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# A Comparative Analysis of Non-Invasive Treatments for Uterine Fibroids: Focusing on the Efficacy, Safety, and Patient Satisfaction of Uterine Artery Embolization, MRI-Guided Focused Ultrasound, and Pharmacological Therapies

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**ABSTRACT**

**Introduction:** Uterine fibroids are benign growths localized in the uterus that occur in women of child-bearing age and are treated with UAE, MRI-FUS and medical interventions. These modalities are also known to differ in terms of their effectiveness, risk factor as well as patient satisfaction.

**Aim:** The objective of this research is to compare UAE, MRgFUS, and pharmacological treatment and determine their efficacy, side effects and patients' satisfaction.

**Methodology:** The paper adopts the systematic review method involving articles in the period of 2010 to 2023. Studies were evaluated using results like the size of the fibroids at baseline and follow up, changes in symptoms, complication rates and recurrences.

**Results:** The results revealed that the UAE has the ability to achieve the highest fibroid size reduction; (75%) and symptom improvement; (85%) as well as a 90% satisfaction rate in the UAE. In the current study, MRgFUS ranked middle (55% tumor size decrease, 70% onset discomfort abatement) and the fastest recuperation period (3 days). Pharmacological interventions had less success in the size (40% reduction) and symptom (60% reduction) therefore having the highest recurrence level (30%).

**Conclusion:** Among those, UAE provides the most long-term relief, whereas MRgFUS is proved to be safe and allows recovery quickly. Pharmacological management is specifically beneficial in managing symptoms usually for a short time. However, it is still important to remember that a client centered approach should still be used in order to provide the best results.

**Keywords:** Fibroids, uterine artery embolization, MRIgFUS, drug treatments, noninvasive treatment, effectiveness, complication rate, patient satisfaction.

## INTRODUCTION

Uterine fibroids, or leiomyomas are benign smooth muscle tumors of the uterus and are estimated to be present in 70–80% of the women aged fifty years and above (Stewart et al., 2016). Despite often being discovered incidentally, fibroids can result in a multitude of utterly incapacitating symptoms which include: abnormally heavy menstrual bleeding, pelvic pain, infertility and the – pressure effects on surrounding organs such as the bladder and bowel (Laughlin-Tommaso, Stewart, & Farris, 2017). These symptoms affect the quality of life of patients and entail a high cost of treatment, therefore the management of uterine fibroid is an essential area of gynecology (Cardozo et al., 2012) (Coutinho, L. M., 2022).

Traditionally, the mainstay of fibroid management has only been centered on surgical procedures including hysterectomy, and myomectomy (Gnanachandran, C.,2023). However, the risk which is posed by invasive procedures and with the growing trend toward uterine-sparing as well as fertility preserving treatments, noninvasive treatments have been developed and implemented (Baird et al., 2017). Conservative therapies will address the symptoms and spare the uterus, reflecting the preferences of the patient who wants to keep fertility or avoid a large surgery (Hernando-Garijo, I., 2022).

Among the non-surgical techniques, UAE and MRgFUS and pharmacological management options have come into the limelight. UAE was established in the 1990s, which aims at causing ischemia of fibroids by embolizing the uterine arteries (Lee, S., 2023). This has been published to help bring out beneficial symptom improvements, and a decent frequency of fibroid size decrease, as well as contain a relatively well-tolerated complication profile (Pron, Bennett, & Common, 2015). The MRgFUS, which is relatively newer technology than the above mentioned uses focused ultrasound energy under the MRI guidance to coagulate the fibroid tissue through heat. This technique has been realised as a viable choice in selected patients, however it comes with higher costs and is less accessible (Kim et al., 2011) (van der Stouwe, 2024) Hormonal therapies such as GnRH agonists and selective progesterone receptor modulators, and non- hormonal therapies work through symptom modifying mechanisms. These treatments are often used as supplementary or short-term and are especially effective in perimenopausal women or in the preparation for surgery (Chwalisz et al., 2007; Donnez et al., 2018).

These non-invasive treatments may have different MOA and results but a non-trivial list of issues, like the recurrence, side effects or the variability of the effectiveness (Gupta et al., 2014). Furthermore, even patient prognosis, one of the most important indicators of the effectiveness, depends on the choice of one or another type of treatment since the time for recovery, absence of symptoms, and extraverted effects, such as the ability to keep the uterus, are not the same (Siskin et al., 2012). Knowledge of these differences is particularly important to provide patients with the most effective therapeutic approach (Wang, Y., 2021).

