

Research Article

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Color Doppler Ultrasound in Uterine Arterial Embolization

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Abstract: Objective: To observe and analyze the effect of color doppler ultrasonography (CDU) in uterine arterial embolization (UAE). Methods: 160 cases of patients with uterine fibroid were selected in this study. CDU were performed on all patients before UAE as well as 5-9 days and 3-6 months after UAE, so as to observe the shape, size and ultrasonogram of the uterus and uterine fibroid, and the blood flow changes of the uterine fibroid. In addition, analysis was carried out on the improvement of the clinical symptoms 3 months to 6 months after UAE. Results: 5-9 days and 3-6 months after UAE, the blood flow of uterine fibroid was significantly reduced or even disappeared, with $P < 0.05$; according to the observation carried out 3-6 months after UAE, irregular menstruation and uterine fibroid compression were significantly relieved; the uterine size and the uterine fibroid volume were significantly decreased; high-level echo was generated inside of the uterine fibroid, which was then gradually reduced into slightly higher echo, equal echo and low echo. High-level echo was found around the uterine fibroid. Conclusion: It is safe and reliable for the patients with symptomatic uterine fibroid to take UAE. The application of CDU can also provide a good basis and has great significance.

Keywords: Color Doppler ultrasound; Uterine fibroid; UterinearterialEmbolization; Application effect

1 Introduction

In the female reproductive system, uterine fibroid is a common benign tumor. According to the relevant survey data, among females aged from 40 to 50 years old, the incidence of uterine fibroid is about 50% to 60%. Therefore,

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it is also known as the “first tumor” in gynecology [1]. Although the uterine fibroid has a relatively low rate of malignant transformation, the disease will cause problems such as hypermenorrhea or prolonged menstrual, lower abdominal pain and oppression, which not only affect the life quality of the patients, but also leads to functional disorders of the reproductive system, endocrine system and gastrointestinal tract and other normal tissues and organs, causing pressure on the patient's mental health [2].

Although there is still no unified understanding on the pathogenic factors of uterine fibroid (as shown in Figure 1), most of the studies suggest that the cause includes cell mutations in the normal muscle layer (shown in Figure 2), complex interactions between sex hormones and local growth factors. The traditional treatment programs for uterine fibroid include drug therapy, and surgical resection of fibroid and uterus. Drug treatment is normally involved with relapse, and hysterectomy will exert certain psychological influence on women. With the continuous innovation of medical technology, UAE has been widely applied in the treatment for the uterine fibroid patients, and good treatment effects have been achieved.

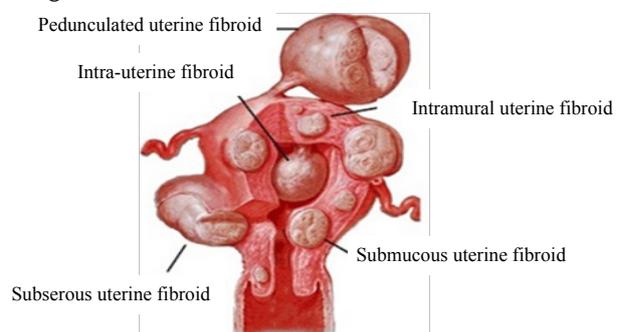


Figure 1. Uterine fibroid

The CDU is of great importance for the dynamic observation of patients with uterine fibroid before and after UAE. In this study, the clinical application of CDU in UAE was observed and analyzed.

