Ultrasonics Sonochemistry 27 (2015) 649–653

Contents lists available at ScienceDirect

Ultrasonics Sonochemistry

journal homepage: www.elsevier.com/locate/ultson

Editorial

The theoretical basis of minimally-invasive and non-invasive medicine: Treatments—Minimize harm to patients

Zhibiao Wang

College of Biomedical Engineering, Chongqing Medical University, No.1 Yixueyuan Rd, Yuzhong District, Chongqing 400016, China

ARTICLE INFO

Article history:
Received 15 May 2015
Accepted 21 May 2015
Available online 28 May 2015

Keywords:
Minimally-invasive and non-invasive medicine
Treatments—minimize harm to patients
HIFU
UAE
Laparoscopic surgery
Hysterectomy

ABSTRACT

This perspective, for the first time, proposed the theoretical basis for the minimally-invasive and non-invasive medicine. It sets the goal of medical treatment that is to minimize harm to patients and to maximize the natural self-healing power for fighting against the disease. It took a historical review on the technological developments shaped by the minimally-invasive and non-invasive ideology with a focus on the course of research, development and clinical deployment of the high-intensity focused ultrasound (HIFU) ablation therapy by the Chinese research team. It also summarized the highlights of the "1st Yangtze International Summit of Minimally-invasive and Non-invasive Medicine 2013" and the mandate of the newly inaugurated International Society of the Minimally-invasive and Noninvasive Medicine (ISMINIM). It provides a perspective on the future development of this emerging field and its impact on human civilization.

1. Theoretical basis of minimally-invasive and non-invasive medicine

1.1. The minimal and optimal structural composition of the human body

Millions of years of human evolution has sculpted the human body into its present state: a minimal, integral, the simplest yet most precise structure known to the mankind. As such, the body will not be structurally sound and intact in the absence of any individual unit in each and every phase of its growth and development of a human life. The layout of its tissues, the morphology of its organs and even the connection between its cells are of extreme precision that displays the heavenly beauty of God's send.

For example, the traditional medical believes of the organ "appendix" has been that not only it bears no beneficial physiological functions to the human body, it often causes harm and pain due to its high incidence of inflammation. Therefore, this organ is customarily removed when diagnosed with inflammation, or resected as a useless organ during a laparoscopic surgery, or should be, as suggested by some, removed at the birth of a child as a preventive measure. This view remained unchanged for centuries until only a few years ago when new insights into the functions of the appendix had been discovered. It is now known that the appendix, being rich in lymphoid tissues, containing B cells and T cells, resembles the bursa of Fabricius structure of a bird. It should be categorized as an organ of the central immune system that could play an eligible role in triggering the two major immune functions of the body: cell-mediated immunity and humoral immunity. The latest research further revealed that the appendix also has secretory cells that can secret various substances including digestive enzyme and growth-related hormones [1].

Structural damage to the body would unavoidably inflict impaired body functions. Therefore, the most desirable medical treatment option would be the one that yields minimal damage to the structure of an organism. Only so, can the structural integrity of tissues and organs be conserved to the fullest, which exemplifies the highest respect for the natural evolution, as well as for the ever growing knowledge of medical sciences.

1.2. The goal of medical treatment is to maximize the natural self-healing power for fighting against the disease

As early as the 4th century BC, Hippocrates, the founding Father of Medicine, cautioned doctors, "Do not over do" since "the primary goal for doctors to exercise their medical skills is to cure the person who has the disease. Among all options to achieve this goal, the simplest one should be selected [2]". He articulated, "Nature is the rehabilitee of the disease" [3]. Underlying the naturopathy of Hippocrates is the message that nature is a consummate and orderly entirety governed by its inherent laws, and any damage to its order may bring disasters [4].

E-mail address: wangzhibiao@haifu.com.cn

http://dx.doi.org/10.1016/j.ultsonch.2015.05.023
1350-4177/

Hippocrates's wisdom is echoed in the philosophy of "Strengthening body resistance to dispel pathogenic factors [1]", a central tenet of Traditional Chinese Medicine (TCM), which accentuates the significance of conquering disease by nurturing the natural healing power within the body [5]. This belief of TCM, is an insightful interpretation of the plain truth of minimally-invasive and non-invasive medicine of the modern medicine.

Thus, the development of a disease and the recovery from it are both a self-organization process for the human body. Then the purpose of medical treatment is to use the minimal intervention to maximally mobilize the natural healing power within the body for fighting against the disease.

1.3. The core concept of minimally-invasiveness and non-invasiveness: treatments—minimize harm to patients

The appearance of body structures such as ribs and abdomen, etc., during the course of evolution of human body is an adaptation to protect or minimize the viscera from incurring the external injuries. The escaping response induced by a pain sensation displays the utmost desire to be saved from injury. "Diseases that harm require therapies that harm less [6]." As such, patients are entitled to receive treatments that are improved towards being "safer, more effective, more comfortable and more efficient". "Treatments: Minimize harm to patients," wherein lies the very essence of the minimally-invasive and non-invasive medicine and will meet the renewed expectations of the patients. In a broad sense, medical treatment involves not only diagnosis and treatment, but also embodies the verbal expression and the behaviors of the medical professionals.

