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Original Research

The Outcomes of Interventional Radiology in Obstetrics and Gynecology at a University Hospital-A 10-year overview

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Abstract:

Objectives: This study aimed to assess the outcomes of interventional radiology (IR) in obstetrics and gynecology patients.

Material and methods: A retrospective cohort study was conducted between 1st of January 2010 to 31st of December 2019 among women (≥ 18 years old) who had a radiological intervention for an obstetrical or gynecological reason.

Results: Out of the 50 pregnant women, 11 (22%) underwent uterine arteries embolization (UAE), 36 (72%) underwent prophylactic internal iliac arteries (IIA) balloon occlusion, one (2%) underwent inferior vena cava (IVC) filter and two (4%) underwent renal biopsies. The success rate of UAE procedures was 100% and there were no further procedures. The success rate of IIA balloon occlusion was 50%, nine (25%) patients needed an emergency hysterectomy, and one (2.8%) patient required another embolization procedure. The success rate of IVC filter and renal biopsies was 100% with no need for further management. A total of 35 women with gynecological conditions were included in the study. The indications for IR were 29 (83%) for uterine fibroids, two (6%) for ovarian mass biopsies and one (3%) case each for ectopic pregnancy, vaginal varicocele, pelvic pseudoaneurysm and uterine leiomyosarcoma. The most common intervention was UAE, 77% (n=27). The overall success rate for all procedures was 80% (n=28). There were Seven (20%) cases that required further alternative intervention which were medical or surgical interventions.

Conclusion: This study showed a high success rate of the interventional radiological procedures with minor complications noted. This study built the base for further prospective multicenter studies.

Keywords: Radiology, interventional, obstetrics, gynecology, complications, uterine artery embolization

Introduction:

Interventional radiology (IR) is a new field of medicine that uses imaging techniques to diagnose and perform a variety of medical procedures that aid in treating various conditions. It is relatively recent, innovative branch of medicine that facilitates the management with minimally invasive approaches for treatment of various presentations in obstetrics and gynecology such as uterine fibroids (UF), ectopic pregnancies and other conditions, without the need for surgical intervention and therefore reducing surgery and anesthesia related complications. It also facilitates the management of many obstetrical conditions during pregnancy and postpartum period such as placenta accreta spectrum (PAS), placenta previa major, postpartum hemorrhage (PPH), pulmonary embolism or deep vein thrombosis [1].

Some of the approaches in obstetrics and gynecology cases are uterine artery embolization (UAE), internal iliac artery balloon catheter placements, CT or ultrasound guided biopsies or aspirations, radiofrequency ablations, endometrial ablations, and others. Introducing interventional radiological approaches have reduced hospitalization time, reduced the time needed to get back to work and preserved the uterus thereby sparing fertility [2].

Various interventional radiological techniques can be performed under local anesthesia or sedation. One such common technique is done by insertion of a small catheter with a balloon or temporary embolic agents (e.g., The Gel foam) into the pelvic arteries under fluoroscope guidance or other imaging types to minimize bleeding either prophylactically before delivery or for management of postpartum hemorrhage [1].

In 2017, there were 295,000 maternal deaths worldwide by a rate of 211 deaths per 100,000 deliveries, mainly in developing countries. Postpartum hemorrhage is the most common cause of maternal death worldwide [3]. Women with abnormal placentation have a high risk of developing postpartum hemorrhage [4]. Postpartum hemorrhage (PPH) is described as excessive bleeding of more than 500 ml after vaginal delivery or more than 1000 ml after cesarean delivery [5]. The main role of interventional radiology here is to decrease the flow of blood to the pelvic arteries. It can be done by prophylactic balloon occlusion of the internal iliac arteries in pregnant women with a high risk for developing PPH after delivery or by uterine arteries embolization with special occluding agents to treat postpartum hemorrhage [6]. A previous study conducted in London concluded that the insertion of prophylactic internal iliac occlusion balloon catheters led to reducing the risk of hysterectomy and postpartum hemorrhage after caesarean delivery for morbidly adherent placenta [7]. Another study from France found that immediate uterine artery embolization after cesarean delivery of women with placenta accrete spectrum can be used as a conservative treatment [8].

