

## ***Ilizarov technology and chinese philosophy (To commemorate the 100<sup>th</sup> anniversary of the birth of Professor Ilizarov)***

**S. Qin<sup>1,4</sup>, J. Zang<sup>2,4</sup>, B. Guo<sup>3,4</sup>**

<sup>1</sup>Rehabilitation Hospital of National Research Center for Rehabilitation Technical Aids,  
Key Laboratory of Human Motion Analysis and Rehabilitation Technology of the Ministry of Civil Affairs, Beijing, China

<sup>2</sup>School of Population Medicine and Public Health, Chinese Academy of Medical Sciences/Peking Union Medical College, Beijing, China

<sup>3</sup>Chuiyangliu hospital of Tsinghua University, Beijing, China

<sup>4</sup>Qinsihe Orthopedic Institute Beijing, China

The Ilizarov technology was honored as a "milestone" in the history of orthopedics in the 20<sup>th</sup> century, benefiting tens of thousands of patients around the world, including Chinese patients. The paper presents an analysis of the integration of the method into Chinese medicine, taking into account national traditions, culture and clinical thinking. Ilizarov technology has revolutionized the orthopaedic surgery and clinical limb regeneration medicine in China. Ilizarov's methodology arose suddenly and brought about revolutionary changes in terms of theoretical guidance, methods of thinking, tools used and medical procedures. For the first time, Ilizarov's discovery made people realize that the human body, natural selection in biology and joint symbiotic evolutionary characteristics are common, namely, as long as the levers activate the tissue regeneration switch and changes in regulation, any tissue at any age and to any degree can complete the self-healing process in according to the requirements of doctors and the expectations of patients, similar to the growth of children. The process of working with an external Ilizarov fixator is like playing chess and changing a kaleidoscope, and the countless number of free combinations of stress configurations can be changed in accordance with the needs of the treatment. In China, Qin Xihe integrated the Chinese culture into the Ilizarov technology, thus forming the Chinese Ilizarov technology. He proposed new concepts such as the concept of natural reconstruction, evolutionary orthopedics, interpretation of body language, one walk, two lines, the principle of three balances, happy orthopedics, etc., which were introduced into clinical practice in the field of limb deformity correction and functional reconstruction. As of December 31, 2018, 35,075 cases of various deformities and disorders of the limbs were entered into the Qinsihe orthopedic database, of which 8113 cases were treated with external fixation (Ilizarov technology). The statistics of a large number of cases showed striking results: diseases treated with this technique covered almost all sections of orthopedic pathology and more than 10 sections of non-orthopedic and traumatological pathology, including vascular, nervous, genetic, metabolic, and skin diseases. In addition to orthopedic, there are more than 170 diseases in total. When Ilizarov's technology is applied, it can magically transform the old into the young. Therefore it is known as a "lifeboat". **Conclusion** Over the past 70 years, Ilizarov's ideas and technologies have been preserved, updated and augmented. Ilizarov's technology serves as an evolutionary phenomenon that transcends bone science. If you understand this technique, you will understand the direction of modern orthopedic surgery and regenerative medicine. Professor Ilizarov's morale and the spirit of fighting to alleviate the suffering of patients were transferred to the Chinese medical community. This awakened many Chinese doctors who followed the norms of the old and stereotyped medicine. After celebrating the centenary of the birth of Professor Ilizarov, ASAMI China will also prepare for the "Sixth ASAMI & ILLRS-BR World Conference (Beijing 2023)". We believe that orthopedics and allied disciplines around the world have a bright future.

**Keywords:** Ilizarov method, Ilizarov philosophy, Chinese medicine, Chinese philosophy, cultural traditions of China, integration of the Ilizarov method into Chinese medicine, biological laws

Professor G.A. Ilizarov was a world-renowned medical scientist nursed by the great land and culture of Russia. The Ilizarov technology was honored as a "milestone" in the history of orthopedics in the 20<sup>th</sup> century [1], benefiting tens of thousands of patients around the world, including Chinese patients. When Ilizarov died on July 24, 1992, Qin Sihe happened to visit the Hospital of the Jewish Autonomous Region of the Far East of Russia and attended the memorial ceremony held in the hospital, witnessing the Russian people's worship of Dr. Ilizarov as a national hero. On July 27 of the same year, Qin Sihe, on behalf of China, signed a cooperation agreement between China and Russia in orthopaedics with the Department of Health of Birobizhan City, thus promoted the spread, development and transformation of the Ilizarov technology in China. Ilizarov's spiritual and technical system has also been injected into the development of the Qin Sihe

orthopaedic team and transformed into the discipline culture.

