

Revolutionizing Fertility: A Review Of High-Intensity Focused Ultrasound On Uterine Fibroids

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Abstract:

Background: The aim of the study is to review the safety and the success in fibroid patients by using high intensity focused ultrasound and compare with those of other surgeries for treatment of fibroid.

Materials and Methods: We searched in Google Scholar, PubMed, Scopus and Web of Science by using the keywords MRHIFU and High Intensity Focused Ultrasound, uterine fibroid, fertility sparing and pregnancy. The literature reviews for the recent 7 years were searched. The database search was limited to English although much of publications and studies were those of China.

Results: HIFU has significant advantage over other methods and improving the health related quality of life. It has a significant effect in shortening pregnancy interval thereby preserving ovarian function. HIFU treatment displayed a relatively higher pregnancy rate, shorter pregnancy interval by preserving ovarian function. This, it is an excellent option for treating symptomatic fibroid patients willing to conceive.

Conclusion: HIFU is a safe and effective non-invasive treatment for patients with symptomatic fibroids, offering a good quality of life with minimal complications.

Keywords: High Intensity Focused Ultrasound, Fertility sparing, Uterine Fibroid, Non-invasive treatment, MRHIFU

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I. Introduction

Uterine fibroids, or leiomyoma, are benign neoplasms that arise from the smooth muscle of the uterus, affecting 20-50% of women during their reproductive years¹. These tumours can lead to significant clinical manifestations, including menorrhagia, pelvic discomfort, and urinary symptoms, which adversely affect women's quality of life². Additionally, fibroids can complicate fertility, making conception and pregnancy maintenance more challenging, particularly depending on their size and anatomical location³. Historically, treatment for symptomatic fibroids has primarily involved surgical methods such as myomectomy and hysterectomy, along with medical management options like hormonal therapies and GnRH analogues⁴. While these interventions can be effective in alleviating symptoms, they are invasive and can pose risks to ovarian function, raising concerns for younger women seeking to preserve fertility⁵. In recent years, minimally invasive alternatives have gained attention, particularly High Intensity Focused Ultrasound (HIFU). This innovative technique employs focused ultrasound energy to create localized heating that leads to the destruction of fibroid tissue, sparing surrounding areas⁶. HIFU offers the advantage of outpatient treatment, significantly reducing recovery times and complications compared to traditional surgical options⁷. Research suggests that HIFU not only reduces fibroid volume but may also enhance uterine perfusion, potentially improving reproductive outcomes⁸. However, the evidence regarding pregnancy rates following HIFU treatment remains inconclusive, with some studies reporting variable outcomes⁹. Therefore, a thorough examination of the literature is essential to evaluate the safety and effectiveness of HIFU as a fertility-sparing approach for uterine fibroids. This review seeks to synthesize the available research on HIFU in the context of uterine fibroids, emphasizing its safety, success rates, and comparisons with conventional surgical methods. From recent studies, we aim to find out HIFU's role in managing symptomatic fibroids and its broader implications for reproductive health in women.

II. Materials and Methods

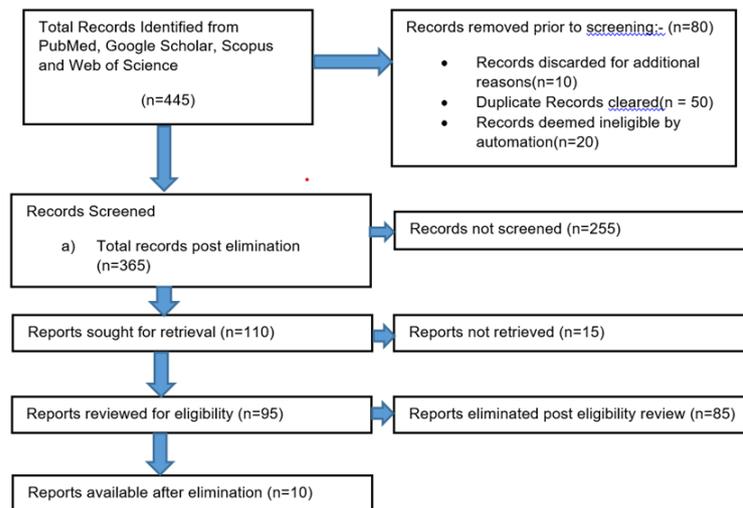
A comprehensive literature search was conducted across four databases: PubMed, Scopus, Web of Science, and Google Scholar, using keywords such as "High Intensity Focused Ultrasound," "HIFU," "Uterine Fibroids," "Infertility," and "Pregnancy Outcomes." The search identified a total of 445 records. After removing 80 duplicate and ineligible records prior to screening, 365 articles were assessed for relevance. Following a detailed screening process, 255 articles were excluded, leaving 110 reports requested for retrieval. Of these, 15