Inferior vena cava filter is usually placed for women at high risk for developing pulmonary embolism from a deep vein thrombosis as a prophylactic method. The most common indication when anti-coagulation drugs are contraindicated or in postpartum women with active bleeding [9].

Uterine artery embolization (UAE) is a minimally invasive, image guided procedure that aims to occlude the uterine artery by injecting embolic agents such as polyvinyl alcohol to block blood supply to the uterus. UAE is done by inserting a catheter up the femoral artery to the uterine artery under imaging guidance. Historically, the procedure was done to reduce pelvic bleeding. Nowadays it is also used to treat uterine fibroids [2]. UAE has shown a success rate of 82% to 92% in the treatment of uterine fibroids [10]. The incidence of UF in women at reproductive ages is 20% to 40% [2]. Also, UF are found in almost 60% of women older than 40 [11]. The common symptoms associated with UF include heavy menstrual bleeding and abdominal pain [12].

A study done in Canada on more than 500 patients found that after 3 months of UAE there was 42% mean reduction in the size of the UF and 35% in uterine volume. Seventy-seven to eighty-six percent of the patients had improvement in their symptoms. However, within 1.5 to 5 years there

were 20% - 30% of patients requiring surgery [13]. Regarding fertility and chance of having live births, a Cochrane review of 26 women who tried conceiving after UAE showed a pregnancy rate of 50%, delivery rate of 19% and miscarriage rate of 53% [2].

In terms of cost and efficiency, O'Sullivan *et al.* study have found that UAE is more cost-effective than hysterectomy. The study compared different strategies and procedures to treat UF in terms of cost-effectiveness. The study also considered magnetic resonance guided focused ultrasound fits in the range of cost-effective modalities [14].

Other minimally invasive procedures used in treatment of gynecological conditions are using transabdominal or transvaginal ultrasound drainage of pelvic abscess. In the study of Ching and Sumkin, they found 100% clinical success using this procedure for drainage of pelvic abscess [15].

Interventional radiological procedures have a high success rate limiting the need for a second treatment. However, few patients may require another treatment like a hysterectomy due to failed procedure. IR can lead to some complications such as those related to embolotherapy or ischemic complications. [4] There is still some sort of concern about its effectiveness and safety. The study aimed to identify the outcomes of interventional radiology (indications, efficacy, complications, and any further alternative interventions) in obstetrics and gynecology at a tertiary hospital in Oman.

Material and methods:

This is a retrospective cohort study conducted at a tertiary care hospital, based in Muscat, Oman. The study period included patients between 1st of January 2010 to 31st of December 2019. Ethical approval was obtained from the Medical Research Ethics Committee at the College of Medicine and Health Sciences.

The data was collected using the electronic patient record (EPR) from the Hospital Information System (HIS), known as the, 'TrakCare' system. The study included all women (≥ 18 years old) who were seen and assessed by the obstetrics and gynecology teams and had a radiological intervention for treating obstetrics and gynecology condition(s). This study also included all obstetrical patients including those with full term pregnancy, post-partum women, women who underwent ultra-sound guided biopsies for liver, kidney, breast and lymph nodes and all pregnant women with placental pathologies.

The study assessed primarily the indications, outcomes and complications caused by the radiological intervention. The radiological interventions included were uterine artery embolization, CT or ultrasound guided biopsies or aspirations ultra-sound guided biopsies for ovarian masses, bilateral internal iliac artery balloon occlusion and embolization of pseudoaneurysm, pelvic vein and internal pudendal artery.

The outcomes studied included the type of intervention, success rate of the procedure, duration of hospitalization and alternative interventions required. Complications that arise after the procedure such as thromboembolic events, infection, hematoma and post embolization syndrome were also considered. For long term outcomes, the efficacy of the procedure was assessed by evaluating the pregnancy rate after the procedure and its outcome.

UAE, balloon catheterization, and internal iliac artery, and venous branches embolization were considered successful if no other alternative intervention was required either being surgical or medical. Ultrasound guided biopsies were considered successful if the biopsy taken for histopathological examination was sufficient for diagnosis. Balloon Catheterization done prior to myomectomy was considered successful if the blood loss during the surgery was less than 1000 mL. For prophylactic Internal iliac arteries Balloon occlusion procedures: If the estimated blood loss after delivery was < 2500 mL if there was no need for further intervention (e.g., emergency hysterectomy or another embolization procedure) to stop postpartum hemorrhage.