The Ilizarov technology has taken root in China and completed its local transformation [2]: Qin Sihe integrated it with Chinese cultural elements in clinical thinking; the concept of natural reconstruction was proposed in orthopedic clinical practice [3]. A case database of orthopaedic surgery was established [4]. A technical system of correction and functional reconstruction of limb deformities under stress control with Chinese characteristics has been formed, and tens of thousands of complex wounds, limb deformities and intractable diseases have been cured. Ilizarov technology has revolutionized the orthopaedic surgery and clinical limb regeneration medicine in China. Through the connection between multiple clinical disciplines, engineering technology and digitization, the Ilizarov technology has saved a large number of

patients with limb deformity who are on the verge of amputation. Ilizarov is the second person in the Russian medical and health circle who made great contributions to the Chinese medical community after Ivan Petrovich Pavlov, winner of the Nobel Prize in Physiology and Medicine in 1904. We are forever grateful to Russia for its contribution to Chinese medicine.

The year 2021 is the 100<sup>th</sup> anniversary of the birth of Professor Ilizarov. As a major academic organization for the application, promotion and dissemination of Ilizarov theory and technology in China, ASAMI China will hold a Humanities and Academic Forum to commemorate the centenary of Professor Ilizarov's birth on June 18-20, 2021 to review the brilliant development of the Ilizarov technology.

### **I. Ilizarov's theory and technology "deviations" have brought enlightenment to the development of Chinese medicine**

The 20<sup>th</sup> century witnessed six milestones in the world of orthopedics, namely, the nail and rod system of spinal surgery, artificial joints, arthroscopy, microsurgery, AO internal fixation and the Ilizarov technique [1]. Although each has its own indications, the basic principles of the first five advances are as follows: fracture reduction and fixation and deformity correction are completed during surgery; replacement reconstruction or prosthesis replacement; free skin flap repair; if the problem cannot be solved by one operation, two or more operations are needed. Those who cannot solve the problem can choose to amputate and install a prosthetic limb. However, the Ilizarov technology emerged suddenly and made a groundbreaking change in terms of theoretical guidance, thinking methods, applied instruments and medical procedures [5]. Internal fixation technology requires technical integration, and the treatment concept is open reduction, full exposure, strong fixation, and early postoperative functional exercise. While Ilizarov technology emphasizes the flexible use of Tension-Stress Law and the choice of fixed mode according to individual differences to maximize the protection of autogenous tissue. It utilizes the stable spatial mechanical structure of random combination to mobilize the repair potential of autogenous tissue.

Stress-regulated limb reconstruction is the second revolution in orthopedics and reconstructive surgery. For the first time, it made people realize the human body and natural selection in biology and collaborative symbiotic evolution characteristics in common, namely, as long as leverage, activate the switch of tissue regeneration and regulation change, any tissues at any age or any extent can complete the process of self-healing reconstruction according to the requirements of doctors and patients' expectations, similar to the growth of children. The operation process with Ilizarov external fixator is like playing chess and changing a kaleidoscope, and countless free combinations of stress action configurations can be changed according to the needs of treatment. If

the disordered tissue has lost the basic conditions for self-repair, the doctor should be decisive to implant the patient with an artificial prosthesis or replace functional items.

As the guiding ideology changes, the corresponding medical path, medical model, clinical path, academic guidance, industry culture and language expression should also change. Doctors who use the technology must learn a new language and intellectually reshape and conform to the culture of the profession. However, the orthopedic profession is too attracted by the market of "Internal fixation", "Joint replacement" and alternative reconstruction, and most people may not realize that limb regeneration and repair and ecological reconstruction are the medical mainstream in the third millennium. Therefore, we should carefully consider what is ecological orthopedic and what kind of doctor patients need.