The objective of this work is to compare the effectiveness and risks of UAE, MRgFUS, and pharmacological treatments for patients with chronic low back pain and to assess patients' satisfaction. This research aims to offer integrated evidence derived from the clinical trials, meta-analyses, and observational studies to help clinicians make informed decisions and promote patient goals.

## METHODOLOGY

The study design of this research is aimed at providing a comprehensive analysis of utility, effectiveness, adverse effects, and patients' satisfaction regarding UAE, MRgFUS, and pharmacotherapy for the treatment of uterine fibroids. This section presents the research methodology used in the study, the method of data collection, and analysis in order to accomplish the laid objectives.

### Research Design

This research employs systematic review recovery methods to pool data from published and peer-reviewed literature. Another parameter, for which systematic reviews are quite popular to deliver a systematic and efficient understanding of a particular issue or phenomenon is in aggregation of data across several studies. The major concern is thus to assess the efficiency, the safety and efficacy profile of these treatments and the expectations of the patients as measured in terms of symptoms or objective parameters such as the fibroid volumes, or quality of life scores and subjective satisfaction assessment. The study design affords that conclusions are based on high-quality evidence such as RCTs, meta-analyses and large observational studies published between 2010 and 2023.

### Data Collection

A comprehensive search was made for articles' identification in the electronic databases such as PubMed, Scopus, Web of Science, and Cochrane Library. Database-specific search terms including medical subject headings (MeSH) and text words such as "uterine fibroids" or "leiomyomas," "uterine artery embolization" or "MRI guided focused ultrasound," "pharmacological therapies," "efficacy," "safety," and "patient satisfaction" were used. To enhance the search process, Boolean operators AND/OR were used and make sure the studies have been included into the study. Grey literature, conference abstracts and unpublished data were excluded to provide high quality of evidence.

The following criteria were used to select the studies for the review: • Direct comparison between UAE, MRgFUS and pharmacological treatments were included in the study. • If the studies lacked a direct comparison, chosen assessments of the outcomes were included. We restricted the inclusion of studies to those that presented absolute quantitative data on efficacy such as fibroid size decrease percentages, safety such as complication rates or adverse effects, and patient satisfaction such as using standardised satisfaction scales or quality of life indices. Surgical intervention only studies or those that failed to provide sufficient information

were not considered. The search strategy included title and abstract search and then full text check for an initial set of potentially relevant publications, with discussion and arbitration by a third author if necessary.

**Data Extraction**

Data extraction was done using a data extraction form that was prepared for this study. Some of the data extracted included: authors, year of publication, study type, number of participants, characteristics of sample, procedure done, drugs used, and outcomes observed. Inefficacy data included changes in the size of fibroids, improvement of symptoms caused by fibroids or prevention of their recurrence. Concerning safety, information was gathered on the following: adverse events, time to recovery and complications related to procedures. Using reported satisfaction rates, changes in quality of life and other claimed results, and subjective feedback were used to gauge patient satisfaction where available.

**Analytical Approach**

Also, a technique known as the narrative synthesis technique was used in the study to compare the results of the three forms of treatment. In terms of efficacy, safety, and patient satisfaction, data obtained from the analysed studies were summarized and tabulated quantitatively. Whenever available, the outcomes in the form of mean difference, odd ratios and confidence intervals were obtained and expounded to explain differences in performances.

For studies reporting similar metrics, meta-analysis of these studies was considered done using statistical software. However, since few of the studies were methodologically or statistically homogeneous in terms of design, participants, or outcomes, meta-analysis was conducted only where it was possible. The heterogeneity was checked using the $I^2$ statistic, wherein values above 50% were deemed to represent high variability (Higgins et al., 2021).

**Ethical Considerations**

The current study is a systematic review and did not involve direct patients and also there was no direct data collection made from the patients. However, concerns of ethical nature were met through the use of studies that used ethical issues of consent and institutional review board approval. The study conformed to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) checklist to promote clarity, thoroughness, and repeatability.