The data analysis was performed using Statistical Package for Social Sciences (SPSS) software version 25. Descriptive statistics were used to describe the frequencies, percentages and mean of

the data collected. Continuous data such as age and body mass index (BMI), mean and standard deviation was calculated. Overall success rate of procedures, alternative interventions, complications were presented as frequencies and percentages. Cross tabs were used to display the success rate of each type of intervention.

Results:

IR in Obstetric Patients:

Patient Demographics:

In this study, a total of 50 patients were analyzed. The mean age was 32.34 (SD±4.77) years ranging from 25 to 42 years old. The mean gravidity and parity were 3.39 (SD±2.63) and 1.22 (SD±1.65) respectively. Thirty-five (70%) had previous history of cesarean section. Most of women delivered by cesarean section (n=47, 94%) and the mean estimated blood loss after delivery was 2156.86 (SD±1654.84) mL. Table 1.

Table 1: Patient Demographics. Total No.= 50

Demographic	Mean ± SD (Range)
Age (years)	32.34 ± 4.77 (25-42)
Gravidity	3.39 ± 2.63 (1-7)
Parity	1.22 ± 1.65 (0-6)
Estimated blood loss (mL)	2156.86 ± 1654.84 (400-5000)
Duration of hospital stay (days)	7.27 ± 5.95 (0-23)

Indications and radiological intervention
Among the studied population, 17 (34%) of them underwent IR for primary postpartum hemorrhage, three (6%) for secondary postpartum hemorrhage, 17 (34%) for placenta accreta spectrum, 10 (20%) for placenta previa major, one (2%) for pulmonary embolism and two (4%) for renal lesion.

Most patients (n=36, 72%) underwent prophylactic internal iliac arteries balloon occlusion, 11(22%) patients underwent uterine arteries embolization to control postpartum hemorrhage, two (4%) patients had renal biopsy and one (2%) underwent insertion of inferior vena cava filter.

The success rate of the interventional radiological procedures:

All the 11 (100%) procedures of uterine arteries embolization were successful and there were no failed procedures. Among the 36 procedures of internal iliac arteries balloon occlusion, half of the procedures were successful, n=18 (50%). The insertion of the inferior vena cava filter in the single patient and the two procedures of renal biopsies were all successful (100%)

The complications of the interventional radiological procedure:

Among the 50 cases, 46 (92%) of IR procedures ended with no complications, three (6%) were complicated with hematoma and only one (2%) was complicated by post embolization syndrome.

The need for further management after performance of the interventional radiological procedures:

Among the 11 patients who underwent uterine arteries embolization, two (18.2%) did not need any further management after performance of IR, six (54.5%) needed blood transfusion, two (18.5%) needed Bakri balloon with blood transfusion and one (9.1%) required evacuation of hematometra. Among the 36 patients who underwent internal iliac arteries balloon occlusion, nine (25%) did not need any further management, 12 (33.3%) needed blood transfusion, five (13.9%) needed planned total/ subtotal hysterectomy with blood transfusion, nine (25%) required emergency hysterectomy with blood transfusion and one (2.8%) needed another embolization procedure with blood transfusion after delivery. The one patient who underwent inferior vena cava filter to prevent pulmonary embolism and the two patients who underwent renal biopsies did not need any further management (Table2).

Table 2: The need for further management after performance of the interventional radiological procedures

	Uterine arteries embolization (11 patients)	Internal iliac arteries Balloon catheterization (36 patients)	Inferior Vena Cava filter (1 patient)	Renal biopsies (2 patients)	Total (50 patients)
No further management needed	2 (18.2%)	9 (25%)	1 (100%)	2 (100%)	14 (28%)
Blood transfusion	6 (54.5%)	12 (33.3%)	0 (0%)	0 (0%)	18 (36%)
Bakri balloon + blood transfusion	2 (18.5%)	0 (0%)	0 (0%)	0 (0%)	2 (4%)
Evacuation of hematometra	1 (9.1%)	0 (0%)	0 (0%)	0 (0%)	1 (2%)
Planned total/subtotal hysterectomy + blood transfusion	0 (0%)	5 (13.9%)	0 (0%)	0 (0%)	5 (10%)
Emergent Total/subtotal Hysterectomy + blood transfusion	0 (0%)	9 (25%)	0 (0%)	0 (%)	9 (18%)
Another embolization + blood transfusion	0 (0%)	1 (2.8%)	0 (0%)	0 (0%)	1 (2%)

