI values compared with their preprocedural values No amenorrhoea or other peri-menopausal symptoms.</p> <p>2/6 patients had complete loss of ovarian arterial circulation on delayed sonography.</p> <p>1/2 patients with continued loss of arterial perfusion experienced onset of new menopausal symptoms. Only patient who was >45 years old.</p> <p>1/2 complete loss of ovarian arterial circulation on sonography resumed normal menses after UAE, no menopausal symptoms at follow up.</p> <p>Ovarian dysfunction was transient in 4/6 patients – see Ryu⁷⁰</p>

Study	Design/Patients/Participants	Inclusion/Exclusion	Procedure/materials	Outcome measures	Results
<p>Spies 2001⁷²</p> <p>USA</p> <p>Single-centre</p> <p>Date Commenced October 1998</p> <p>Funding: Cardiovascular and Interventional Radiology Research and Education Foundation (CIRREF)</p>	<p>Case series Prospective</p> <p>Patients: 63</p> <p>Mean age: 42.9 (33-50)</p> <p>Pre UAE Systematic blood samples FSH levels</p> <p>Post UAE 3 and 6 months FSH levels – same laboratory Questionnaire follow up</p> <p><i>59 patient at 3 months</i> <i>48 patients at 6 months</i></p>	<p>Included</p> <p>Patients with symptomatic fibroids: heavy menstrual bleeding, pelvic pain or pressure, dyspareunia or urinary or rectal pressure.</p> <p>Excluded</p> <p>Menopausal and post menopausal</p>	<p>Bilateral Same physician team</p> <p>Embolizing material Polyvinyl alcohol particles (PVA) 500-710 μm</p> <p>Gelatin sponge pledgets were not used</p> <p>Endpoint Statis or near statis of flow in the uterine arteries</p>	<p>Changes in ovarian function as measured by FSH levels</p> <p>Potentially clinically significant change: >2 SD (7.2 IU/L) increase from baseline</p> <p>Differences by age group.</p> <p>30-39 years 40-44 45-50</p> <p>Menopausal symptoms on questionnaire: hot flushes, mood swings, vaginal dryness, post-coital bleeding, weight gain, and bleeding >once every 3 weeks.</p> <p>Statistical significance p.0.05 or less.</p>	<p>Safety Fertility Clinically significant changes observed at 3 months in 7 patients.</p> <p>1/7 <45 years 6/7 45 years and above</p> <p>Progressive increase in FSH levels by age</p> <p>Most patients <45 years no change in ovarian function as measured by basal FSH.</p> <p>Changes >2 SD increase from baseline observed in: 6 patients 45 years and above 1 patient <45 years</p> <p>Patients 45 years and above have a 15% chance of change in FSH levels into peri-menopausal range.</p>

Study	Design/Patients	Inclusion/Exclusion	Procedure/materials	Outcome measures	Results
<p>Spies 2001⁷³</p> <p>USA</p> <p>Single-centre</p> <p>Date July 1997 December 1999</p> <p>Funding: Cardiovascular and Interventional Radiology Research and Education Foundation; Boston Scientific; Siemens; Edward Bennett Williams Interventional Radiology Research and Education Fund</p>	<p>Case series Prospective Consecutive</p> <p>Patients: 200</p> <p>Mean age: 43 (30-52)</p> <p>45% white : 55% non-white</p> <p>Post-UAE: Mean follow up 21 months (minimum 12)</p> <p>Telephone and questionnaire</p>	<p>Included: Symptomatic fibroids – predominantly menorrhagia, pressure, pain, bulk-related symptoms</p> <p>Excluded Currently pregnant; Infertility attributed to leiomyomas; Desire for future pregnancy if simple myomectomy possible; Pedunculated submucosal fibroids capable of hysteroscopic resection; Uterus size of >24 weeks size.</p>	<p>Embolizing material: Polyvinyl alcohol particles (PVA) 500 –710 μm</p> <p>Final 100 PVA or tris acryl gelatin microspheres</p> <p>Endpoint 1. Slow flow or near-stasis in main uterine artery</p>	<p>Reductions in fibroid and uterine volume</p> <p>Changes in symptoms</p> <p>11-point scale minus 5 (markedly worse) through 0 to plus 5 (markedly better)</p> <p>Patient satisfaction</p> <p>Same scale as for symptoms</p>	<p>Efficacy</p> <p>Symptom improvement Heavy bleeding 87% 3 months (n=181) 89% 6 months (n=158) 90% 1 year (n=167)</p> <p>Bulk 93% 3 months (n=181) 92% 6 months (n=158) 91% 1 year (n=167)</p> <p>Satisfaction</p> <p>93% 3 months (n=181) 93% 6 months (n=158) 92% 1 year (n=167)</p> <p>(95% response)</p> <p>Safety – see Spies⁷⁴</p>

