

# A High-Intensity Focused Ultrasound Surgery Theater Design in a Private Clinic

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## Abstract

Noninvasive high-intensity focused ultrasound (HIFU) surgery has become a popular surgical treatment for fibroids, adenomyosis, and various gynecological diseases in China and many countries. While traditional theater designs in hospitals are standardized and easily available for reference, an outpatient HIFU theater design is not yet available in the literature or is nonexistent. The authors presented the design and setup of an ultrasound-guided HIFU center in Hong Kong and listed the space and safety requirements and special features of their HIFU theater. Despite its limited space, the HIFU surgery center has made available a nursing station, a changing room, and an observation/recovery room. A room for learning HIFU treatment and viewing is also available without any intrusion of patient's privacy during treatment. The article concluded that because the space requirements for a HIFU theater were much reduced, the cost of the HIFU theater setup would be much cost-effective. Finally, its relaxing lighting environment was totally different and impossible to be installed in a traditional operating theater in a hospital.

**Keywords:** Adenomyosis, fibroids, HIFU, theater design

## INTRODUCTION

Noninvasive surgery using high-intensity focused ultrasound (HIFU) ablation has become a common treatment for fibroids, adenomyosis, and various gynecological diseases.<sup>[1,2]</sup> Currently, ultrasound or magnetic resonance imaging (MRI) is used for guidance during the procedure. MRI has excellent anatomical resolution and could offer temperature monitoring during the treatment of magnetic resonance-guided focused ultrasound surgery (MRgFUS). Compared to MRgFUS, ultrasound-guided HIFU (USgHIFU) ablation is less costly and is more suitably installed in clinics. Ultrasound offers real-time monitoring imaging and the gray-scale change during HIFU treatment is reliable in monitoring the response of the treated tumor to HIFU. In addition, USgHIFU ablation does not require the patient to be positioned in a confined space, the HIFU surgeon and

the nurse sit close to the patient. The patient experiences a friendly environment and can comfortably communicate with the HIFU surgeon or the nurse, and the treatment time is much shorter. Up to now, nearly up to 120,000 patients were treated with USgHIFU ablation surgery. Twenty-six countries have imported and studied this USgHIFU technology; these countries include the United Kingdom, Germany, Italy, South Africa, Argentina, Singapore, Korea, and Japan. Although USgHIFU is now common in hospitals in China and around the world, Korea is the only country where the USgHIFU treatment is used in outpatient clinics. Yet, there is no theater guideline for setting up a theater for USgHIFU. HIFU ablation is a safe and effective treatment for patients with uterine fibroids, adenomyosis, and other gynecological diseases, for the time being, nearly all HIFU ablation and equipment are performed and accommodated in hospitals

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for convenient and practical purposes. Because HIFU ablation is a noninvasive treatment with low complications and morbidities, it should be feasible to be performed in outpatient clinic either in hospitals or commercial doctors' clinic. The second author had visited many well-established and busy HIFU centers in China and Korea where more than 300–500 patients with fibroids and other gynecologic diseases are being treated in each clinic or center every year. The requirements and spaces of these HIFU theaters and their designs are being modified in the design of his new HIFU theater. In this article, the authors presented the design and setup of a new HIFU surgery center at a building in a very busy business area in Hong Kong and list the requirements and special features of the new theater. The objectives of this article are to share their experience and list the requirements and rational behind them in the design to set up a practical HIFU theater of a surgery center.

## GENERAL CONSIDERATIONS

Any theater design has to conform to conventional theater design in hospitals or outpatient department, not unlike those small day only theaters for minor surgeries or gastrointestinal endoscopic surgery. While theater designs in hospital had been standardized since the nineteenth century,<sup>[3]</sup> these guidelines are easily obtainable from the government departments or related health departments. However, an outpatient HIFU theater design has not been available in the literature or in existent. Conventionally, any theater design is the cooperative efforts between the architects and doctors or administrators toward the design and practical theater functions correlated at an early stage of planning, and most importance of all, the designs are to create an aseptic condition and provide adequate spaces for operations following any past regulations of theater requirements.