IR in Gynecology Patients:

Patient Demographics:

Total of 35 women were included in this study. The mean age was 38.69 (SD±6.68) years ranging from 27 to 50 years old. The mean gravidity and parity were 2.97 (SD±3.23) and 2.54 (SD±2.80) respectively. The mean BMI of the women was 28.71 kg/m^2. Majority of the women (n=33) (94%) were in the pre-menopausal state, while only two (6%) women were post-menopausal at the time of the radiological intervention. Four (11%) women had a radiological intervention in the past. (Table 3)

Table 3: Patient Demographics. Total No.= 35

Demographic		**Mean ± SD (Range) or No. (%)**
Age (years)		38.69 ± 6.68 (27-50)
Gravidity		2.97 ± 3.23 (0-11)
Parity		2.54 ± 2.84 (0-10)
Body Mass Index (kg/m^2)		28.71 ± 7.07 (12.73-46.47)
Menopause	**Pre**	33 (94)
	Post	2 (6)
Previous Surgery		23 (66)
Previous Radiological Intervention		4 (11)

Indications and Radiological interventions:

The most common gynecological condition that required radiological intervention in SQUH was uterine fibroids in 29 (83%) women. There were two (6%) ovarian mass biopsies and one case each for ectopic pregnancy, vaginal varicocele, pelvic pseudoaneurysm and uterine leiomyosarcoma (3% for each).

Majority of radiological interventions done were UAE in 27 (77%) women, followed by three (9%) bilateral internal iliac artery occlusion, two (5.7%) US guided biopsies and one (3%) each for pseudoaneurysm embolization, pelvic vein embolization and internal pudendal artery embolization.

Outcome of the interventions

The overall success rate for the procedures was 80% (28/35). Table 4 shows the success rate for each type of radiological intervention that was performed in this study.

Table 4: Success of each type of intervention

		Procedure Successful (n)		**Total**
		Yes	**No**	
Type of Intervention	**Uterine Artery Embolization** % within type of intervention	**21** 78%	**6** 22%	**27** 100%
	Pseudoaneurysm embolization % within type of intervention	**1** 100%	**0**	**1** 100.0%
	Pelvic vein embolization % within type of intervention	**1** 100%	**0**	**1** 100%
	Internal Pudendal artery embolization % within type of intervention	**1** 100%	**0**	**1** 100%
	Bilateral internal iliac artery balloon occlusion % within type of intervention	**2** 67%	**1** 33%	**3** 100%
	US guided biopsy % within type of intervention	**2** 100%	**0**	**2** 100%
Total		**28** 80%	**7** 20%	**35** 100%

As shown in the table 2, 21 (78%) UAE procedures were successful as they didn't require any other alternative procedure, and six (22%) required an alternative procedure after the UAE to control the bleeding from UF. All other three embolization of the arteries and vein were successful. From the three bilateral internal iliac artery balloon occlusion, two (67%) didn't require any further alternative intervention and one (33%) case required further intervention. The two US guided biopsies for the ovarian masses were sufficient for histopathological diagnosis, thus the two procedures were successful.

Out of the 35 cases, seven (20%) required further alternative intervention. The type of alternative interventions included one hysterectomy, three myomectomies, two had Gonadotropin Releasing Hormone Analogues and one had Ulipristal.