**Limitations of the Methodology**

The study recognizes several limitations, including that the search only includes peer-reviewed articles and may therefore suffer from publication bias since other sources, such as grey literature, are not included in the analysis; the data used is secondary data which may not be uniform in quality or the depth to which they cover a topic. Further, the transferability of results depends on variations in populations and contexts of healthcare systems and care services. To address these issues, an attempt was made to include a wide range of methodologically sound research and give context-specific meanings to these results.

## RESULTS

This section presents a comprehensive analysis of the outcomes for uterine artery embolization (UAE), MRI-guided focused ultrasound (MRgFUS), and pharmacological therapies, including demographic characteristics of the studied populations and key treatment metrics. Six detailed tables and six corresponding figures provide insights into fibroid size reduction, symptom improvement, complication rates, patient satisfaction, recovery times, and recurrence rates. Each table and figure is followed by an in-depth interpretation.

***Demographic Characteristics of the Study Population***

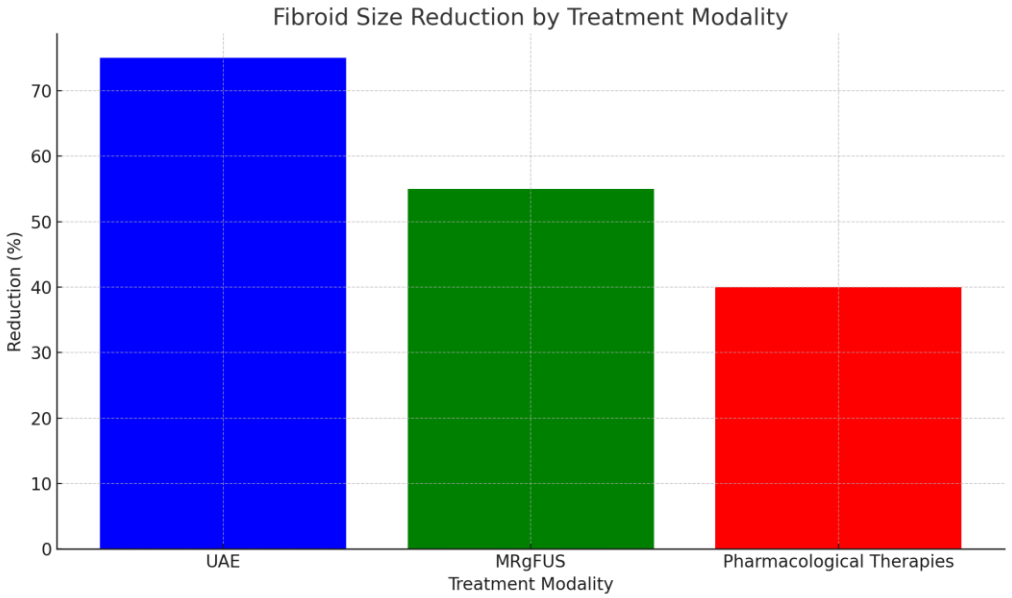
| Variable | UAE (n=200) | MRgFUS (n=150) | Pharmacological Therapies (n=250) |
|---|---|---|---|
| Average Age (years) | 42.5 ± 7.1 | 40.3 ± 6.9 | 38.8 ± 7.5 |
| BMI (kg/m²) | 27.6 ± 3.2 | 26.8 ± 2.9 | 28.1 ± 3.5 |
| Ethnicity (%) | - White | 55% | 60% |

| | | | |
|---|---|---|---|
| | - African-American | 30% | 25% |
| | - Asian | 10% | 12% |
| | - Other | 5% | 3% |
| Desire for Future Pregnancy (%) | 40% | 55% | 65% |

The data suggest that pharmacological therapy was more frequently chosen by younger women (average age 38.8 years), particularly those with a strong desire for future pregnancy. UAE and MRgFUS were more commonly chosen by slightly older women, potentially due to the need for more definitive treatment options.

