ORIGINAL ARTICLE

Efficacy and Safety of Uterine Artery Embolization for Symptomatic Uterine Leiomyomata in Pakistan: A Single Centre Experience

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ABSTRACT

Background: Uterine fibroids are the most common pelvic tumors in women, often causing gynecological hemorrhage, lower abdominal pain, dysmenorrhea, and infertility. Uterine artery embolization (UAE) is a minimally invasive alternative to hysterectomy for the treatment of uterine leiomyomas.

Objective: This study aimed to assess the effectiveness of UAE in treating symptomatic uterine fibroids and reducing their size.

Methods: This was a retrospective study conducted on 67 patients who underwent uterine artery embolization for symptomatic fibroids at the Interventional Radiology department of Ziauddin University Hospital, Karachi, during the period from June 1, 2016, to June 1, 2021.

Results: A total of 67 patients underwent uterine artery embolization. Two patients were lost to follow-up, so the results of 65 patients were included. Post-procedure mean fibroid volume was found 436.83 + 287.113 ml while pre-procedure mean fibroid volume was 797.08 + 253.211 ml which indicates successful uterine artery embolization. Complete embolization of tortuous and dilated uterine arteries was achieved, resulting in a 100% technical success rate and resolution of symptoms. Clinical success was observed in 61 out of 67 patients (91%). However, two patients experienced an increase in fibroid size and volume due to a significantly enlarged, multifibroid uterus.

Conclusion: We concluded that selective uterine artery embolization is a safe and effective treatment for gynecological hemorrhage and should be integrated into the management protocol for symptomatic fibroids in females. Our findings suggest that submucosal leiomyomas respond more favorably to UAE.

Keywords: *Uterine fibroids, uterine artery embolization, fibroid volume, symptomatic fibroids.*

INTRODUCTION

Uterine fibroids are among the most common benign tumors, affecting approximately 40% of women under the age of 35 [1]. They pose a significant challenge to the healthcare system, as uterine fibroids account for 30% of the 600,000 hysterectomies performed annually in the United States [2]. In Pakistan, according to some studies, the incidence of uterine leiomyomata varies between 20-40% [3]. While many women with fibroids remain asymptomatic, some experience distressing symptoms [4], which can be categorized into four groups: abnormal bleeding (irregular or heavy menstrual flow), pain (affecting the back and pelvis), tumor-related effects (pressure on the bladder and intestines, leading to increased activity), and reduced fertility [5].

Fibroid treatment options commonly include hysterectomy, myomectomy, and hormone therapy, each with its benefits and limitations, including but not limited to anesthesia-related complications, postoperative bleeding, infection, and potential damage to surrounding structures [5].

Uterine fibroid embolization (UFE) is a minimally invasive treatment option for women with symptomatic fibroids. Large randomized controlled trials have demonstrated its effectiveness, comparable to surgical myomectomy and hysterectomy while offering the added benefits of a shorter hospital stay and eliminating the risks associated with surgery and anesthesia [6-9].

Since its recognition as a treatment for uterine fibroids in 1995, uterine artery embolization (UAE) has been widely utilized [10]. The procedure involves delivering specialized particles, such as polyvinyl alcohol or gelatin-coated polymer microspheres, into both uterine arteries to induce obstruction and ischemia within the fibroid while preserving the surrounding uterine tissue [11-13]. According to various studies, UAE has resulted in an improvement of menorrhagia in 85-95% of patients and a reduction in tumor-related pressure symptoms in 70-90% of cases [14].

Despite the growing demand for UAE, research on predictive factors influencing treatment response remains limited. Several variables, including the location, size, and number of leiomyomas, may impact post-procedural outcomes [15-17]. Magnetic resonance imaging (MRI) is the most accurate imaging technique for identifying leiomyomas and distinguishing them from conditions such as adenomyosis, solid ovarian tumors, and leiomyosarcomas [18]. Pre-procedural MRI is also valuable in assessing the likelihood of UAE success and potential adverse effects [19, 20].