Because HIFU ablation surgery is noninvasive without any wounds or blood loss, it is then possible to distinguish the necessary from the unnecessary requirements in these theater designs compared to traditional theaters. They are (1) because of the minimal infection risk, sterile equipment, or instruments are not usually required during surgery. There is then no need for an easy access to a Central Sterilization Department and supply unit where sterile instruments and equipment are stored; (2) surgeons entering the HIFU theater do not have to change their cloths into sterile clothing, wearing clean hair cover/cap, masks, and boots. All storage designs to keep and dispose these items in male and female rooms are not necessary, this would reduce the use of spaces for change rooms and storage space; (3) spaces for keeping medical waste product like contaminated blood-stained swabs or gauzes are much reduced, apart from a few medical waste box for sharps. This reduces the requirement of dirty areas

for storage medical waste; (4) A simple handwashing basin is that would be required because very clean handwashing procedure can be avoided before and after the surgery; and (5) there is no need to design dirty corridor for medical wastes and contaminated instruments and clean corridor for doctors and patients.

As a result of the above differences, the demand for a larger theater space is much reduced; and thus saving the building cost and reduce the economic impact of building a new HIFU theater.

## MODERN HIGH-INTENSITY FOCUSED ULTRASOUND THEATER DESIGN IN A BUSINESS CENTER

### The size requirement of a high-intensity focused ultrasound theater

Figure 1 shows the commonly used HIFU machines in China – the JC 200 model and JC model which are manufactured by the Chongqing Medical Technology Co., Ltd. and are used to perform the HIFU ablation surgery for uterine fibroids, adenomyosis, and other gynecological diseases.

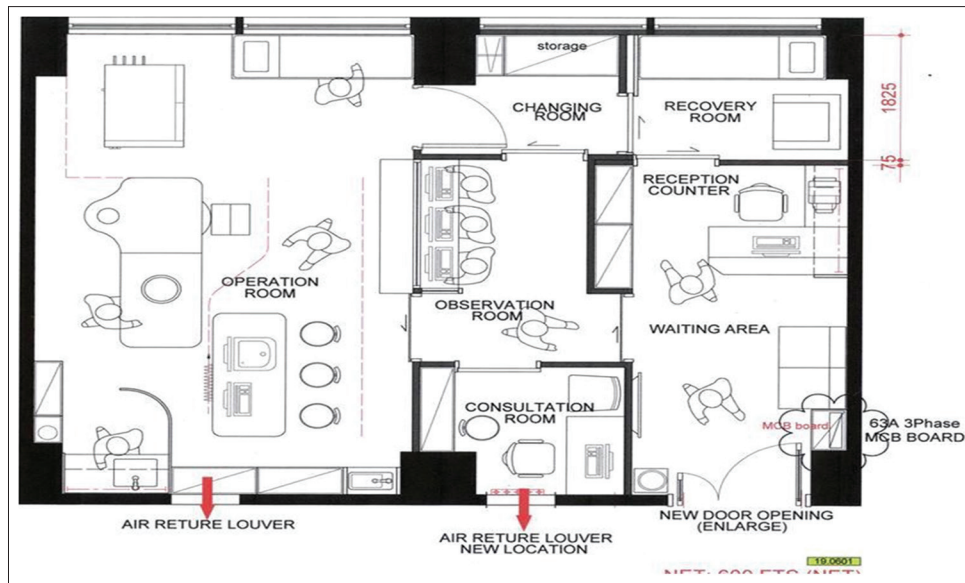
As advised by the manufacturer (Chongqing HAIFU Medical Technology Co., Ltd.), the area required to accommodate these machines are 400 sq.ft (around 40 m<sup>2</sup>) for JC and 300 sq.ft (around 30 m<sup>2</sup>) for JC 200, respectively. On a whole, the basic requirements for a HIFU theater setup compares to traditional theater are illustrated as follows:

Compared to the design guidelines of the modern endoscopy or day surgery center, the new HIFU theater does not have to link with a central sterile supply department, provides laminar airflow ventilation, maintains aseptic conditions, and solves the problem of cross infection.<sup>[4]</sup> Since HIFU ablation is a noninvasive surgical procedure with no wound or bleeding; thus no sterile environment is required during the HIFU ablation treatment. Furthermore, there are no contaminated medical wastes such as blood-stained gauzes, needles, sharps, or blood-contaminated instruments; it will reduce the spaces used to store these medical wastes.