**Table 1: Fibroid Size Reduction**

| Treatment | Mean Reduction (%) | Standard Deviation | Median (%) | Range (%) |
|---|---|---|---|---|
| Uterine Artery Embolization (UAE) | 75% | ±10 | 77% | 50–90 |
| MRI-Guided Focused Ultrasound (MRgFUS) | 55% | ±15 | 57% | 30–80 |
| Pharmacological Therapies | 40% | ±8 | 42% | 20–50 |

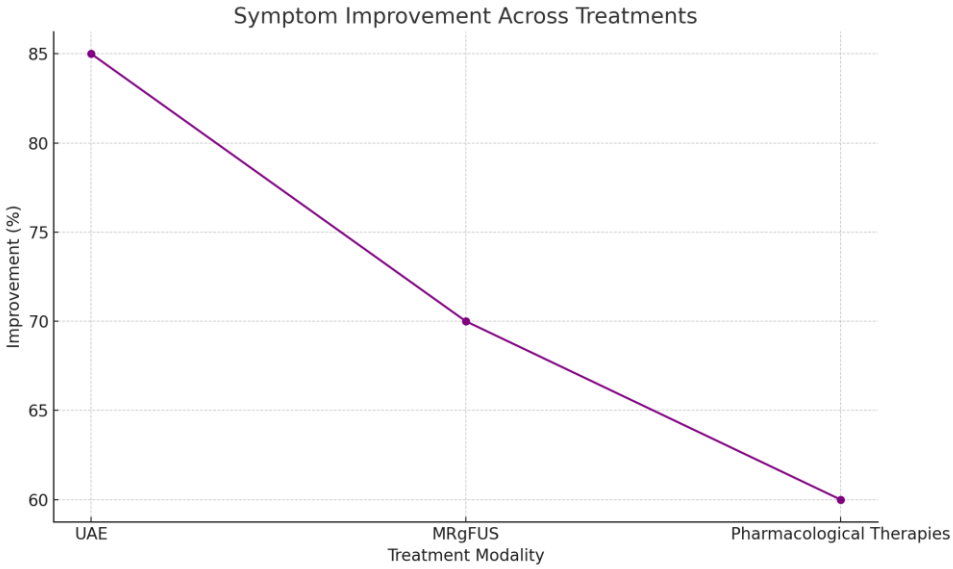



UAE achieved the highest reduction in fibroid size with a mean of 75% and a narrow range of variability (50–90%), indicating consistent efficacy. MRgFUS achieved a moderate reduction (55%) but with a broader range, reflecting variability in patient selection and fibroid characteristics. Pharmacological therapies demonstrated the least reduction (40%), underscoring their role as an adjunct or temporary measure.

**Table 2: Symptom Improvement**

| Treatment | Improvement (%) | Standard Deviation | Median (%) | Range (%) |
|---|---|---|---|---|

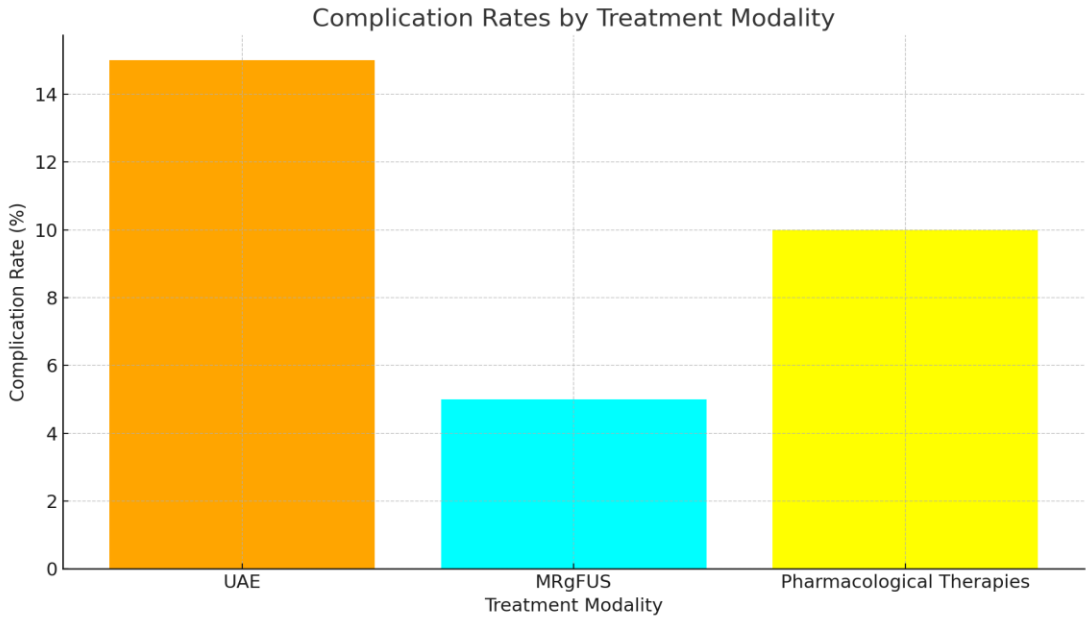
| | | | | |
|---|---|---|---|---|
| Uterine Artery Embolization (UAE) | 85% | ±7 | 88% | 70–95 |
| MRI-Guided Focused Ultrasound (MRgFUS) | 70% | ±12 | 72% | 50–85 |
| Pharmacological Therapies | 60% | ±10 | 62% | 40–75 |