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Since no formal guidelines exist for uterine artery embolization, gynecologists and interventional radiologists must establish clear indications and a structured treatment strategy to ensure a well-coordinated and effective approach [21].

This study seeks to evaluate the treatment response of uterine leiomyomas in UAE by examining various factors observed in pre- and post-procedure MRI scans.

METHODS

This was a retrospective study in which we reviewed medical records and MRI findings of patients with uterine fibroids who underwent UAE for the treatment of symptomatic fibroids from 1st June 2016 to 1st June, 2021 at Dr. Ziauddin University Hospital, Karachi. This study was approved by the Ethical Review Committee of Ziauddin University (Reference 10080425MARAD).

All patients with symptomatic uterine fibroids who underwent UAE during this period were included in the study. They were referred by gynecologists, and the procedures were conducted by an experienced interventional radiologist with over 10 years of expertise. Patient selection was performed according to the Society of Interventional Radiology Quality Improvement Guidelines for Uterine Artery Embolization for Symptomatic Leiomyomata, which included patients presenting with the following symptoms: heavy or prolonged menstrual bleeding, severe menstrual cramping, pelvic pressure, discomfort, excessive bloating or fullness, dyspareunia, urinary frequency, urgency, nocturia or retention secondary to proven enlarged leiomyomatous uterus, and hydronephrosis caused by enlarged uterus [22]. Patients with any other gynecologic pathologies of the pelvic cavity such as adenomyosis, or ovarian endometrial cysts, which were confirmed on MR imaging before the procedure, were excluded from our study. The location of the uterine fibroid was not considered to be a contraindication to the procedure.

Clinical and laboratory data, imaging details, provided care, and outcome metrics were extracted from hospital medical records. The collected parameters for each patient included age, marital status, presenting symptoms, hemorrhage severity, comorbid conditions, and MRI findings. Angiographic characteristics encompassed the type of anesthesia administered, catheters used for embolization, embolization technique, and the type of embolic agents employed. Additionally, post-procedural complications (excluding pain) and follow-up duration were recorded.

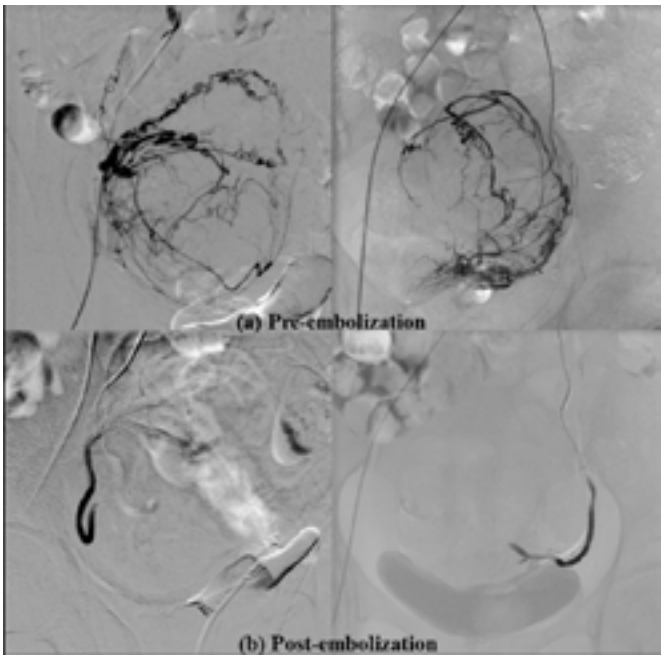

Fig. (1): a) Pre-embolization angiogram demonstrates dilated tortuous uterine arteries with large tumoral blush. **b)** Post-embolization angiogram shows complete exclusion of tumor blush.

Comorbid conditions such as cardiovascular disease, diabetes, renal disease, coagulopathies, and infections were assessed before UAE through a comprehensive gynecologic history, physical examination, endometrial sampling (if indicated), and imaging studies.

