Brave to Advance the Theoretical and Technological Innovation on the Basis of Orthopedic Practice

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Innovation springs from practice, and its soul lies in practical thinking. All human wisdom is a product of practice and needs to be tested during the practice. With the rapid development of medicine, a clinician has to keep pace with the new era, grasp the pulse of the times and innovate. Only in this way, could he or she lead the trend of the new era. Clinical medicine is a practical science and implemented mainly by clinicians, requiring them to explore the truth and pursue technological innovation all the time. At the same time, as an academic leader, a clinician is encouraged to practice actively, to take risks to innovate, to pursue truth and test truth in the practice, discarding old ideas and correcting wrong theories and technologies. To summarize, a clinician has to push forward practice-based innovation of theory and technology to keep up with the pace of the times.

Discovering issues in practice are the primary essential in innovating. Without participating in the process of clinical diagnosis and treatment and contacting with patients personally, clinicians could not identify problems and solve them, let alone deliver meaningful innovation. Innovation based on clinical practice is convenient and practicable, which can truly solve clinical problems in reality. Innovation raised merely through talking is like water without a source or a tree without roots, which could not go through the proof-test of practice.

Throughout the history of the development of orthopedics in the world, all scientists who have made outstanding contributions in orthopedics, without exception, found problems and inspiration in the course of clinical practice and carried out repeated practice and demonstration to find new ways to solve problems. Known as the "The father of orthopedics," the Chinese Orthopedic Pioneer Prof. Fang XZ devoted his life to orthopedic research. He completed the first surgery of removal of bone tuberculous lesions in the world when he was 40 years old, and solved the problem that had puzzled the world's orthopedic surgeons for the year.[1] In the process of lumbar interbody fusion, the neurosurgeon of the University of Hawaii Burns Medical School found that the use of autologous bone as a graft material for intervertebral fusion had the disadvantages of displacement, collapse, and pain in the donor site. Kuntscher, a German orthopedist, after numerous operations, designed the Kong's nail that became popular in the 1980s.[2] These discoveries, inventions, and creations were all derived from clinical practice, and they were the result of the accumulation of clinical practice and the crystallization of thinking over the years.

As a clinician, reading is important, but clinical practice is more important. Reading should not only focus on medical books but more on the outside books. From the ivory tower to go out to practice, it is a big step forward to find the problem. It is possible to discover clinical problems by the combination of knowledge and practice. In the future, the proportion of contribution of technology in medicine might be up to 80% and that of surgical skills around 20% or less. If this standard is not met, it cannot be called modern medicine. Surgeons who only immerse themselves in surgery could only be called surgeons – operating their own "robot". From knowledge to practice, and from practice

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to knowledge, innovation is possible through practice and thinking; and therefore, a thoughtful "intellectual" clinician could be sought.

Medical science is constantly developing, and theories, techniques, and materials based on practice must be consecutively reformed, improved, enriched, and developed. That is what we call "Innovation". The international status of Chinese orthopedics has developed from "running after" in the 1980s and "running together" in the 1990s to presently "leading" in the field of some theories, techniques, and materials. Prof. Qiu GX from Peking Union Hospital made a breakthrough in the research of molecular genetics of scoliosis.[3] He found that *TBX6* gene was closely related to scoliosis, and the result was published in The New England Journal of Medicine.[3] The core idea of "a closed loop regional trauma treatment system focusing on synthetical hospitals" proposed by Prof. Baoguo Jiang was published in the Lancet.[4] Prof. Wei T from Beijing Jishuitan Hospital solved the long-term fatal shortcoming of minimally invasive surgery through robot accurate navigation technique. The original orthopedic surgical robot successfully completed the world's first orthopedic robot-assisted Magerl screw insertion for internal fixation of the odontoid fracture.[5-7] A research of novel cartilage scaffold invented by Prof. Ao YF from Peking University Institute of Sports Medicine was published in Advanced Materials.[8] Our team spent 15 years and completed the first national epidemiological survey of traumatic fractures across China. We built the Chinese orthopedic big database on traumatic fractures, which can be used to inform injury prevention policies and interventions.[9-11] Prof. Yu AX from Zhongnan Hospital of Wuhan University adopted biological semiconductor nanoparticle labeling for thrombus, coordinated with photoacoustic imaging technology to monitor the morphology of thrombus during treatment, and the relevant outcome was published in ASCNANO.[12] Prof. Weng XS from Peking Union Hospital developed a silk-based hydrogel with self-repairing photopolymerization properties, which was published in Advanced Functional Materials.[13] Prof. Luo ZJ found that mutation of *SCL26A2* gene is closely related to dysplastic spondylolysis, and the result was published in PNAS.[14] Prof. Tang PF from the General Hospital of the People's Liberation Army of China first revealed the immune negative regulation mechanism for multi-organ damage, and established a new diagnosis standard, classification and prognosis evaluation system for multi-organ damage, making a major breakthrough in the treatment of severe traumatic or military injuries.[15-18]