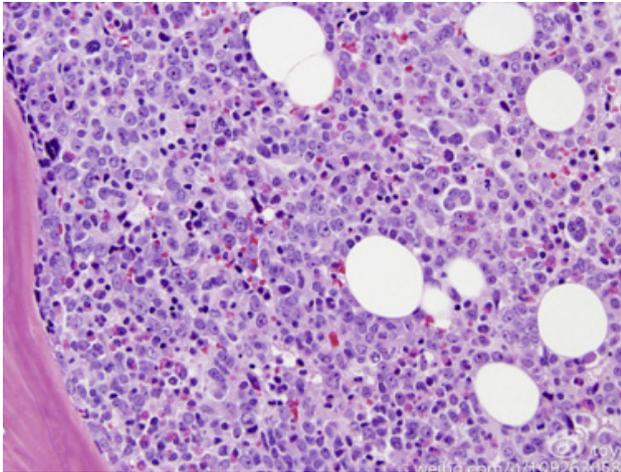


Figure 2. Matrix cell mutations

The clinical symptoms of all cases were manifested as: varying degrees of menstrual disorders, significant symptoms of fibroid compression, such as excessive menstruation, prolonged menstruation, lower abdominal pain, pain in back and loin, constipation, or frequent urination. Patients with uterine fibroids have a course of 3-10 years, with an average course being (5.6 ± 1.2) years. The general data of all patients were comparable, with $P > 0.05$.

Ethical approval: The research related to human use has been complied with all the relevant national regulations, institutional policies and in accordance the tenets of the Helsinki Declaration, and has been approved by the authors' institutional review board or equivalent committee.

Informed consent: Informed consent has been obtained from all individuals included in this study.

2 Data and method

2.1 General data

The research objects of this study were 160 patients with uterine fibroid receiving treatment in the hospital from February 2013 to February 2017. The ages of the patients were between 30 and 48 years old, averaging at (38.6 ± 2.5) years old. All patients have been married and have already delivered a baby. There were a total of 182 fibroids, including 98 intramural fibroids, 52 submucosal fibroids and 32 subserosal fibroids (shown in Figure 3).

2.2 Method

The procedure of UAE: polyethylene glycol particles (PVA) with a diameter of 350-500 μ m were used for the embolization of uterine fibroid vascular bed, while gelatin sponge particles were used for the embolization of the uterine artery trunk. The size of the fibroid and the richness of blood supply were regarded as the basis for the applied amount of the embolic agent; the operation was carried

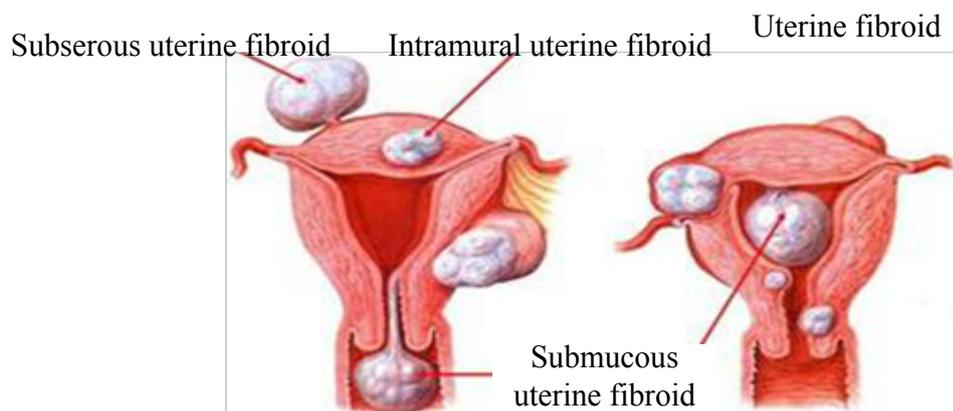


Figure 3. Types of the patients' uterine fibroids

Table 1. General data of selected patients

Number of cases	Age (year)	Course of disease (year)	Intramural fibroid	Submucosal fibroid	Subserosal fibroid
160	38.6 ± 2.5	5.6 ± 1.2	98	52	32

out according to the following procedures: firstly, the femoral artery was punctured with Seldinger technique; the 5F catheter sheath was then inserted in, and then the 5F Yashiro or Cobra II catheter was inserted into the offside internal iliac artery via the sheath [3]. The opening position of the uterine artery clarified with radiography. If necessary, the radiography of the right anterior oblique position or the left anterior oblique position was added, so as to obtain the clear opening position on the uterine artery. The vascular map was used as the road mapping for guidance. Then, the super selective insertion of the catheter was performed on the uterine artery trunk. After having an understanding of the vascular pattern, the location and fibroid stain of the uterine fibroid, the embolic agent was injected into the artery via catheter [4], until the muscle tumor blood vessels completely disappeared and the blood flow of the artery was slowed down significantly. Finally, the gelatin sponge particles were injected into the uterine artery via catheter to block the uterine artery trunk. After the embolization, re-examination angiography of internal iliac arterial was implemented to make clear the embolization degree. The ipsilateral uterine artery was embolized according to the same procedure [5].

