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PREAMBLE

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Ultrasound has been commonly used as a diagnostic real time imaging modality in medicine for decades because it is relatively safe, inexpensive and noninvasive. Long before it became a diagnostic modality, ultrasound had been applied as a therapeutic tool. Unfocused ultrasound has been used in physical therapy since the 1930s; the development and application of techniques for this purpose was recently reviewed by Nyborg (2001). Focused ultrasound has been employed clinically since the 1950s. In a review, Fry (1958) describes both structural and functional changes produced in exposures of the central nervous system to focused ultrasound, and states that “by appropriate control of the dosage conditions, it is possible to produce either reversible or selected irreversible changes.”

In the past ten years or so, therapeutic ultrasound has grown rapidly. It has been shown that several emerging ultrasonic techniques may already have or will become very powerful therapeutic tools in medicine. The purpose of this book is to bring together internationally renowned authorities and experts in this field to give our readers comprehensive reviews on basic physical principles and applications of those emerging therapeutic ultrasound techniques. The topics of this book include reviews of mechanisms for bioeffects of ultrasound relevant to therapeutic applications (Chap. II), high intensity focused ultrasound and its application in surgery (Chaps. V and VIII), ultrasound assisted target drug and gene delivery (Chaps. III, IV, VI) and transdermal drug delivery (Chap. VII). We believe that medical professionals, biomedical engineers, graduate students and others working

in this multidisciplinary field will benefit by reading the exciting chapters written by our contributors, many of whom are pioneers in their fields.

Some techniques discussed in this book have already been used clinically. For example, extracorporeal ultrasound-guided high intensity focused ultrasound (HIFU) has been successfully used in treatment of patients with solid malignancy (Chap. VIII). From December 1997 to March 2004, approximately 3,500 patients received HIFU treatment of solid malignancies in 20 Chinese hospitals. The malignancies treated with HIFU include liver cancer, malignant bone tumors, breast cancer, soft tissue sarcomas, kidney cancer, pancreatic cancer, abdominal and pelvic malignant tumors, uterine fibroid, benign breast tumors, and hepatic hemangioma. When combined with MRI, an imaging modality of high resolution, HIFU may be further improved in its accuracy of locating tumors, as well as temperature monitoring and will eventually provide surgeons a “knife” of high precision without opening a patient’s body (Chap. V).

Other techniques are still at the clinical trial stage. For example, professionals in several countries have shown that ultrasound can enhance the efficacy of thrombolytic agents to benefit acute stroke patients (Chap. IV). Transdermal drug delivery is another successful application of ultrasound. Clinical studies have already demonstrated that low-frequency ultrasound (20 kHz–100 kHz) can be effectively used in both transdermal drug delivery and glucose extraction applications (Chap. VII). Compared with traditional oral and injection drug administration methods, transdermal delivery can avoid gastro-intestinal side effects and can release drugs in a controlled fashion for a sustained period of time.

Gene therapy and targeted drug delivery are two promising technologies in medicine. They are evolving and will continue to change how medicine can be delivered. Although the development of ultrasound-directed drug and gene delivery is still in a research stage, their potential has already been demonstrated *in vitro* and *in vivo* (Chaps. III, IV and VI). Specificity in targeting is a unique characteristic of ultrasound techniques, compared with other delivery means such as electroporation and many viral techniques.

The ultrasonic techniques described in this book are still swiftly developing. It is our hope that this book will serve as a reference for this exciting field. Readers who are interested in learning more about techniques

described in the various chapters can find further information in the comprehensive bibliographies provided.

References

- Fry WJ. Intense ultrasound in investigations of the central nervous system, in Tobias CA, Lawrence JH (eds.) *Advances in Biological and Medical Physics* (1958) Academic Press: New York, pp. 281–348.
- Nyborg WL. Biological effects of ultrasound: Development of safety guidelines. Part II: General review. *Ultrasound Med Biol* (2001) **27**: 301–333.