### **II. The thought of limb reconstruction consciously entered the philosophical palace of "medical way of nature"**

The Ilizarov technology introduced orthopedics into the palace of natural philosophy [6], and, for the first time in the history of medical science in the world, it introduced the concepts of natural philosophy, such as time and space, development, evolution, symbiosis and regulation, into the clinical process of treatment. In China, Qin Sihe integrated the Chinese culture into the Ilizarov technology, thus forming the Chinese Ilizarov technology. He proposed new concepts such as 'natural reconstruction concept', 'evolutionary orthopedics', 'body language interpretation', 'one walk, two lines, three-balance principle', 'happy orthopedics' and so on, which have been put into clinical practice and become a representative figure in the field of limb deformity correction and functional reconstruction in China.

Clinicians' understanding of the Ilizarov technology generally goes through four stages: suspicion, recognition, appreciation and obsession. In addition, learning and applying Ilizarov technology also need to experience four realms: apparatus, technology, art and philosophic cognition. Yet most doctors are only at the technical stage. Philosophy originates from doubt and is a kind of intellectual activity seeking truth. The Ilizarov technology is a challenger of the classical rules of orthopedic surgery and a subversive of some previous principles. Doctors skilled in the application of the Ilizarov technology and good at thinking are bound to enter the interest of philosophical thinking, because many novel clinical problems cannot be solved without philosophical thinking [10, 11]. The following case of foot and ankle deformity correction is a vivid example (Fig. 1). I believe that at this time, you will feel the endless charm of the ancient Chinese classic Daodejing [12], which states that "existence and non-existence grow together, the difficulty and the easy complement each other, the upper good is like water, and the way follows the nature".



**Fig. 1** Cases of severe foot and ankle deformity corrected with Ilizarov technique: (a) Hu, female, 14 years old, bilateral foot and ankle deformity (frontal view); (b) Bilateral ankle deformity, right foot turned back; (c) View from front in supine position; (d) Prone position and view from behind; (e) Twenty days after Ilizarov technique application; (f) Four and a half months after right foot surgery (frontal view); (g) Four and a half months after right foot surgery (lateral view); (h) 29 days after left foot surgery; (i) Follow-up: Right side, 40 months after surgery; Left side, 36 months after surgery; (j) Follow-up: Right side, 40 months after surgery, Left side, 36 months after surgery

China is a formal member of the International Limb Lengthening and Reconstruction Society (ILLRS) and the Association for the Study and Application of Methods of Ilizarov (ASAMI). In recent years, Qin Sihe, as the chairman of the China Desk of the two associations, has been invited to attend almost all important ILLRS&ASAMI conferences around the world, and got to know and listen to the lectures of relevant experts and scholars who are representative of the world. The overall conclusion is that all the leading Ilizarov or limb reconstruction surgeons have concluded their lectures with philosophical phrases such as "life is simple, therefore the Ilizarov method is simple"; "Body reconstruction is a model of nature imitation, which contains a unique philosophy"; "Ilizarov technology is a four-dimensional reconstruction because 'time' is part of the treatment"; "Efficacy is born from the heart, the device follows the heart"; "The Law of Tension

Stress (LTS) is medical relativity"; "The circular frame model is a mathematical formula (equation) that can produce a strange effect if correctly inserted" etc. The limb deformities correction and functional reconstruction under stress regulation can regulate the doctor-patient ecology and the balance of body and mind. The treatment process is in sync with the biological clock and the rhythm of life, which contains flexible and varied artistic and aesthetic taste, and has been confirmed in domestic and foreign literatures [13, 14]. From this perspective, it completely confirms that "the peak of surgery is art, and the ultimate of medicine is philosophy".

### III. Clinical practice gives birth to "limb regeneration and reconstruction"

As of December 31, 2018, a total of 35,075 cases of various limb deformities and disabilities have been included in the Qinsihe orthopaedic database [4], among



which 8113 cases were treated with external fixation (Ilizarov technology) [15]. The statistics of large number of cases showed amazing results: the diseases treated by this technique covered almost all subspecialties of orthopedic department, and more than 10 subjects including vascular, nerve, genetics, metabolism, skin, etc. besides orthopedic diseases, with a total of more than 170 diseases. These cases are difficult to treat or even cannot be treated by classical medicine or even high technology, such as lower limb deformity due to brittle bone disease, scleroderma, cavernous hemangioma; extensive scar contracture, ischemic disease of the limbs, drug poisoning, joint contracture caused by burns; diabetic foot; poliomyelitis lower extremity sequelae in the middle-aged and elderly, and so on. Some of them with severe limb deformities could have had amputation as the only choice, if Ilizarov technology had not been used for treatment; and when the Ilizarov technology is applied, it can turn the old into young magically. Therefore, it is known as the "lifeboat" [16], or "assassin's mace".