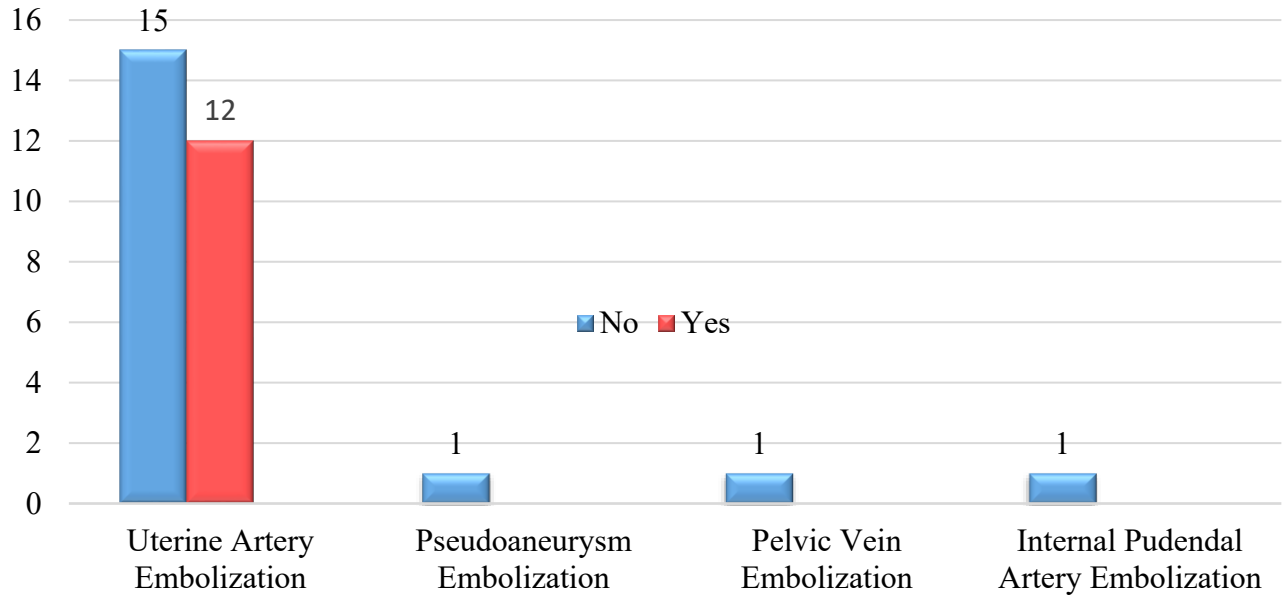
Long-term outcomes of fertility:

The long-term fertility outcomes of the studied sample have shown that five patients had successful pregnancies after the intervention resulting in three live births and two miscarriages. It is important to note that some of the patients had already completed their family at the time of procedure, few women remain unmarried and two out of the sample studied were lost to follow up. Also, from the total sample studied (35) there were four cases who were known to have infertility problems prior to the radiological intervention.

Complications from the intervention

Regarding the complications after the radiological intervention, none of the cases resulted in a hematoma, infection or thromboembolic event post intervention. However, around 40% (12 out of 30) of patients underwent embolization intervention experienced post embolization syndrome. All 12 cases had a uterine artery embolization. (Figure 1)

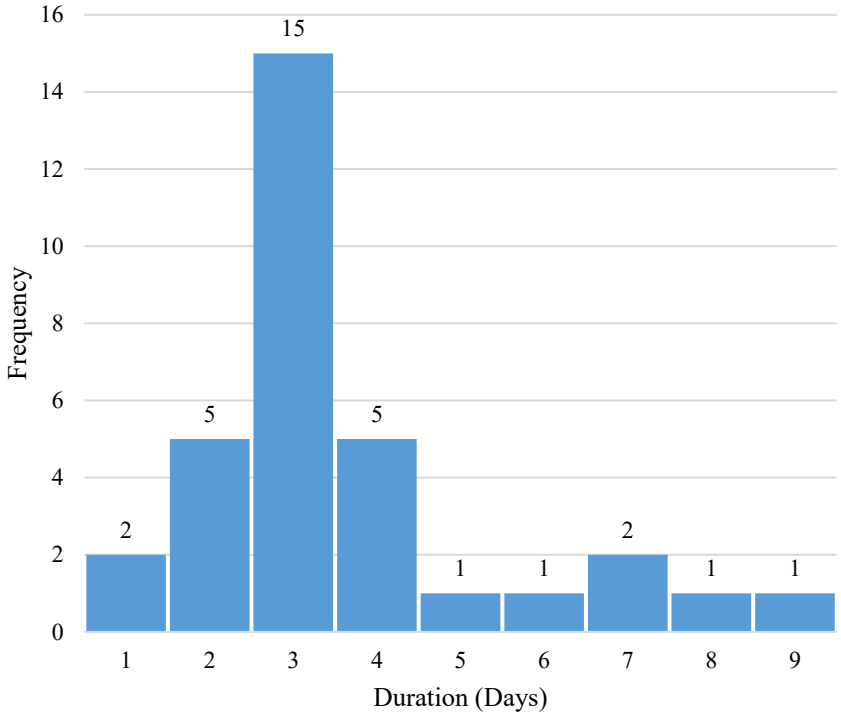
Figure 1: The prevalence of post embolization syndrome in embolization intervention