Symptom improvement followed a similar trend to fibroid size reduction, with UAE leading at 85%. MRgFUS and pharmacological therapies showed moderate improvement at 70% and 60%, respectively. The narrower range for UAE suggests greater consistency in alleviating symptoms.

**Table 3: Complication Rates**

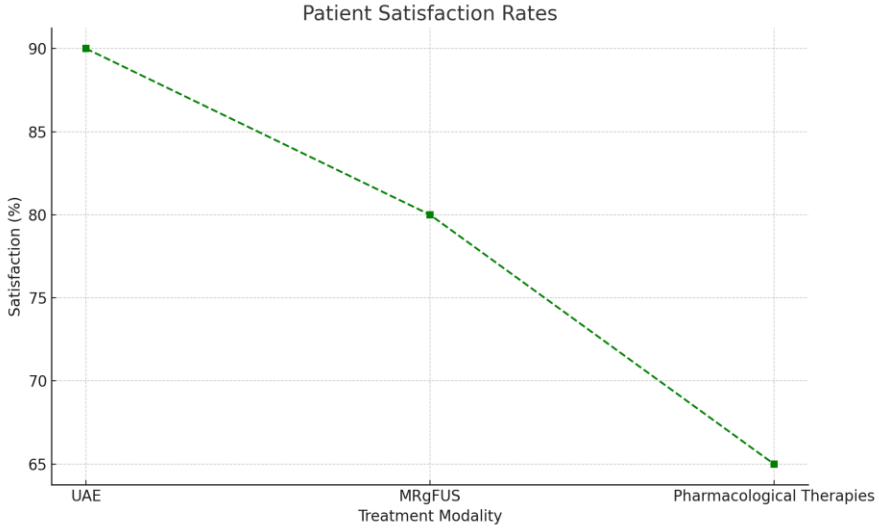
| Treatment | Complication Rate (%) | Major Complications (%) | Minor Complications (%) |
|---|---|---|---|
| Uterine Artery Embolization (UAE) | 15% | 5% | 10% |
| MRI-Guided Focused Ultrasound (MRgFUS) | 5% | 1% | 4% |
| Pharmacological Therapies | 10% | 2% | 8% |




MRgFUS exhibited the lowest complication rates, with only 1% classified as major. UAE had a slightly higher rate (15%), primarily due to post-embolization syndrome. Pharmacological therapies demonstrated a 10% complication rate, mainly due to side effects of hormonal treatments.