Following skin preparation of the right inguinal region, 10 ml of 2% lidocaine HCl was administered locally. The right femoral artery was punctured using an 18G angiocatheter needle, and a 6Fr arterial access sheath was placed. Both uterine arteries were accessed with 4Fr or 5Fr Cobra-type catheters (Cordis) and a 0.035-inch Terumo wire (Terumo), allowing for uterine angiography. In selected cases, a super-selective uterine arteriogram was performed using a 2.7Fr microcatheter (Progreat-Terumo), inserted coaxially through the macrocatheter. In some instances, embolization was conducted without the use of a microcatheter. The embolic materials utilized included polyvinyl alcohol particles (Boston Scientific), gel foam, and embosphere (Merit Medical).

Post-embolization pelvic angiography was performed, with the procedural endpoint being the occlusion of the peri-fibroid plexus while maintaining sluggish antegrade flow in the uterine arteries **(Fig. 1)**. Following the procedure, manual compression was applied to the puncture site while the patient remained in a supine position to achieve hemostasis. Post-procedure pain was managed by I/V medications, spinal anesthesia, and hypogastric plexus nerve block. None of the patients received general anesthesia.

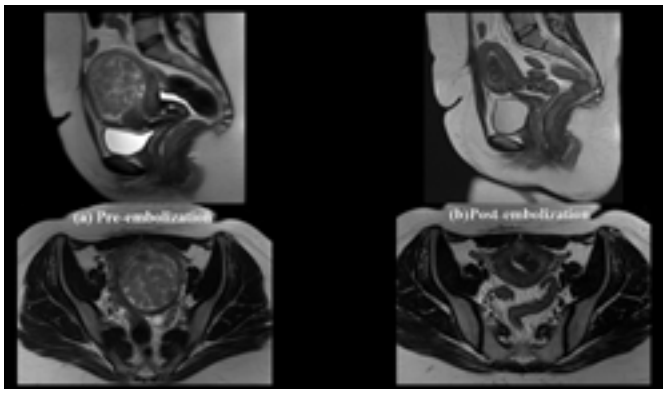

Fig. 2: a) Pre-embolization MRI demonstrates enlarged uterus with solitary submucosal cum intramural (FIGO-1) fibroid arising from left anterolateral wall causing distortion & displacement of the endometrium. **b)** On post-embolization MRI, there is almost 70% volume reduction of uterus & 90% volume reduction of fibroid.

Successful embolization is defined by the complete elimination of the tumoral blush. Technical success is determined by the cessation of bleeding observed in the post-embolization angiogram. Clinical success refers to the resolution of menorrhagia, lower abdomen symptoms & fibroid volume, number, and size reduction on follow-up MRI scan **(Fig. 2)**.

Data was entered into SPSS statistical software version 25.0. Mean and standard deviations were computed for quantitative variables. Frequencies and descriptive analysis of the variables were also measured. Normality of age, pre-procedure fibroid volume, and post-procedure fibroid volume were assessed using the Kolmogorov-Smirnov test, which showed p-values > 0.05, indicating a normal distribution. Descriptive statistics, including mean, standard deviation (SD), minimum, and maximum, were calculated for age, pre-procedure fibroid volume, and post-procedure fibroid volume. Frequencies and percentages were used to summarize categorical variables, including age groups, marital status, symptoms, number of fibroids, and fibroid location (FIGO (The International Federation of Gynecology and Obstetrics) classification).

A paired t-test was applied to compare pre-procedure and post-procedure fibroid volumes, with p-values <0.05 considered statistically significant. Stratification analysis was performed to assess the impact of age, marital status, symptoms, number of fibroids, and fibroid location on mean changes in fibroid volume using independent sample t-tests and one-way ANOVA, with Tukey's post-hoc analysis for pairwise comparisons between fibroid locations. Clinical and technical success rates were calculated based on defined criteria. All statistical tests were two-tailed, with significance set at p <0.05.

Table 1: Descriptive statistics for age, pre-procedure fibroid volume & post-procedure fibroid volume.