New instruments and techniques based on the Law of Tension Stress have extended the idea of limb lengthening to other fields. At present, the international "Distraction Osteogenesis" has been extended to "Distraction Histogenesis", which can increase the height of short-stature people (dwarfism) by more than 30 cm, and does not need any bone grafts and other materials, and the risk of surgery has been reduced to the minimum. Clinical application extends from bone reconstruction to composite tissues reconstruction [17]. Modern limb lengthening technology&system cannot only treat limb deformity, but also be used for the treatment of severe and complex bone nonunion, bone defect, chronic osteomyelitis and other diseases.

From a global perspective, limb regeneration and reconstruction under stress control represented by the Ilizarov technology has gone far beyond the scope of osteology in terms of indication and type of diseases [18], such as management of skull defect and maxillofacial defects, correction of severe spinal deformity and lumbar spondylolisthesis, treatment of complex deformities of upper extremity and lower extremities from pelvis to toe. This theoretical guideline can be applied or combined with other methods to improve the patient's function, regardless of age, trauma, or disease, if the limb is deformed, mutilated, or functionally impaired.

#### IV. Why Ilizarov Technology cures so many diseases?

The biggest surprise of the Ilizarov technology is that unexpected and unique curative effects are often found clinically. For example, when treating bone nonunion, the signs of diabetic foot patients significantly improved. After treating chronic skin ulcers on the left leg, the disease of the right leg recovered naturally. Traction osteogenesis was originally used to treat bone defects, but it was not expected that skin defects could also be repaired naturally. High tibial osteotomy with the Ilizarov technique was used to correct the genu varus deformity, but patient's knee osteoarthritis unexpectedly was cured naturally. And the widespread stiffness of scar contracture, which relaxes and softens by its slow tugging, has inspired clinicians to open up a whole new field. Since the birth of modern medicine, there has not been a method, technology or equipment, like the Ilizarov

technology, able to treat so many conditions in different age groups, different disciplines, and different nature of difficult diseases. It also continues to open up new fields, and the existing medical science theory cannot help but be satisfied with these clinical phenomena!

How can a simple, slow, steady and regulated movement of external fixation evolve into a story of extraordinary physical and functional reconstruction? This is because the methods, instruments and diagnosis and treatment paradigm represented by the Ilizarov technology are based on natural biological laws, and it is a brand-new treatment system in line with ecological laws. The most important secret of the Ilizarov technology is that it can be regulated, which is permeated with unique philosophy [16]. On the mountain of the Tao of Nature and the simple beauty, no other technology competes.

The evolution of animal world relies on the blood circulation to supply oxygen and energy; all activities of life tissues cannot be separated from the blood circulation to supply oxygen and nutrition. The same is true of nerve tissues. Every large nerve has a companion blood vessel, and the brain tissue consumes 1/5 of the blood. The principle of distraction osteogenesis is accompanied by angiogenesis (i.e. bone-angiogenesis coupling) [19], so blood circulation is open, all nutrients can be transported to the lesion site, new life phenomena occur naturally, and all problems of tissue regeneration, including nerve repair, may be solved!

#### V. Natural integration of Ilizarov effect and TCM theory

Chinese medicine believes that "work" is the principle of all things in the world. If it doesn't work, it will hurt. *If it doesn't work, it will plug. If it doesn't work, it will get sick.* This is the philosophical reasoning of "distraction osteogenesis to cure various diseases". Traditional Chinese medicine orthopedics "internal and external treatment, promoting blood circulation to remove blood stasis, dynamic and static combination, equal emphasis on muscles and bones, conditioning meridians", and so on, is a natural match with the Ilizarov technology.

Medical biology theory has been discussed for hundreds of years. In the field of limb reconstruction, the general tendency of thinking is to return to life philosophy of the "unity of man and nature" and "harmony and co-prosperity". Returning to *the balance of Yin and Yang, internal and external treatment, hand touch heart will, dynamic and static combination, syndrome differentiation treatment, supporting the healthy and dispelling evil* is the theoretical framework of TCM. The author cannot help but sign that the Ilizarov technology is the space-time cycle of the development of Eastern and Western civilization, or the inevitable path to solve the deep contradictions of Western medicine.