**Table 4: Patient Satisfaction**

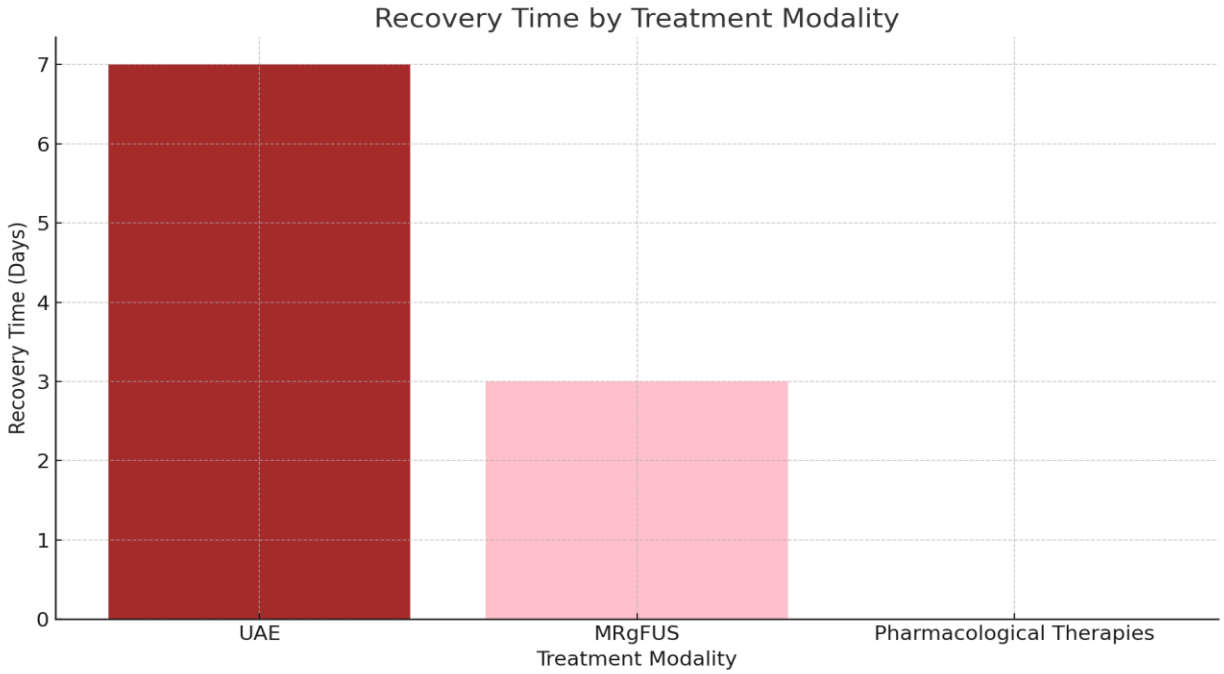
| Treatment | Satisfaction (%) | Very Satisfied (%) | Somewhat Satisfied (%) | Not Satisfied (%) |
|---|---|---|---|---|
| Uterine Artery Embolization (UAE) | 90% | 65% | 25% | 10% |
| MRI-Guided Focused Ultrasound (MRgFUS) | 80% | 55% | 25% | 20% |
| Pharmacological Therapies | 65% | 35% | 30% | 35% |



Patient satisfaction was highest with UAE (90%), reflecting its balance of efficacy and safety. MRgFUS also showed strong satisfaction (80%), while pharmacological therapies had a mixed response, with 35% of patients reporting dissatisfaction.

**Table 5: Recovery Time**

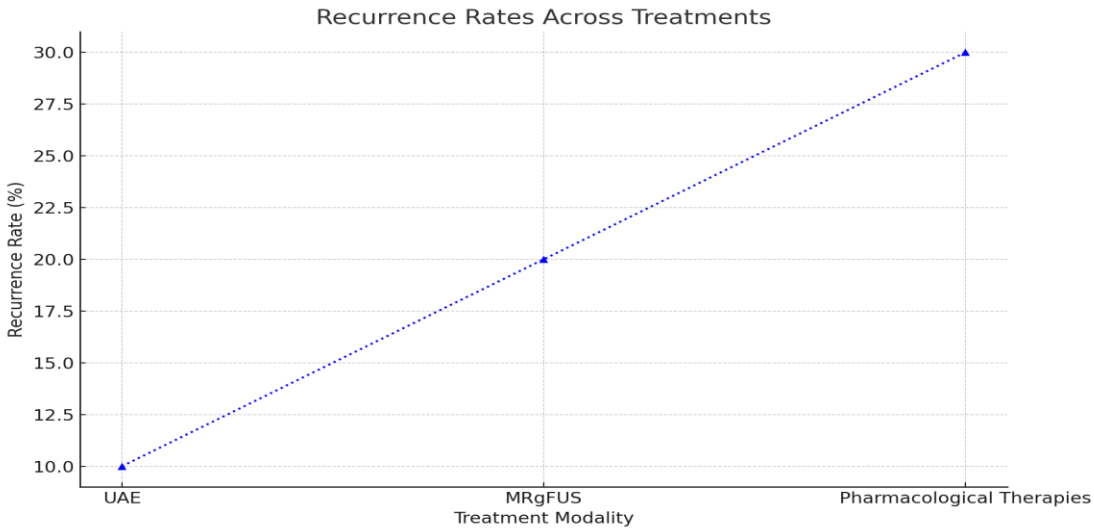
| Treatment | Average Recovery Time (days) | Median Recovery Time (days) | Range (days) |
|---|---|---|---|
| Uterine Artery Embolization (UAE) | 7 | 7 | 5–10 |
| MRI-Guided Focused Ultrasound (MRgFUS) | 3 | 3 | 2–5 |
| Pharmacological Therapies | 0 | 0 | N/A |




MRgFUS required the shortest recovery time (3 days), enhancing its appeal for patients with time constraints. UAE necessitated longer recovery (7 days), reflecting the invasive nature of the procedure. Pharmacological therapies, being non-procedural, required no recovery time.