Variable	Minimum	Maximum	Mean + SD
Age (years)	24	53	34.14 + 7.132
Pre-procedure Fibroid Volume (ml)	220	1500	797.08 + 253.211
Post-procedure Fibroid Volume (ml)	22	1500	436.83 + 287.113

RESULTS

From 1st June 2016 to 1st June 2021, a total of n=67 patients underwent UAE for symptomatic uterine fibroids at our institution. All patients underwent therapeutic transcatheter uterine artery embolization. Two patients were lost to follow-up, so the results of 65 patients were included. To assess the normality of distribution for age, pre-procedure fibroid volume, and post-procedure fibroid volume, the Kolmogorov-Smirnov test was applied and found P-values greater than 0.05. So, the data follows a normal distribution. A total of n=22 patients (33%) had decreased Hb on pre-procedural labs, for which they had to undergo packed red blood cell transfusion. Those patients who had Hb <8 gm/dl, were transfused, stabilized & then proceeded with the procedure. The mean age of the participants was 34.14 + 7.132 years. Pre-procedure mean fibroid volume was found to be 797.08 + 253.211 ml while post-procedure mean fibroid volume was 436.83 + 287.113 ml **(Table 1)**. There were no major post-procedure complications, and none of the patients had

Table 2: Descriptive statistics for marital status, symptoms, no. of fibroids & location.

Variable	Frequency (%)
Age (years)	
24-30	22 (33.8%)
31-53	43 (66.2%)
Marital Status	
Married	46 (70.8%)
Un-married	19 (29.2%)
Symptoms	
Dysmenorrhea	5 (7.7%)
Infertility	3 (4.6%)
Lower abdominal pain	19 (29.2%)
Menorrhagia	38 (58.5%)
No. of Fibroids	
Single	39 (60%)
Multiple	26 (40%)
Location (FIGO Classification)	
0	7 (10.8%)
I	16 (24.6%)
II	8 (12.3%)
III	16 (24.6%)
IV	10 (15.4%)
V	4 (6.2%)
VI	4 (6.2%)

Table 3: Comparison of pre-procedure and post-procedure fibroid volume.

Variable	N	Mean + SD	p-value
Pre-procedure Fibroid Volume (ml)	65	797.08 + 253.211	<0.001
Post-procedure Fibroid Volume (ml)	65	436.83 + 287.113	

repeat procedures. The average hospital stay was 1.5-2.5 days depending upon post embolization pain.

In this study, out of n=65 patients, n=22 (33.8%) lie in the age group 24-30 years while n=43 (66.2%) patients lie in the age group 31-53 years. N=46 (70.8%) were married while n=19 (29.2%) were unmarried. In relevance to symptoms, dysmenorrhea was found in n=5 (7.7%), infertility found in n=3 (4.6%), lower abdominal pain found in n=19 (29.2%) while heavy menstrual bleeding was found in n=38 (58.5%) of participants. N=39 (60%) patients had single fibroids while n=26 (40%) had multiple fibroids. In relevance to location, FIGO classification was assessed; n=7 (10.8%) for 0, n=16 (24.6%) for I, n=8 (12.3%) for II, n=16 (24.6%) for III, n=10 (15.4%) for IV, n=4 (6.2%) for V and n=4 (6.2%) for VI **(Table 2)**.

A paired samples t-test showed that the patients' mean fibroid volume on MRI significantly decreased from pre-procedure values of 797 +/- 253.211 ml to post-procedure values of 436.83 +/- 287.113 ml (P-value <0.05), indicative of a successful uterine artery embolization **(Table 3)**.

Stratification was done to assess the effect of age, marital status, symptoms, no. of fibroids, and location on mean change in fibroid volume. An independent samples t-test was applied to determine the association between a decrease in mean fibroid volume and the number of fibroids, which was significant (P-value = 0.008). ANOVA was applied to determine the association between a decrease in mean fibroid volume and the location of uterine fibroids (as per FIGO classification) which was also significant (P-value <0.001) There was no significant association between age, marital status, and symptoms **(Table 4)**.

Table 4: Stratification of mean change in fibroid volume concerning age, marital status, symptoms, no. of fibroids, and location.