During the CDU examination, Siemens Sequoia 512 and Philips HDI 5000 color ultrasound diagnostic apparatus were used. The frequency of the trans-abdominal probe and the trans-vaginal probe respectively was 2-5MHz and 5-9MHz, respectively. After the implementation of trans-abdominal ultrasound, the patient emptied their bladders, and then trans-vaginal ultrasound examination was performed. All cases were examined on the 7th day before UAE, 5-9 days and 3-6 months after UAE. The uterus size, the fibroid diameter, the number and location of fibroid, internal echo were measured and recorded. Moreover, color Doppler was used to observe the status of the fibroids [6].

2.3 Index observation

The blood flow of the fibroids can be divided into four grades, including: no blood flow type, which means

no blood flow around and in the fibroid, namely 0 grade; rare blood flow type, which means Dotted and strip blood flows around the fibroid, while no blood in the fibroid, namely grade I; relatively rich blood flow type, which means multiple dotted and strip blood flows around the fibroid, and sparse dotted blood flows in the fibroid, namely grade II; rich blood flow type, which means multiple dotted blood flows, short-linear blood flow and strip blood flow around and in the fibroid, namely grade III [7]. The calculation formula for volume: uterine volume = size × length × width × thickness, fibroid volume = $0.5 \times D1 \times D2 \times D3$ (D1, D2 and D3 represent the radius of the three longitudes of the fibroid, respectively). UAE was performed on all the 160 patients 3-6 months before and after UAE in order to learn the improvement condition of menstrual disorder and fibroid compression.

2.4 Statistical method

The data was analyzed and processed by SPSS21.0 statistical software. The enumeration data was expressed in the form of (n,%), and tested by chi-square. The measurement data was expressed in the form of ($\bar{x} \pm s$), and tested by t. Only when $P < 0.05$, the difference can be considered of statistical significance.

3 Results

3.1 Results of follow-up examination of clinical symptoms

Among the 160 patients, there were 142 patients having improvement of irregular menstruation, occupying 88.75% of the total patients, 140 patients having different degrees of improvement of fibroid compression after UAE, occupying 87.50% of the total patients, and 30 patients with mild and moderate anemia returned to normal level within half year after UAE, occupying 18.75% of total patients.

Table 2. Size changes of uterus and fibroid before and after UAE ($\bar{x} \pm s$)

Indicator	Before UAE	5-9 days after UAE	3-6 months after UAE	Average reduction ratio
uterine volume (cm ³)	372±141	258±78	160±82	60%
fibroid volume (cm ³)	179±65	102±16	62±10	70%

3.2 Size change of uterus and fibroid before and after UAE

As shown in Table 2 below, 3-6 months after UAE, the average reduction of fibroid volume is 70%, and the average reduction of uterine volume is 60%, which is significantly decreased compared with the size before operation, $P < 0.05$.

3.3 Changes of fibroid echo before and after UAE

Before operation, among the 182 fibroids, there were 98 low echoes, 32 high echoes, and 52 equal echoes. The internal echoes of all fibroids were relatively uniform, with a clear outline. In addition, there was halo around the fibroid. On the 5-9th day after operation, most of the internal echoes of the fibroids were in ascending form [8], and appeared in stripe and patchy shape, with uneven echo. Ring-shaped strong echo was found around the fibroid. During 3-6 months after operation, unevenly high echo, low echo and equal echo were found in the fibroids.

3.4 Changes of uterus and fibroid blood flow before and after UAE

According to the Table 3 below, before operation, there were rich dotted and strip blood flows in most of the fibroids, and circular and semi-ring blood flow around the fibroids. Compared with the status before operation, the blood flow condition examined 5-9 days, 3-6 months after operation was significantly reduced, with $P < 0.05$; the myometrium blood flow in the early stage after the operation was significantly reduced, which was then returned to normal level 3-6 months after operation. The data was as shown in Figure 4 and Figure 5 below.