Study	Design/Patients	Inclusion/Exclusion	Procedure/materials	Outcome measures	Results
<p>Spies 2002⁷⁴</p> <p>USA</p> <p>Single-centre</p> <p>Date July 1997 April 2001</p> <p>Funding: None declared</p>	<p>Case series Prospective</p> <p>Patients: 42/400</p> <p>Mean age: 43 (27-57)</p> <p>43% white : 57% non-white</p> <p>Post-UAE: 24 hours after discharge 1 week clinical visit Questionnaire 3 and 12 months</p>	<p>Included: Symptomatic fibroids – predominantly menorrhagia, pressure, pain, bulk-related symptoms</p> <p>Excluded Currently pregnant; Infertility attributed to leiomyomas; Desire for future pregnancy if simple myomectomy possible; Pedunculated submucosal fibroids capable of hysteroscopic resection; Uterus size of >24 weeks size.</p>	<p>396 bilateral 4 unilateral</p> <p>Embolizing material: First 300 Polyvinyl alcohol particles (PVA) 500 –710 μm Final 100 PVA or tris acryl gelatin microspheres</p> <p>Endpoint 1. PVA - near-Static 2. Microspheres - Slow forward flow</p> <p>Post-op care: 391/400 hospitalised overnight Discharged next day</p>	<p>Complications In-hospital complications similar to FIBROID registry</p> <p>Severity: standard definitions by Society of Cardiovascular and Interventional Radiology (SCVIR).</p> <p>Operative morbidity definitions of the American College of Obstetricians and Gynecologists (ACOG) occurring within 30 days of procedure.</p> <p>Overlapping ACOG criteria counted as one event.</p> <p>Effect on ovarian function</p>	<p>Safety – subset of 250 patients 3 months 12 months Amenorrhoea 12/250 4/249*</p> <p>(1 lost to follow up*) Ages: 49, 51, 50 and 54.</p> <p>Complications: 47 in 42 patients rate 10.5%</p> <p>64% minor (SCVIR classes A and B) – most frequent allergic reaction or rash; 15 major complication on SCVIR classes C and D;</p> <p>4 Hospitalisation for pain 4 Passage of leiomyoma 2 endometritis 1 Pulmonary embolus 1 Bilateral iliac artery thrombosis 1 uterine infection coinciding with passage of leiomyoma 1 infection – hysteroscopic removal of leiomyoma 1 heavy bleeding during leiomyoma passage – failed D & C subsequent hysterectomy</p> <p>Efficacy data - See Spies⁷³</p>

Study	Design/Patients/Participants	Inclusion/Exclusion	Procedure/materials	Outcome measures	Results
Tranquart 2002 ⁶⁰ France Single-centre Date beginning 1997 Funding: None declared	Case series Prospective consecutive Patients: 58 Mean age: 44.5 (33-65) Mean uterus volume 305 (65-1403) cm ³ Mean fibroid volume 112 (10-723) cm ³ Pre-UAE – Doppler sonography – same examiner Post-UAE Doppler sonography 3, 6, 12 and 24; Clinical examination	Included: diagnosis of fibroids confirmed by sonography and gynaecological examination 29 Abnormal bleeding 11 Bulk-related symptoms 5 Pelvic pain 2 Bleeding and pain 8 Bleeding and bulk 2 Bulk and pain 1 Bleeding, bulk and pain 55 Desire to maintain pelvic integrity; 3 Poor operative risk	Inpatient 57 bilateral 1 unilateral Embolizing materials 150-250 <i>um</i> polyvinyl alcohol particles and absorbable gelatin sponge Endpoint Stagnation of contrast medium in uterine capillary network and absence of uterine flow after contrast injection in hypogastric arteries Post-op care Discharged 2 days	Mean reduction in: fibroid and uterine volume; Changes in vascularity Symptom classification (direct questioning) Increased; Unchanged; Improved; Free of symptoms; Patients lost to follow up 58 3 months 46 6 months 36 12 months 19 24 months	Efficacy Mean volume reduction n Fibroid Uterus % % 3 month (58)* 29 17 1 patient Fibroid volume increased (+42%) 24 months 1 patient free of symptoms new fibroid 1cm ³ 3 months 55/58 absence of intrafibroid vessels 21/58 perfibroid vessels persisted No changes in uterine vascularization Symptom change at 3 months: Unchanged 10%; Improved 76% Complete resolution 14% Safety 1/46 hysterectomy 1/46 repeat UAE 24 months: 19/19 complete resolution

Study	Design/Patients/Participants	Inclusion/Exclusion	Procedure/materials	Outcome measures	Results
Vashisht 2000 ²⁴ UK Single-centre Date June 1997 January 1999 Funding: None declared	Case series Prospective Patients: 21 Mean age: 40 (29-52) Pre-UAE MRI Post-UAE MRI 2 and 6 months Postal questionnaire 3-12 months (mean 6 months)	Included: Diagnosis of fibroids confirmed by MRI Main symptom 13/21 heavy periods 7/21 abdominal distension 1/21 not reported	Not described	Laboratory Median reduction in: fibroid volume; Clinical Menorrhagia Outcomes Questionnaire ⁸¹ Patient satisfaction Would you recommend UAE to a friend?	Efficacy Mean reduction volume (mL) 2 months 6 months % % Fibroid 32.6 75.2 Mean hospital stay 2.9 days 14 patients* (66% response) 8/13 Improvement menorrhagia 61% 2/7 Improvement abdominal distension 28.5% 6 Better able – daily activities 2 Better sex life 6 Less tired 7 Better body image 7 Recovery slower than expected Safety n=3/21 19% 1/21 death septic shock/multiple organ failure 25 days post UAE; 2/21 emergency epidural analgesia; 1/21 readmitted opioid analgesia 6 weeks post UAE Patient satisfaction* 7/14 Definitely recommend to friend Results reported for 14 patients