Variables	N	Mean + SD	p-value
Age			
24-30 years	22	381.3182 + 119.57	0.4727
31-53 years	43	349.4654 + 187.85	
Marital status			
Married	46	383.1739 + 159.41	0.086
Un-married	19	304.7368 + 178.09	
Symptoms			
Dysmenorrhea	5	328.80 + 244.39	0.515
Infertility	3	321.6667 + 28.87	
Lower abdominal pain	19	408.9474 + 235.62	
Menorrhagia	38	343.0789 + 115.26	
No. of Fibroids			
Single	39	404.6667 + 178.33	0.008
Multiple	26	293.6154 + 125.89	
Location			
0	7	437.8571 + 208.43	< 0.001
I	16	493.5 + 149.49	
II	8	386.875 + 58.62	
III	16	317.3125 + 86.09	
IV	10	333.5 + 66.73	
V	4	269.5 + 30.14	
VI	4	-32.5 + 39.47	

Since the mean change in fibroid volume was found to be significantly different concerning location, multiple comparisons for different FIGO classifications were done by using post hoc Tukey's test. The results found significant differences between (0 & VI), (I & III), (I & IV), (I & V), (I & VI), (II & VI), (III& VI), (IV & VI) and (V & VI) as shown in Table **5**.

Clinical success was defined by symptom resolution and a reduction in fibroid number, size, and volume on the six-month follow-up MRI after the initial uterine artery

Table 5: Tukey's post-hoc analysis for location.

Multiple Comparisons	Mean Difference	Standard Error	p-value
0 & I	-55.64	52.50	0.937
0 & II	50.98	59.96	0.978
0 & III	120.54	52.50	0.264
0 & IV	104.36	57.09	0.535
0 & V	168.36	72.62	0.253
0 & VI	470.36	72.62	< 0.001
I & II	106.62	50.17	0.352
I & III	176.19	40.96	0.001
I & IV	160	46.71	0.018
I & V	224	64.77	0.017
I & VI	526	64.77	< 0.001
II & III	69.56	50.17	0.807
II & IV	53.37	54.95	0.958
II & V	117.37	70.95	0.648
II & VI	419.37	70.95	< 0.001
III & IV	-16.19	46.71	> 0.999
III & V	47.81	64.77	0.990
III & VI	349.81	64.77	< 0.001
IV & V	64	68.55	0.965
IV & VI	366	68.55	< 0.001
V & VI	302	81.93	0.009

embolization, with no need for additional embolization or surgery. Symptoms improved within 24 to 48 hours, with clinical success being reported in n=61 patients (91%).

Technical success was defined as the cessation of bleeding observed in the post-embolization angiogram. Embolization was successfully performed in all patients, resulting in a 100% technical success rate.

DISCUSSION

Uterine artery embolization (UAE) is a minimally invasive procedure designed to relieve symptoms caused by symptomatic uterine fibroids. It also serves as a highly effective uterine-preserving treatment for patients who wish to preserve their uterus [23].

In our study from 1st June 2016 to 1st June 2021, 67 eligible patients with symptomatic fibroids were studied and intervened. Complete embolization of tortuous and dilated uterine arteries was achieved, resulting in 100% technical success and symptom resolution. Clinical success was observed in 61 out of 67 patients (91%). However, two patients experienced an increase in fibroid size and volume post-embolization due to a significantly enlarged, multi-fibroid uterus. Additionally, two patients in Class C did not respond to treatment. Two patients were lost to follow-up, one of whom had an atypical fibroid; embolization was initially declined, but due to comorbid conditions, hysterectomy was not a viable option. She had perfused menorrhagia with HB of 4 g/L. Hence UAE was performed. Later on, the patient lost to follow-up then after one year she presented with sarcomatous transformation.

Several studies have examined the impact of uterine artery embolization on the treatment process. Katsumori *et al.* studied 60 cases [20], Marshburn *et al.* examined 62 individuals [24] and Motamedfar *et al.* [25] analyzed 80 patients. Based on these findings, the sample size in our research appears to be within a reasonable and acceptable range.