4 Discussions

Uterine fibroid is one of the most common benign tumors in the female reproductive system. The common clinical symptoms include menorrhagia, and abdominal pain, frequent urination, and constipation, which cause great influence on the patient's physical and mental health.



Figure 4. Status of fibroid before UAE

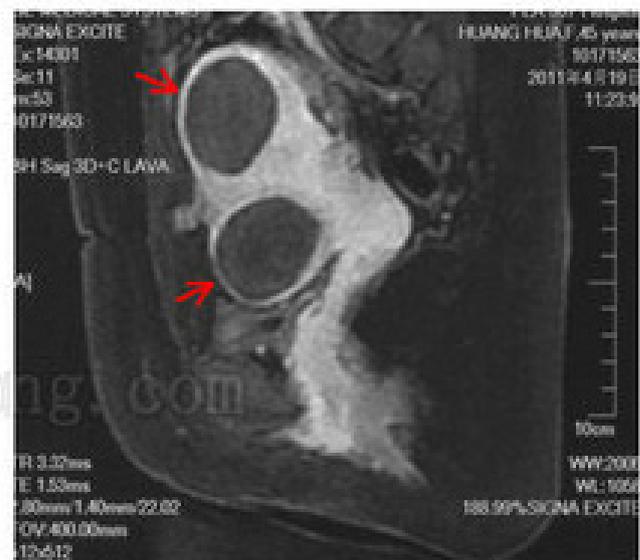


Figure 5. Status of fibroid 6 months after UAE

Table 3. Changes of uterus and fibroid blood flow before and after UAE

Measuring time	Rich or relatively rich (grade II +grade III)	Rare or disappearing (grade 0+grade I)	Number of fibroids
Before UAE	166	16	182
5-9days after UAE	30	78	108
3-6 months after UAE	8	48	56

The conventional treatment of uterine fibroids includes drug therapy and hysterectomy. However, due to multiple complications and relatively large trauma that are normally involved with conventional methods, it is of great importance to develop a new treatment replacing the traditional treatment of uterine fibroids [9].

The mechanism of UAE is to perform super-selective insertion of catheter on bilateral uterine artery with interventional radiology technology and insert the embolic agent into the fibroids and the uterine artery [10]. In this way, the treatment can realize the degeneration, necrosis, shrinking, or even calcification of uterus myomas, but also prevent mesometrium from being avascular necrosis due to the formation of collateral circulation in the pelvic cavity [11-12].

According to the results of this study, the CDU examination objectively showed the blood flow changes of uterus and fibroid before and 5-9 days, 3-6 months after UAE. The blood flow of the fibroids was significantly reduced and then disappeared, which then gradually returned to normal level 3-6 months after operation, showing that the operation could cause ischemic infarction of fibroid and would not cause myometrium necrosis [13]. The fibroid echo figure showed that there was strip and patchy high echo in the fibroids, and high echo ring around the fibroids after UAE. Therefore, during UAE embolization, a large amount of PVA particles accumulated on the fibroid vascular bed and in blood supply artery because of the “syphonic effect” caused by fibroid vessel thickening and blood flow accelerating.

After UAE, fibroid ischemia caused extensive degeneration and necrosis. According to dynamic observation, uneven high echo, equal echo, and hypoecho and other characteristics of the sonogram were found. Therefore, CDU examination on the changes of the uterine and fibroid volume and the hemodynamic changes has a good response, and can express the pathological process of the fibroid ischemic changes [14]. In addition, the CDU examination is simple and noninvasive, with reasonable cost and other advantages. Thus, it has been used as the preferred method for the follow-up observation after UAE.

5 Conclusion

Above all, UAE treatment of uterine fibroids has significant curative effect. At the same time is safe and reliable, and can retain the womb. Thus, it gains the patient’s satisfaction. CDU can reflect the shape of fibroid and blood flow indicators after UAE, thus having huge application value.

Conflict of interest statement: Authors state no conflict of interest

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