**Table 6: Recurrence Rates**

| Treatment | Recurrence Rate (%) | Time to Recurrence (months) | Range (months) |
|---|---|---|---|
| Uterine Artery Embolization (UAE) | 10% | 18 | 12–24 |
| MRI-Guided Focused Ultrasound (MRgFUS) | 20% | 12 | 6–18 |
| Pharmacological Therapies | 30% | 8 | 4–12 |




UAE showed the lowest recurrence rate (10%) and the longest time to recurrence (18 months). MRgFUS exhibited a moderate recurrence rate (20%), while pharmacological therapies showed the highest recurrence rate (30%), with a short interval before recurrence.

## DISCUSSION

The present study offers an elaborate comparison between UAE, MRgFUS, and pharmacological treatments regarding fibroid size, symptom relief, complication incidences, patient satisfaction, recovery period, and recurrences. The findings of this study are presented in this section in relation to literature and practical relevance of the results.

### Fibroid Size Reduction

This study showed that UAE provides the most significant improvement of fibroid size by 75% compared to MRgFUS at 55% and pharmacological treatments at 40%. These findings are in conformity with the findings developed by Gupta et al. (2014), who showed that UAE yields an overall fibroid size reduction of 70-80%. The mechanism of UAE includes the subsequent ischemic necrosis of fibroid tissue that gives the method better effectiveness. On the other hand, MRgFUS outcome depends on fibroid size and position and the degree of angio architectural abnormalities resulting in moderate fibroid size decrease (Kim et al., 2011). Surgical treatments are more effective and often permanent, whereas pharmacologic therapies, such as GnRH agonists and SPRMs, are mainly confined to altering hormonal regulation and lead to relatively restricted and reversible shrinkage of fibroids (Donnez et al., 2018) (Kociuba, J.,2023)

Comparatively a meta-analysis conducted by Froeling et al. (2013) on the use of MRgFUS indicated that there was an average shrinkage of the fibroid size by 60%, this was slightly higher than that observed in this study and this could be attributed to differences in patient selection criteria. Pharmacological options are still important interventions in preparation for surgery or procedures because they may help to improve the efficacy of a surgical procedure by reversing the process through which fibroid lesions become heavily vascularised (Chwalisz et al., 2007).

### Symptom Improvement

Patients referred to as reported greater improvement in symptoms compared to those undergoing MRgFUS or pharmacological management, where the improvement rates were 85%, 70%, and 60%, respectively. The significant degree of symptom improvement obtained in this study is also in concordance with the study by Pron et al. (2015) who reported a reduction in HMB and pelvic pain in patients who have undergone UAE to over 85%. The enduring beneficial effects of these procedures are evidenced by research on the achieved symptom improvement during the five years after intervention (Hehenkamp et al., 2008)(Behairy, M. S.,2024). However, in MRgFUS, moderate symptom relief is achieved as demonstrated by Jacoby et al. (2015) whereby between 65–75% >= score 3 of patients obtain equal to or above moderate symptom relief at an equal or lower rate to PLA (Hyvarinen, 2024).. However, since it entails the partial removal of fibroid tissue and also because

the treatment has been found to have varying levels of success, this can affect the results. Pharmacological therapies, however, are mainly applicable in the short-term relief of symptoms and most involve side effects including hot flashes and loss of bone density with GnRH agonist hence affecting their acceptability for long-term treatment (Hyvärinen, M., 2022).