Innovation has the following three characteristics: originality, practicality, and recoverability. If innovation is not original, it cannot be called innovation. If there is no practicality, there is no innovation value. Innovation without value is to be sensational, not only harming others but also harming oneself. If it cannot be recovered, it is unscientific. Indeed it is an innovation of fraud. In 2005, South Korea's "Father of Clone," Hwang Woo-suk, professor of Seoul National University, whose research group published a paper in the world's top academic journal, Science, claiming to be able to clone embryonic stem cells using somatic cells. In 2014, Haruko Obokata and his research team from Waseda University published a paper in another top journal (Nature) which announced the preparation of a "universal cell" - the stimulus-triggered pluripotent cells. Both of them were ruined for academic fraud.

Clinical scientists should keep a healthy mindset. We should correctly control ourselves, be the practitioners of innovation in the field, and be the leader of ideas. We should also grasp the clinical practice, be good at discovering, think with heart, and effectively improve the innovation ability of ourselves and the team.

To be a creative scientist and an expert capable of leading the direction of innovation, there are six aspects to be kept in mind: (1) Foster a strong sense of innovation and keep innovation in mind. Problems must be solved by all means. We should consider how to apply the innovation, how to make the innovation spread simply and widely, and how to adapt the innovation to the properties of bone and soft tissues and cause less harm of bone and soft tissues. (2) Practice the innovation thinking quickly. If we have an innovation inspiration, we should conduct basic experiments to prove the inspiration and publish the results on journals as soon as possible. Then, we should do some further research, such as application test and long-term prospective and multi-center research. (3) Challenge to tradition and get rid of constraint. Some traditional equipment, technology, and materials have been unable to adapt to the development of science and technology, and opinions from abroad, from experts or famous universities, are not entirely true either. We should consider whether mainstream equipment, technology, and materials can become more convenient, effective or practical. (4) Strengthen capacity building for innovation. We should not only make up for our shortcomings but also find other researchers' limitations and find ways to make them better. Thinking is the soul of innovation, so we should be able to think as well as learn. (5) Be willing to be lonely without distractions. Innovation requires concentration, not going with the trend, not going after fame and wealth, and not innovating for the sake of innovation. (6) Be persistent in doing things. Many clinical problems that have not been solved and needed to be solved remain before us. We can solve problems perfectly only with critical technology and multiple approach, and persistence. We need to be prepared because innovation is not always easy. We also need to learn from our failures, find the causes, improve over and over again, work together, and keep faith until we get scientific results.

Theory comes from practice, and guides practice, and is tested by practice. The practice has no limits, and innovations of theory, technology, and material have no limits either. The world of medicine is developing and changing all the time. Theory, technology, and materials are constantly developing and progressing. We must persist in learning and keep up

with the trend of the times, in theory, the pace of the times in technology, and the development of the times in material science, constantly understand the rule and lead the new trend of medical development.

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