reports were not retrieved, resulting in 95 reports evaluated for eligibility. Ultimately, 85 reports were excluded based on criteria such as lack of outcome data and insufficient information.

The Inclusion Criteria: finally comprised of a total of 10 articles.

The Exclusion Criteria: consisted of cases with uterine fibroids treated earlier wherein no data was available for statistical analysis. The reviews, conference, abstract and case reports were not included.

Figure 1. Search Strategy



III. Results

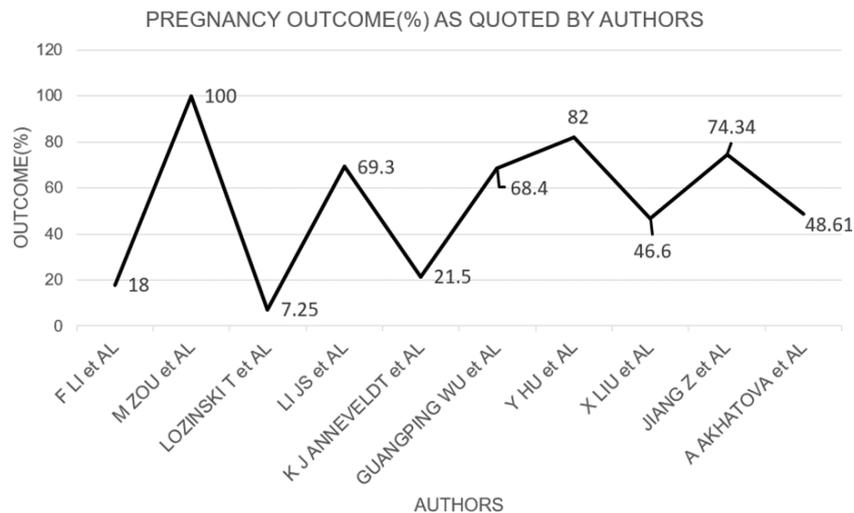
The exploration of high-intensity focused ultrasound (HIFU) as a treatment for uterine fibroids has revealed significant variability in outcomes across multiple studies. A retrospective study by F Li and J Chen (2023) reported a modest pregnancy rate of 18%, while M Zou et al. (2017) showcased an impressive 100% success in their observation study, raising concerns about potential selection bias. In contrast, Lozinski et al. (2019) found a much lower rate of 7.25% in their meta-analysis, emphasizing the inconsistencies in the literature. J Li and Y Wang (2017) noted a more favourable outcome of 69.3%, but K J Anneveldt and H J van 't Oever (2021) highlighted variability with rates ranging from 7% to 36%. Guangping Wu's comparative study (2020) supported HIFU's efficacy with a 68.4% success rate, while Y Hu and X Song (2023) reported a promising 82% in their meta-analysis, though this may reflect publication bias. X Liu and L Xue (2018) found a 46.6% outcome rate, suggesting room for optimization, and Jiang Z et al. (2021) reported a high rate of 74.34%. Finally, A Akhatova et al. (2023) unveiled a broad outcome range of 18.69% to 78.53%, underscoring the necessity for further research. Collectively, these findings highlight HIFU as a potential non-invasive treatment for uterine fibroids, while also pointing to significant variability and the need for consistent safety and efficacy assessments. Ten articles met the inclusion criteria for this review, encompassing 150 reported pregnancies following MR HIFU treatment for uterine fibroids. Notably, there were 2 documented cases of placenta previa. The reported pregnancy rates vary, with an overall range of 60–75%. Additionally, the miscarriage rate was 10%, underscoring the need for further investigation into the long-term outcomes of pregnancies following HIFU treatment. This comprehensive review highlights the potential of HIFU as an option for patients with fibroids who seek to conceive while also addressing important safety considerations.