Our HIFU clinic is located in a unit of 65 m<sup>2</sup> with its floor plan shown in Figure 2. Despite the limited area of our



**Figure 1:** Models JC and JC 200 high-intensity focused ultrasound tumor therapeutic systems



**Figure 2:** The floor plan of a high-intensity focused ultrasound outpatient theater in the clinic



**Figure 3:** The other parts of the high-intensity focused ultrasound center. (a) Reception and nurse station. (b) Interview and consultation room. (c) Change room and recovery room behind the door

premise and the need to provide half the space for the HIFU machine, the design of our HIFU clinic includes a reception area and nurse station, an interview and consultation room, a change room, and a recovery room [Figure 3]. A learning room [Figure 4] is also made available for doctors to learn this new technology without interruption of the HIFU operation. Adequate storage cabinets and cleansing areas are available as required.

For a HIFU theater, the key installation is the heavy HIFU machine and the water deoxygenation and water temperature regulatory cabinet, with a total weight of 3500 kg. The deoxygenation water used during the treatment can be of quite a large amount, and water drainage and water leaking have to be carefully monitored. The electricity power supply has to be adequate, and safety control has to be mandatory. All the technical details require close consultation with the

HIFU engineer from the Chongqing Medical Technology Co., Ltd. or other related HIFU company during the installation of the HIFU system.

Remote communication using high-speed telecommunication system linking Chongqing HIFU Medical Technology Co., Ltd. is also equipped in this new theater. Personnel in the theater can have instant repair instructions for the machine problem, and surgeon can send live surgical demonstration with Chongqing HIFU headquarter where, or prompt operative advice can be available.

### Special features of the high-intensity focused ultrasound theater

To provide a favorable environment and safety supports to patients during treatment, the design of our new theater includes the following features:

1. A multi-color lighting environment – it has been shown that some dual combinations of color lighting may have smoothing effects on a patient's mood. Therefore, a full wavelength LED ceiling lighting was installed in the theater as shown in Figure 4. This ceiling lighting is manufactured from Eco-lightech Solution Ltd., New Zealand. Being a full-spectrum LED lighting, various combinations of lighting and intensity can be adjusted to the comfort and to calm the anxiety of the patient receiving surgery instead of the bright lighting in traditional theater when surgeons often need for operation.<sup>[5]</sup> Doctors operating HIFU ablation treatment do not require the traditional bright operating lighting. As patients are fully awake during the HIFU treatment, dim-colored lighting will be of great help to reduce their anxieties during surgery. Patients in such an environment may feel less frightened, because traditional theater lighting may recall their past surgery experience or those seen in movies



2. The wall picture in our theater creates a relaxing environment. This nontheater like and friendly environment are appreciated by patients who are awake without anesthesia during operation. Often past surgery experiences such as lying in a bed within a brightly lit operation room waiting for injection, intubation, and surgery can be a scaring experience. Then, a pleasant outdoor environment may make a patient feeling relaxed. The wallpaper in our center showed the clear sky of a beach. It is expected that patients may feel more relaxed toward her surgery when she is receiving HIFU treatment
3. Traditional theater safety requirements are also considered important and incorporated into the design of this new center as shown in Figure 5. They are (a) waterproof and nonslippery floor, (b) adequate power and safety keys for preventing sudden electricity surge or blackout, and (c) resuscitation facilities are available if needed. As only sedative and analgesic drug are being used, severe anaphylactic anesthetic events are not expected. Nevertheless, medications for emergency situations are available to tackle unexpected complications, for example,

reactions to oxytocin, electrolyte imbalance, or anaphylactic reaction to the ultrasound contrast (microbubbles) used during treatment. A well-equipped resuscitation trolley is also easily available, and (d) oxygen supply, air tubes, resuscitation manual ventilator, endotracheal tube protector, and camera monitoring are available to handle sleep apnea during sedation. Expensive anesthetic machine and cardiovascular resuscitation device are, however, not necessary or required

4. Education and training: To support the learning of a new surgery, training to doctors are made available in the clinic. Unlike doctors in traditional theater, doctors come for learning are sitting in the learning room [Figure 6] where all HIFU operating screens are displaced, also questions and answers communication between the HIFU surgeon and learners in learning room are available to facilitate the learning process during the surgery.