Hospitalization duration

The mean hospitalization duration was 3.61 (SD±1.87) days. It is important to note that when calculating the mean, hospitalization duration prior to the intervention was also taken into consideration. The stay at hospital ranged from one day to maximum of nine days. There were two missing patients' data due to loss to follow up. Figure 2 shows a histogram of the hospitalization duration of the sample studied.

Figure 2: Histogram of hospitalization duration for patients underwent radiological intervention for gynecological conditions at SQUH



Discussion:

To begin with obstetric arm, the most common indication for IR was obstetric hemorrhage with placental abnormalities accounting as the most common cause probably because of increasing cesarean section rates and our university hospital being the referral hospital as well.

Among the 50 patients in this study, we found that most patients underwent prophylactic internal iliac arteries balloon occlusion followed by uterine arteries embolization to control postpartum hemorrhage. Our study showed 100% success rate for UAE procedures. This high success rate can be attributed to the fact that the UAE procedures are done only in hemodynamically stable patients in contrast to unstable and serious patients who directly undergo emergency surgical intervention. This high success rate in our study is consistent with 96% success rate of UAE procedures performed in 121 patients in a previous Iranian study [16]. On the other hand, our study found that the internal iliac arteries balloon occlusion procedures were successful in only 50% of patients. So, the effectiveness of the procedure was controversial. A previous published systemic review concluded that the use of internal iliac arteries balloon catheters to prevent postpartum hemorrhage in women with placenta previa or placenta accrete spectrum was effective reducing intraoperative blood loss, and hysterectomy rates [17]. Our low successful rate could be explained by the small numbers.

The results of our study showed the importance of using uterine artery embolization as a conservative treatment for both primary and secondary postpartum hemorrhage. It can be considered as a first line treatment instead of hysterectomy in hemodynamically stable women to preserve the uterus and fertility. On the other hand, our study showed that the prophylactic internal iliac artery balloon occlusion procedures were effective in half the number of the cases and ineffective in the other half. However, they could potentially reduce the need for emergency hysterectomy after delivery among most pregnant women with high risk for developing postpartum hemorrhage after delivery due to placental adhesive disorders, uterine atony and uterine or cervical fibroids as 75% of women in our study did not require emergency hysterectomy after delivery.

Our study also assessed the need for further management after the performance of the

interventional radiological procedures in obstetrical patients. For the 11 cases of uterine arteries embolization, about half of the patients needed blood transfusion and there was no need for emergency hysterectomy to stop bleeding in all cases meaning that the UAE procedures succeeded in replacing the conventional hysterectomy in controlling postpartum hemorrhage. This agrees with previous published studies [18,19].

In the remaining 36 patients of prophylactic internal iliac arteries balloon nine patients needed emergency hysterectomy after delivery because of uncontrolled PPH. On the other hand, a previous study done in Italy for 37 women with morbidly adherent placenta who underwent prophylactic internal iliac arteries balloon occlusion showed that the uterus was conserved in every case without the need for emergency hysterectomy [20].

Addressing the complications of the interventional radiological procedures performed in obstetrical patients, our results showed that most interventional radiological procedures did not have complication. However, three patients had hematoma and two patients had postembolization syndrome. No serious complications were found and these two minor complications were easily managed and treated. A previous study done in Iran showed that out of 60 patients who underwent uterine arteries embolization, 11 patients had a transient fever (>38.5ºC) which returned normal within two days, one patient had hematoma and one patient had ovarian failure [16].