Zhou *et al.* found that fibroid location significantly impacts volume reduction, with tumors in intramural and submucosal regions demonstrating better post-treatment outcomes—findings that align with our study [26]. Similarly, Spies *et al.* reported that fibroid positioning within the uterine wall influences treatment efficacy, with submucosal fibroids exhibiting a greater tendency for volume shrinkage, supporting the observations in our study [15].

Firouznia *et al.* reported no significant association between fibroid location and volume reduction, a finding that contrasts with the results of our study [14].

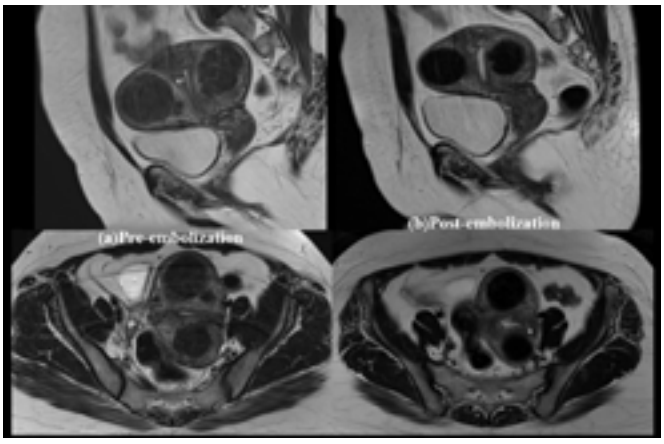

Fig. 3: a) Pre-embolization MRI demonstrates enlarged multifibroid uterus with larger subserosal cum intramural fibroids are seen along anterior (FIGO-IV) and posterior wall (FIGO-V) of the uterus causing mild displacement of the endometrium. **b)** On post-embolization MRI, there is almost 30% of FIGO-IV and 50% of FIGO-V volume reduction achieved.

A large uterine volume before UAE is considered a poor prognostic factor, as it requires embolic particles to be distributed across a larger area [19]. This finding aligns with our study, which demonstrated that a smaller total number of leiomyomas and a lower cumulative diameter were associated with a more favorable response to UAE.

Magnetic resonance imaging (MRI) is regarded as the most precise modality for detecting and localizing fibroids [27]. Due to its ability to distinctly visualize individual tumors, MRI demonstrates greater sensitivity than ultrasound (US) in fibroid detection [28]. The restricted field of view in transabdominal and transvaginal US often hinders comprehensive uterine assessment. In contrast, MRI's superior soft-tissue contrast provides detailed visualization of uterine zonal anatomy, allowing accurate classification of fibroids as submucosal, intramural, or subserosal **(Fig. 3)** [27]. Additionally, MRI has proven to be more reliable than US or hysterosalpingography in identifying fibroids in infertile women before myomectomy [28].

MRI is used for patient selection, planning, and documenting baseline appearances in terms of location, size, and appearance of fibroid before uterine artery embolization (UAE) as well as ensuring that uterine findings do not represent other pathology. Additionally, MRI is also useful following UAE, where it is used to assess post-embolization outcome in terms of fibroid size, liquefaction / necrosis pattern & change in location of fibroid and complications.

This study evaluated various pre-procedure MRI factors to predict the treatment response of uterine leiomyomas following UAE. The findings indicated that submucosal leiomyomas demonstrated a superior

response to UAE [29], and patients with a lower total number of leiomyomas and smaller cumulative leiomyoma diameters experienced better post-treatment outcomes. These results align with previous studies, which also found that submucosal leiomyomas respond more favorably to UAE. The underlying reason for this phenomenon lies in the vascular distribution within the myometrium. The radial arteries, which are primary branches of the intramural uterine artery, supply increased blood flow to the central two-thirds of the myometrium, including the endometrium. Consequently, UAE proves to be more effective in treating submucosal leiomyomas compared to intramural or subserosal leiomyomas [30].