Table.1 Study Details

Sl No	Study Type	Year Of Publication	Author Name	Outcome
1	Retrospective Study	2023	F Li, J Chen ¹⁰	18%
2	Retrospective Observation Study	2017	M Zou, L Chen Et Al ¹¹	100%
3	Meta Analyses	2019	Lozinski T Et Al ¹²	7.25%
4	Retrospective Study	2017	J Li, Y Wang ¹³	69.3%
5	Retrospective Study	2021	K J Anneveldt, H J Van'toever ¹⁴	7% - 36%
6	Comparative Study	2020	Guangping Wu Et Al ¹⁵	68.4%

7	Review & Meta Analyses	2023	Y Hu, X Song ¹⁶	82%
8	Prospective Study	2018	X Liu, L Xue ¹⁷	46.6%
9	Retrospective Study	2021	Jiang Z Et Al ¹⁸	74.34%
10	Meta Analyses	2023	A Akhatova Et Al ¹⁹	18.69% - 78.53%

Graph 1. Pregnancy Outcome (%) As Quoted by Authors



IV. Discussion:

This analysis highlights the potential of High Intensity Focused Ultrasound (HIFU) as an innovative, minimally invasive approach for treating infertility linked to uterine fibroids. Data from 10 recent studies demonstrate HIFU's effectiveness in improving reproductive outcomes, with 150 documented pregnancies and overall pregnancy rates between 60% and 75%. The observed interval between treatment and conception, typically 6 to 12 months, suggests that HIFU may enable a faster restoration of fertility compared to conventional surgical methods. The 10% miscarriage rate is consistent with general population statistics, emphasizing the importance of ongoing research to fully elucidate the safety profile and long-term effects for patients. Furthermore, HIFU not only offers a fertility-sparing option for women with symptomatic fibroids but also addresses the drawbacks of traditional treatments like laparoscopic surgery and hormone therapy. These conventional methods often require longer recovery periods and may impact ovarian function, whereas HIFU provides a non-invasive alternative that can be administered in an outpatient setting. HIFU has come up as a popular alternative for treating uterine fibroids and adenomyosis over the past 2 decades, with systematic reviews demonstrating encouraging fertility and pregnancy rates²⁰. As this technology advances and becomes more widely available, it has the potential to significantly improve the quality of life and reproductive outcomes for individuals affected by fibroids.

V. Conclusion

HIFU presents a significant advantage for patients with fibroids aiming to enhance their fertility, particularly those over 40. This non-invasive technique offers a safe and effective solution for individuals with symptomatic fibroids, resulting in improved quality of life and minimal complications. Beyond fibroids, HIFU shows promise in addressing various conditions, including breast and pancreatic tumors, polycystic ovary syndrome, adenomyosis, and cervicitis. As the technology progresses, its potential applications may expand to encompass a wider array of pathological conditions. Recent research has explored its use in treating ovarian tumors. Notably, HIFU was the pioneering non-invasive method for uterine fibroid treatment to receive FDA approval.

However, the high cost of such advanced technologies poses a significant challenge in developing nations. Increasing the availability of HIFU in rural healthcare facilities would greatly benefit the public, as the principle of sharing and caring should extend to all. Currently, HIFU is predominantly accessible in major urban areas, making it unattainable for lower-income groups. Despite its high device cost, the treatment of fibroids using HIFU offers substantial advantages for infertility patients. Efforts should be made to make this treatment more accessible to the general population.

There is a scarcity of research on HIFU's application for fibroids and infertility, despite the considerable number of affected individuals in India. This gap is primarily due to limited device availability,

high costs, and a lack of trained professionals. It is essential for researchers to engage in collaborative multicentre studies and participate in workshops to enhance their skills in performing HIFU procedures.

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Conflict of Interest

All authors contributed to this study and reviewed the final version. The authors declare that no funds, grants or support were received during the preparation of this manuscript. There was no conflict of interest.

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