In Gynecology group analysis, the main indication for radiological intervention was found to be uterine fibroids. The literature shows that 20% to 40% of women in the reproductive age suffer from uterine fibroids and it reaches up to almost 60% in women older than 40 years [2,11]. However, there aren't studies that explore the prevalence of uterine fibroids compared to other gynecological conditions in women who underwent radiological intervention. The high percentage of cases in SQUH indicated for UF undergoing radiological intervention in comparison with other conditions may be due to that interventional radiology is a new field in medicine worldwide let alone in SQUH. Also, radiological interventional procedures aren't considered the routine procedure in treating uterine fibroids as some patients prefer to go for surgical interventions.

The success rate of UAE procedures in this study was 77.8%. Similarly, a randomized trial comparing uterine fibroid embolization to surgical managements in treating symptomatic fibroids has shown a success rate of 79.2% in the uterine fibroid embolization group [1]. Moreover, the literature shows a higher success rate in women who had UAE for treating UF where the success rate was 82% to 92% [10]. One of the possible causes for the difference in the success rate is the sample size included in the study, as this study had 27 cases of UAE only. A previous study conducted in London showed that a high successful rate with UAE for symptomatic fibroids with only one patient required emergency hysterectomy after embolization because of persistent bleeding [21].

The re-operation and re-intervention rate in a study included 63 UAE interventions was 14.8% [22]. This study showed a similar rate, where it was found that 25% of women required re-intervention. In a more recent retrospective cohort study, the re-intervention rate was found to be lower than our study. It was found that only 7.0% (N=4629) of women underwent UAE required a re-intervention [23]. This could be due to more use of such interventions, stricter selection criteria and increase in the experience of the operator.

Out of the seven patients who required an alternative intervention in this study, three underwent myomectomy, three had a medical intervention and only one had a hysterectomy. However, Manyonda et al. study [22] showed a higher rate of hysterectomy as an alternative intervention than our study. The study had nine women requiring a re-intervention in which six had a hysterectomy, two had myomectomy and one had the embolization repeated. Even though our results and that found in literature may differ in terms of percentages of women requiring hysterectomy, it shows that around 15% - 29% of women who undergo UAE will require an alternative

intervention which may be a surgical intervention [22,23].

This study reported a higher rate of complications after the embolization compared to Manyonda *et al.* study [22]. It was reported that 40% of women underwent an embolization had a post embolization syndrome but no other complications were noted. In contrast, Manyonda et al. reported that only 13.2% of women in the embolization group had a complication. The nine complications noted included six cases of post embolization syndrome, two cases of hematoma and one case of urticaria due to the contrast medium. Our study reported double the cases of post embolization syndrome than that found in the literature. This higher rate of post embolization syndrome reported in our study may be due to the difference in the number of fibroids, their size and location in the uterus.

The literature shows short hospital stay in radiological intervention procedures especially in UAE. In a previous study, the mean hospitalization duration after uterine artery embolization was two days [22]. This study reported a similar result were the mean hospitalization duration for the radiological intervention procedures was three days including the hospital stay prior to the intervention. The difference of one day between our study was because our study included the duration of hospital stay prior to the intervention which was not noted in Manyonda et al. study [22,24].

Fertility and pregnancy outcomes after undergoing radiological intervention especially UAE is still controversial in the literature. A retrospective study aimed to evaluate the outcomes of pregnancy in 187 women who underwent UAE for UF reported 15 pregnancies from the total sample studied, 87.5% of the pregnancies resulted in successful live births, while the rest 12.5% ended up in miscarriage [25]. In another systemic review, the results showed higher miscarriage rate of 35.2% in the embolization group [26]. There were five successful pregnancies reported in our study from 33 patients who were followed up. The outcome of the pregnancies reported in our study showed a slightly higher rate of miscarriage than that reported in the literature with 40% miscarriage and 60% successful live birth rates. The pregnancy outcomes after a radiological intervention remains unclear.

Limitations:

This study has some limitations such as retrospective study with a small sample size and many patients lost to follow up so the long-term complications like amenorrhea and infertility were not studied. Furthermore, although our center is one of the few centers in the country that performs IR procedures, this study therefore does not reflect the outcomes of all radiological interventions performed.

Conclusions:

This study showed a high success rate of the interventional radiological procedures. Only minor complications were noted after the procedure which were similar to other published studies. This study built the base for further prospective multicenter studies assessing the outcomes of IR in various OBGYN conditions in the country.

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