The type of embolic material includes PVA particles, gel foam & atmospheres. A combination of PVA & gel foam was used in used in 41 patients (61%). PVA particles were used in isolation in 22 patients (33%). Embospheres were used in 4 patients (6%). Independent gelfoam as an embolic agent was not used.

We also mentioned catheters used for angiography. In 50 patients (75%) microcatheter was used, whereas in 17 patients (25%) angiography was performed with 4Fr catheter. 5Fr & 4Fr Cobra (C1) catheters were used. In addition to C1, the Simmons (SIM 2) catheter was used in 3 patients due to difficulty in engaging the ipsilateral uterine artery considering the sharp angulation of vessels.

Complications have been infrequent and can generally be classified into six categories: angiographic complications, radiation injury, ischemic events, pelvic infection, pulmonary embolism, and adverse drug reactions. Angiographic complications reported include groin hematoma, contrast-related reactions or nephrotoxicity, rupture of a vesical artery branch, and uterine artery dissection during catheterization [31]. These post-procedure complications were not observed in our study.

Cramping or pelvic pain is a frequent postprocedural symptom and can be severe enough to require hospital admission. A possible late complication is the transvaginal passage of tissue [32, 33]. In certain cases, an emergent dilation and curettage along with antibiotic therapy may be necessary. This risk is particularly relevant for FIGO 0-1 lesions. One of our patients in this classification experienced transvaginal fibroid expulsion and required hospital admission for dilation and curettage.

There have been transient and permanent amenorrhea reported after UAE. Amenorrhea occurs in 2%-5% of women after UAE, with permanent amenorrhea seen in less than 2%, generally among patients of perimenopausal age [32-35]. Ovarian failure (suspected to be secondary to nontarget embolization of the ovaries) and/or endometrial atrophy both can cause amenorrhea. In our study, targeted UAE was done by selective cannulation of uterine arteries.

We, and others [36, 37] did not identify any change in menstrual cycles or gynecological symptoms after UAE.

This study found no long-term effects of common gynecological symptoms or sexual functions, confirming the safety of uterine artery embolization [36].

The discrepancy between the outcomes of this study and previously reported results from retrospective studies and randomized controlled trials could be explained by a number of variables. To begin with, many studies included fewer patients with uterine volumes greater than 1000 cm3, and some researchers eliminated patients with > 1000 cm3 from studies [6, 38].

Our study had some limitations; including the fact that follow-up of patients was up to 6 months post-procedure. Secondly series of patients were enrolled from a single institution. Despite these limitations, the study was carried out in a single institution where the procedure was carried out by an experienced interventional radiologist. In the future, a larger sample size can be used to generalize the results at the multi-institutional level.

CONCLUSION

Conclusively, uterine artery embolization (UAE) is a highly effective and relatively safe treatment for symptomatic uterine fibroids, demonstrating excellent technical and clinical success rates. It should be considered as an alternative for patients who wish to avoid surgery while preserving their uterus.

The results of this study ascertain that UAE is an effective and appropriate procedure for the treatment of uterine fibroids. Particularly sub-mucosal fibroid has a very good response followed by sub-serosal fibroids.

MRI is an ideal modality for pre-treatment assessment and follow-up of uterine artery embolization patients.

ETHICS APPROVAL

This study was approved by the Ethical Review Committee of Ziauddin University (Reference no. 10080425MARAD). All procedures performed in studies involving human participants followed the ethical standards of the institutional and/ or national research committee and the Helsinki Declaration.

CONSENT FOR PUBLICATION

Not applicable.

AVAILABILITY OF DATA

The datasets generated and analyzed during the study are available from the corresponding author upon reasonable request and institutional approval.

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None.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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Declared none.

AUTHORS' CONTRIBUTION

Ali M: Drafting the article, revising the article, final approval

Gul R: Conception and design of study, acquisition of data, analysis, interpretation of data, drafting the article

Hussain A: Analysis and interpretation of data, drafting the article, revising the article, final approval

Swaleh FS: Drafting the article, revising the article, final approval

Siddiqui H: Analysis and interpretation of data, drafting the article, revising the article

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