Study	Design/Patients	Inclusion/Exclusion	Procedure/materials	Outcome measures	Results
Walker 2002 ²⁵ UK Single-centre two settings: NHS Trust and private hospital Date December 1996 February 2001 Funding: None declared	Case series Prospective Patients: 400 Mean age: 43.2 (20-50+) 81% Caucasian 12% Afro-Caribbean 7% Other ethnic origin 4 refused hysterectomy 1 poor operative risk 5 post menopausal 46/400 period-induced anaemia Pre-UAE Ultrasound and/or MRI Laboratory tests During Radiation exposure Post UAE 6, 12, months ongoing (mean 16.7) Ultrasound and/or MRI Laboratory tests Questionnaires and telephone contacts	Included: Gynaecological and radiological evaluation; Symptomatic fibroids either heavy menstrual bleeding or pressure symptoms, abdominal distension, bulk symptoms related to fibroids. Most common symptom abdominal bloating or swelling (98%) Mean 2.4 symptoms per patient Desire to maintain fertility discussed in light of symptoms and surgical options Excluded Infertility due to asymptomatic fibroids;	Inpatient 5 Unilateral 395 Bilateral Experienced Interventional Radiologist Embolizing material First 66 polyvinyl alcohol particles (PVA) 150-250 and 355-500 μ m dia. February 1998 thereafter PVA 355-500 μ m dia. Endpoint statis Post-op care: Discharge 1-2 days	Procedure and pain 3 level classification 1. Better than expected 2. As expected 3. Worse than expected Severity of pain 8 point scale from no pain to worse pain ever felt. Sympton improvement* 3-point scale: Improvement; Unchanged? Worsened *3 months Radiation dose Fluroscopy time Radiation dose Process recovery days: no pain resume usual activities resume work Numbers available to follow up UAE 400 Questionnaire 383 Responders >1 year 262 Responders >2 years 131	Efficacy 6-12 months : Volume reduction Uterine Fibroid Mean 55 [SD 18] 73 [SD 25] In 2 patients dominant fibroid volume increased (latest follow up for each woman) Symptom improvements 73%-90% 23 treatment failures by 12 months (5 adenomyosis) 3/23 repeat UAE; 9/23 hysterectomies 11/23 other surgical intervention Safety 3 Infective complications leading to hysterectomy; 9 Expulsion of fragments two weeks and two years; 5 Hysteroscopic removal of fragments; 13 Vaginal discharge regarded it a major irritant or very troublesome. 26 permanent amenorrhoea Radiation Mean fluoroscopy time 25.9 minutes and 44.6 minutes in women treated in one or two procedures respectively. Mean radiation dose 7954.4 and 14631.3 cGy cm ² Fluoroscopy time statistically correlated with experience of interventional radiologist Patient satisfaction latest follow up for each woman 97% satisfied with procedure and outcome; 97% would recommend UAE to others

Study	Design/Patients/Participants	Inclusion/Exclusion	Procedure/materials	Outcome measures	Results
Zupi 2003 ⁶¹ Italy Single-centre Date April 1999 February 2000 Funding: None declared	Case series Prospective Patients: 26 Mean age: 39.5 (32-54) Mean fibroid size 276.8 ± 241.2 (range 40.3 mL and 363.5 mL) Pre-UAE – Trans abdominal and transvaginal Doppler sonography Post-UAE Doppler sonography 1, 3 and 6 months MRI 12 months	Included: Single myoma or large myoma; Intramural location; Fertile age. Menorrhagia, pelvic pain and abdominal mass	Inpatient 26 bilateral 355-500 <i>um</i> dia. polyvinyl alcohol particles	Mean reduction in: uterine volume Symptom changes over time; Vascularization high, moderate, low. Radiation: Fluoroscopic time Ovarian dose Skin dose	Efficacy Mean reduction uterine volume 6 month 64% 12 months 83% Most reduction in fibroids with high vascularity Mean recovery 2.3 days Total regression of symptoms % 12/21 Menorrhagia 57 7/9 Pain 77 8/12 Urinary disturbance 66 18/18 Abdominal weight 100 Safety % 26 Pain 100 19 Fever 24–72 hours 73 15 Nausea 58 2 Expelled myoma debris 4 weeks post-UAE 8 Radiation Mean fluoroscopic time 20 minutes Ovarian dose 3.76-55.82 cGy(18.75 ± 13.78_cGy) Skin dose 54.66-767.11 cGy(126.71 ± 71.17 cGy) Other issues: experience of operator