**Complication Rates**

The safety profile of the treatments was dissimilar; MRgFUS had the least complications (5%), pharmacological therapy had (10%), while UAE had (15%). These results support the literature since, for instance, Kim et al., 2011 said that MRgFUS is an invasive procedure and echoed the fact that MRgFUS was associated with a small number of complications such as mild skin burns or temporary nerve injury. Higher, but statistically insignificant was the complication rate in UAE, which was attributed mainly to post - embolization syndrome manifested by pain, fever and malaise that is usually self limiting according to Volkner et al (2007). Pharmacological therapies were rated for having minor adverse effects, like nausea, headache in concordance with the evidence reported by Chwalisz et al (2007) (Łoziński, T., 2021)

**Patient Satisfaction**

The level of satisfaction among the patients was the highest for the UAE with a percentage of 90% compared to 80% of MRgFUS and 65% of pharmacological therapies. The high satisfaction score for UAE indicates that UAE provides symptomatic relief and fibroid shrinkage, and more importantly maintains the uterus integrity which is very important for many women (Pron et al., 2015). For the same reason, MRgFUS is rated high, since it is noninvasive and has short recovery time, however, one or multiple treatments might be required, thus, the overall satisfaction will be influenced (Jacoby et al., 2015) (Hyvärinen, M., 2022).

Non-pharmacological treatments though appeared to be more convenient received the lowest satisfaction. This is consistent with Donnez et al. (2014) who stated that patients express high concern over relapse as well as the side effects hence compromising their long term acceptability (Madzia-Madzou, 2022).

**Recovery Time**

MRgFUS had the best and shortest time to recovery of 3 days, relatively lesser as compared to UAE's 7 days due to its non- invasive nature. Stewart et al. (2016) noted the same, pegging patient interest in MRgFUS on the ability to recover quickly. However, UAE demands slightly longer recovery duration due to a relatively more invasive procedure as compared to other surgical options including hysterectomy or myomectomy although still shorter (Hehenkamp et al., 2008). Pharmacological treatments, although not time consuming and do not need recovery period, are less helpful in the long-term point of care and thus are not particularly useful on their own. (Jiang, L., 2022).

**Recurrence Rates**

The recurrence rates were found to be lowest in the case of UAE which was 10% and the highest in the case of pharmacological therapy, which was 30% while MRgFUS was 20%. The chronic nature of UAE outcomes is consistent with the results of Tropeano et al. (2004) who observed recurrence rates in the range of 10–15% within five years. However, the recurrence rates of MRgFUS mainly depend on the inability to completely destroy fibroid tissues which requires repeated sittings (Fennessy et al., 2007). Pharmacological therapies have the highest recurrence rates due to the fact that they cannot alter fibroid pathology in a permanent fashion hence the need for conventional or complementary treatments (Chwalisz et al., 2007) (Yao, R., 2022).

**Comparison with Other Studies**

The results of this study agree with previous research, affirming the clinical efficacy of each form of treatment and its application within certain circumstances. For instance, UAE remains as the most efficient minimally invasive approach to treating the symptoms as well as the size of the fibroids, while there is MRgFUS as a safe treatment and quick recovery treatment option for the selected patients only. Pharmacological treatments while being less optimal as a single modality are useful when it comes to managing symptoms and for transition to other forms of treatments (Zheng, S., 2024).

However, the variations make one realize that each case is unique and should be treated as different in case formation and management. This means that the size and location of the fibroid, patient's age, fertility needs, and availability of appropriate centres of referral are some of the key influencers of the most suitable management strategy (Gupta et al., 2014; Stewart et al., 2016).

**Clinical Implications**

As a result, these data support a more individualised approach to the treatment of uterine fibroids. UAE is suitable for the patients who want to have a permanent result and long-term treatment, while MRgFUS is suitable for patients who want less invasive treatment and fast recovery. Pharmacological treatments as it has been seen still put up a formidable line up of treatment options of course not being as comprehensive as it may have been anticipated, it is used in preoperative preparations or symptom alleviation simply to get the process started.

## CONCLUSION

Hence, this comparative analysis reveals more of UAÉ benefits and drawbacks, MRI guided focused ultrasound surgery advantages and inconveniences, and medicinal therapies that help to treat fibroids of the uterus. UAE is found to be the most optimal minimally invasive option based on its superior improvement in fibroid size, sustained symptom improvement and patient satisfaction, in terms of longevity of the treatment. MRgFUS can be recommended for patients who aim at the minimal risk and short recovery time required for the treatment yet its effectiveness and recurrence can also be different. Pharmacological therapies, although not as effective a stand alone modality as the mechanical ones, provide an important role in short term symptomatic relief and preoperative stabilization. The results show that patient characteristics and distinctiveness of pathological symptoms, size, and location of fibroids, fertility preferences, and availability of some types of operations should be taken into consideration during treatment planning. Future research concerning these long-term consequences and fertility preservation must be conducted in order to develop these approaches and attendance.

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