### CONCLUSION

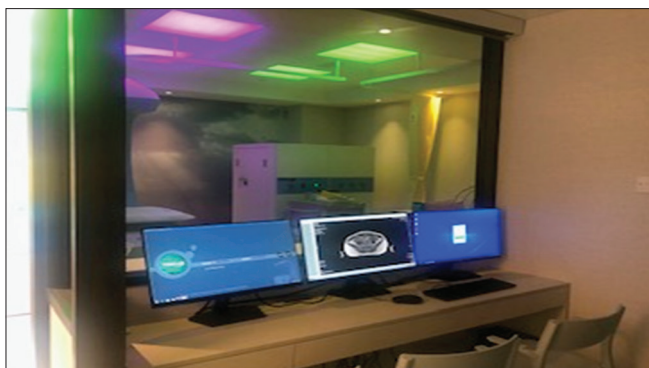
The operating theater is the place in which surgical procedures are being carried out. With the increasing use of HIFU ablation surgery in hospitals and around the world, there will be a need of a dedicated HIFU theater which can be structurally and functional different from traditional operation theater. Today, publications with practical details for setting up a HIFU theater are nonexistent. At present, these HIFU theaters are either placed in a room within a ward or within a traditional theater. Placing a HIFU theater in traditional operating theater will be a waste of space and money. It seems to be a lack of consideration of the economic implications and inappropriate understanding for this new technology. If a HIFU theater is to have its own more functional design, the functionality and basic requirements are extremely important, necessitating careful planning to provide comfort to patients



**Figure 4:** The appearance and colored lighting of the high-intensity focused ultrasound operating theater



**Figure 5:** Monitoring and safety requirements installed in the high-intensity focused ultrasound clinic



**Figure 6:** The facilities of a learning room

and surgeons during the HIFU treatment. In this article, we would like to share our experience in setting up a new HIFU theater for consideration.

From our experience, theater spaces are not an important issue for a HIFU theater, because our small room with a floor area of 300 sq.ft can adequately accommodate the HIFU machine. Of course, larger available area will enable more comfortable and spacious environment for the surgeon and patients and provide larger training facilities for doctors.

Even though our HIFU theater is located in a clinic, depending on a patient's medical condition, for example, sick patients, patient with terminal cancer, or unstable hemodynamic condition, it may be more acceptable to treat these patients in hospital where more monitoring and postoperative care are considered safer. For this reason, some HIFU theaters can be more suitably located at the outpatient department of a hospital or within the hospital complex. In addition to the proper selection of patients for HIFU ablation surgery in a clinic, it is recommended to have a properly designed HIFU theater, which can provide adequate monitoring facilities and nursing care to look after patients during and after the HIFU surgery.

To summarize, there are many advantages of a dedicated and well-designed HIFU theater; these are as follows:

1. Economic impact – reduced building cost to hospitals, indirectly it may benefit patients' expenditure by minimizing space and accessory uses of equipment and instruments
2. Environment impact – the use of HIFU definitely minimizes the production of medical waste and contributes to reducing pollution in the world environment
3. Patients receiving HIFU ablation surgery will experience

a different surgical service with comfort and painless treatment, as well as outside a traditional theater environment

4. Infection control – hospital cross infection can rarely occur due to the noninvasive nature of the surgery
5. Early discharge home – patients can go home on the same day or after overnight stay in a day surgery center or hospital.

On a whole, this is a new era of noninvasive surgery, especially in the field of the treatment of fibroids, adenomyosis, and other gynecological conditions. Here, we are to share our experience of setting up a dedicated designed HIFU theater, hopefully to contribute to the knowledge and better understanding of this new surgery.

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Nil.

### Conflicts of interests

The second author was involved with the design and use of this facility, and he received advice from Chongqing HAIFU Medical Technology Co., Ltd. regarding the technical issue. We wish to share our theater design and experience of setting up a new modern HIFU theater concept which would contribute toward future development guidelines of HIFU theaters.

### REFERENCES

1. Chen J, Li Y, Wang Z, McCulloch P, Hu L, Chen W, *et al.* Evaluation of high-intensity focused ultrasound ablation for uterine fibroids: An IDEAL prospective exploration study. *BJOG* 2018;125:354-64.
2. Zhang L, Zhang W, Orsi F, Chen W, Wang Z. Ultrasound-guided high intensity focused ultrasound for the treatment of gynaecological diseases: A review of safety and efficacy. *Int J Hyperthermia* 2015;31:280-4.
3. Smylie HG, Dudley HA. Some principles in operating theatre design. *Scott Med J* 1961;6:589-96.
4. Mulder CJ, Jacobs MA, Leicester RJ, Nageswar Reddy D, Shepherd LE, Axon AT, *et al.* Guidelines for designing a digestive disease endoscopy unit: Report of the world endoscopy organization. *Dig Endosc* 2013;25:365-75.
5. Dinshah D. *Let There Be Light*. Malaga, NJ: Dinshah Health Society; 1985.