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Magnetic Resonance–Guided Focused Ultrasound (MRgFUS) - A New Therapeutic Tool for Uterine fibroid: Review Article

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ABSTRACT

Uterine fibroids are the most common clinical findings associated with females in the reproductive age group. Early detection and treatment planning may result in a safe outcome for the victim; otherwise, the outcome may be fatal or complicated. Some techniques are already available, such as surgery, etc., but Magnetic Resonance-Guided Focused Ultrasound (MRgFUS) is a new era in medical science that is being used to treat tumours like uterine fibroids and others. Currently, Magnetic Resonance-Guided Focused Ultrasound (MRgFUS) is widely used to treat uterine lesions, but it can be used for other lesions as well. There is no need to admit the patient for this procedure. MRgFUS has become a popular choice of non-invasive treatment tools for both benign and malignant tumours. MRgFUS is also approved by the US Food and Drug Administration (FDA) for uterine fibroid treatment.

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INTRODUCTION

Background: Magnetic resonance imaging (MRI) is a medical imaging technique that uses magnets and radiofrequency pulses to diagnose some suspected lesions. It is a non-invasive technique. Magnets are the heart of the MRI system. A radiofrequency pulse is a packet of energy that is used to excite the body's hydrogen protons, which turn back to their original state to form an MRI image. Ultrasonography uses sound waves in the form of ultrasounds (sound waves with a frequency higher than that of human hearing) to create a picture of internal body structure. Magnetic resonance-guided focused ultrasound (MRgFUS) is a non-invasive therapeutic tool that is used to treat small fibroids and other lesions.

Aim and objective of this study is to investigate the therapeutic application of MRgFUS in medicine.

The MRgFUS technique was approved by the European Community in 2002, and by the United States Food and Drug Administration in 2004 [1]. Basically, two techniques are used together in this therapeutic approach: (1) anatomical guidance and imaging with the help of MRI; and (2) high-intensity focused ultrasound (HIFU). MRI provides a well-defined three dimensional image with excellent soft tissue resolution and also monitors the body temperature with an accuracy of ± 2 °C [2]. This is a choice of techniques for patients suffering from uterine fibroids, uterine myomas, mifepristone, asoprisnil, etc. who might become pregnant in the future [3,4].

Magnetic resonance-guided focused ultrasound (MRgFUS), is an alternative technique to the complex medical and surgical approach in the management of uterine abnormalities. There are fewer post procedure complications as compared to other approaches like myomectomy and hysterectomy [5]. Several clinical studies have shown that it is a very safe and effective method for the management of symptomatic uterine fibroids [6,7]. Magnetic resonance-guided focused ultrasound (MRgFUS) significantly cured uterine myomas in approximately 70-80% of cases [8].

Currently, MRgFUS has been used for a variety of purposes to manage the problems associated with breast tumours, painful bony metastases, liver tumours, neurosurgery, etc. For this purpose, we can also use high intensity focused ultrasound (HIFU), but the lack of MRgFUS integration leads to very little application, and, in most situations, it cannot compete with the surgical approach. Excessive heat deposition in a specific region can be complicated and cause tissue burn. Magnetic Resonance-Guided Focused Ultrasound (MRgFUS) integration leads to safe handling of the whole procedure under the control of MRI observation. MRI can observe and measure heat at a specific site while also providing a 3D image of the object; marginal approaches may be misled at times, but this approach can improve the marginal approach while also reducing procedure repetition.

Improving the imaging strength from basic to 3 Tesla or more might be a useful tool to improve the ability of the entire procedure. Because increasing the strength of imaging guidance will also improve anatomical details, it can help plan and execute the procedure in a safe manner [9,10].

Magnetic Resonance-Guided Focused Ultrasound (MRgFUS) was used for the first time clinically to treat benign breast fibro-adenomas [11]. Following the successful trial of this procedure on a breast lesion, it is now widely used to treat uterine fibroids. [12]. The patient does not need to be admitted to the hospital or clinic for the Magnetic Resonance Guided Focused Ultrasound (MRgFUS) procedure. It will take 2-3 hours to complete the whole procedure. The entire procedure can be performed with conscious sedation to relax the patient during and after the procedure; otherwise, it might be a little bit painful. A person may visit the hospital's outpatient department (OPD) and return home on the same day or even after 3–4 hours. The length of the procedure may vary depending on the sample and the size of the area to be treated [13]. Large lesions must be pre-treated with gonadotropin-releasing hormone therapy to reduce the size of the lesion [14].

A study of 83 women who underwent abdominal hysterectomy was recruited in seven separate centres to provide a contemporaneous assessment of safety. There were no life-threatening problems associated with this technique. Women undergoing MRgFUS had fewer clinical complications than women undergoing hysterectomy [15].

The failure rate is very low with MRgFUS. A study reveals a failure rate of 11.22%, and a similar rate is registered in other evidence, with a value of 12.7 and 11% after 12-month observation [16].

although it is a choice of method to manage the benign lesion. This technique is very safe for breast lesions due to the absence of bone and gas. These devices make an easy and effective therapeutic tool for breast tumour ablation [17].

A study conducted on 50 women underwent uterine fibroid treatment at Jaslok Hospital and Research Centre using the MRgFUS system. The average age was 36.2 8.3 years when they were treated with PD. There were no side effects or complications reported during the six-month treatment. After six months of therapy, the average fibroid shrinkage was 30% 11% [18].

The MRgFUS study included 87 women who were being treated for uterine fibroids. After various screenings, 80 patients were treated. Following MRgFUS, 69% of patients did not require any additional treatment, while 24% required other surgical interventions. Hypo-intense fibroids were associated with a higher chance of successful treatment than hyper-intense fibroids [19].

CONCLUSION

The MRgFUS is a hybrid technique to treat and manage different tumours and cancerous lesions with the help of MRI imaging and high-intensity focused ultrasound. Uterine fibroid is the most common type of non-cancerous tumour found in women of reproductive age. All the fibroids do not show symptoms. Menstrual bleeding, back pain, frequent urination, and other symptoms have been reported [20]. The advantage of this technique over others is that a minimally invasive procedure leads to very few complications during and after the procedure. There is no requirement to admit the patient, and it will also lead to cost effectiveness as well as a faster recovery rate [21-23].

MRgFUS uses non-invasive thermal ablation equipment integrated with a magnetic resonance imaging system to ablate soft tissue. Recent applications of MRgFUS have also included the treatment and management of breast cancer, liver cancer, brain cancer, and metastatic bone cancer [24–27]. MRgFUS has emerged as a non-invasive treatment option for both benign and malignant tumours over the last two decades. MRgFUS was also approved by the US Food and Drug Administration (FDA) for uterine fibroid treatment [28–30]. All steps followed during MRgFUS are labelled in the diagram.

Diagram 1: Steps followed during MRgFUS

Compliance With Ethical Standards Statements

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