We should not be satisfied with inflicting no or little damage to the body structures in the "operation" path, attention should also be given to minimize destruction to the structure of tissues and/or organs around the lesion in the targeted organ during an operation-like procedure. Simply because that the damage to the abdominal wall should not be neglected. Take an example of the operative treatment of the paramedian incision in the hypogastrium. The very first incision would result in the loss of continuity in the skin and breakage of ramus cutaneous anterior, the subcutaneous vascular and lymph-vessel of intercostal nerve and the subcostal nerve. Further incision and divulsion of abdominal wall would cause the sequential ripping apart of the fat layer, muscle layer, fascia and peritoneum, most of which will be marked by permanent scars during the tissue repair process. What these scars speak to us are the irrevocable damage to the normal structure in each layer of the abdominal wall, which, in turn, will have functional consequences, such as reduced skin sensation and muscle weakness due to denervation. Worse still, along with the scars, the inherent biomechanical properties of the abdominal wall are altered, leaving "weak spots" on the abdominal wall, thus lowering the labor capacity. In some sever cases, abdominal wall hernia may occur. The longer the incision, the more sever is the damage, and the more adverse impact on the general health state post-operation.

An excellent solution for abdomen operation path has been worked out since last century: the surgical "incision" procedure was replaced with laparoscopic "perforation". In a laparoscopic surgery, pore canals at three discrete positions are made. Compared with incision surgery, the laparoscopic surgery no longer produces continuous damage to the abdominal wall or disruption of the overall tissue organization. It has the additional merits of speedy recovery. From the end of last century to the beginning of this millennium, a non-invasive surgical-like method, the high-intensity focused ultrasound (HIFU) surgery, has being developed that has the capability to deliver treatment to the internal targeted organ excorporally limiting the desired damage only to the lesions within an organ. This surgical procedure, not only leaves negligible or no damage to the structures on the operation path, it preserves the surface of the target organ unscarred. At the completion of such surgery, the abdominal wall is cosmetically and functionally intact and the quality of life and health of patient are not compromised. The development of this surgical procedure exemplifies the essence of "Treatments—Minimize harm to patients".

The principle of "Treatments—Minimize harm to patients" embodies the following: (1) the treatment option of choice can effectively eliminate the source of the disease thus in turn reduce its threat to the well being of the patient; (2) the treatment option of choice causes minimal harm to the patients when it is deployed; and (3) the ratio of the benefits of treatment to the harm is maximized.

The harms resulted from a surgical procedure include both the physiological and the psychological damages, with the latter may suffer from damage to the outer appearance, the loss of an organ or the discomfort experienced during the treatment. Therefore, the following factors should be taken into account for the treatment planning: (1) to weigh in the pros and corns of the different treatment options to determine whether a treatment is required, and if so what will be the optimal treatment of choice that will minimize the harms; (2) once a treatment option is indentified, one needs to weigh in the balance between the "completeness" of the treatment to eradicate the disease and the "harms" it will inflict for achieving such completeness. Finding such balance is the key to determine the appropriate level of a given treatment. For example, hysterectomy can improve the quality of life by eliminating menorrhagia resulted from myoma, but if the loss of womb would significantly lower the quality of life for the depression it might cause, uterus-preserving myomectomy will be a more appropriate choice. Along the same line, breast cancer, can be cured by radical operation or modified radical operation through excision of part of the breast or excision of the whole breast based on tumor staging. Both operations are of curative intent. However, both will result in drastic appearance change that could lead to severe psychological trauma. This is the form of unspeakable "harmfulness" of treatment that in the past, many patients would avoid to incur. Now as required by the patients, reconstruction of damaged breast is adopted to restore the appearance, thus reducing or eliminating the debilitating impact on mental health of a cancer patient.

"Treatments—Minimize harm to patients" is a philosophy that governs every aspect of medical practice. From a surgical point of view, it involves not only the selection of the means and levels of surgery, but also includes every procedure performed in the entire process. To be specific, care must be taken to make sure the surgery paths follow the physiological gaps without separating parenchymal tissue; surgical procedure involving sharp dissection (causing incision injury) is preferable over blunt dissection (causing laceration); if applicable, one hemostat is preferred over two for hemostasis; in the operation, dressing is pressed, but not brushed to prevent brush-burn. Man is an emotional being. A patient's perception to harms associated with a treatment is heavily influenced by his/her psychology. If medical professionals can provide clearer explanations and more consolation, patients will have less negative feelings and more confidence about the treatment outcome.

2. Technological developments shaped by the minimally-invasive and non-invasive ideology

Only when we whole-heartedly embrace the creed "Treatmen ts—Minimizes harm to patients", can we develop medical technologies in accordance with the belief that "respect for life begins with respect for the integrity of each tissue and organ of the body",