The progress of science is a history of increasing integration and simplicity of knowledge and technology. It is like a medical smartphone, which to some extent unifies most subdisciplines of orthopedics, and medical diseases even go beyond orthopedics. It connects medicine, philosophy, humanities and arts, and gives birth to a new integrated discipline - limb reconstruction. It completes the integration of orthopedics and other disciplines at the macroscopic knowledge and

technology level. The Ilizarov technology has occupied the "high" points of "truth and morality" in clinical medicine. It opened up a medical model based on time as a unified measurement of space for the first time in the clinical field of medicine, replacing "space" (changes in

body shape and function) with "time regulation". It has not only established the new development direction in limb reconstructive surgery, but also laid the foundation of modern scientific research and development of bone and soft tissue growth and regeneration.

#### SUMMARY AND INSIGHT

Over the past 70 years, Ilizarov's ideas and technologies have been preserved and renewed. The Ilizarov technology serves life with an evolutionary phenomenon that transcends bone science and becomes part of it. If you understand this technique, you will basically understand the direction of modern orthopaedic surgery and regenerative medicine. Professor Ilizarov's moral character and the spirit of fighting to relieve the

suffering of patients have passed on to the Chinese medical community. It has awakened many Chinese doctors who used to follow the norms of old and stereotyped medicine. After the celebration of the centenary of Professor Ilizarov's birth, ASAMI China will be also preparing for "The Sixth World Conference of ASAMI&ILLRS-BR (Beijing 2023)" [22]. We believe that orthopedics and related disciplines worldwide will have a bright future.

*The research supported by project of Operation funds of key laboratory of rehabilitation of Ministry of Civil Affairs(No 120603020068).*

#### REFERENCES

1. Qin S., Liu Z. Progress of orthopedics in the 20th century: analysis of six milestones. *Orthopedics*, 2016, vol. 7, no. 2, pp. 73-75.
2. Qin Si River, Guo B., Zang J. Ilizarov technology introduced into Chinese mainland for 30 years. *Department of Orthopedics*, 2020, vol. 11, no. 3, pp. 181-185.
3. Zang J.C., Qin S.H. [From Wolff law, Ilizarov technology to natural reconstruction theory]. *Zhongguo Gu Shang [Orthopedics and Traumatology of China]*, 2013, vol. 26, no. 4, pp. 287-290. (in Chinese)
4. Qin S., Guo B., Zang J. et al. Statistical analysis of 35075 patients with limb deformity and disability treated by surgery (Qin Sihe. *Orthopedics*, 1978.5.25-2018.12.31). *Chinese Journal of Repair and Reconstruction Surgery*, 2019, no. 11.
5. Zhu Y., Xu Y., Qin S. Ilizarov's Instrument, Technology and Philosophy. *Chinese Journal of Repair and Reconstruction Surgery*, 2018, vol. 32, no. 10, pp. 1238-1240.
6. Qin S. External fixation and limb functional reconstruction under stress control ascend the palace of Natural Philosophy. *Chinese Journal of Repair and Reconstruction Surgery*, 2018, vol. 32, no. 10, pp. 6-8.
7. Qin S. Exploration of biological evolution and human orthopedic diseases. *Chinese Journal of Orthopedics*, vol. 15, no. 08, pp. 635-639.
8. Zang J., Qin S., Vigneshwaran P., Lei Shi, Xulei Qin. The treatment of neurotrophic foot and ankle deformity of spinal bifida: 248 cases in single center. *Journal of Neurorestoratology*, 2019, vol. 7, no. 3, pp. 153-160. DOI: 10.26599/JNR.2019.9040016
9. Zang J., Li D., Shi L., Qin S. Origin, development and clinical practice of "happy orthopedics". *Medicine and Philosophy*, 2020, vol. 41, no. 8, pp. 64-67.
10. Qin S., Jiao S., Shu H. *Limb lengthening and reconstruction*. People's Military Medical Press, Beijing, 2017, pp. 69-70.
11. Qin S., Zang J., Jiao S., Pan Q., editors. *Lower Limb Deformities: Deformity Correction and Function Reconstruction*. Singapore, Springer, 2019. DOI: 10.1007/978-981-13-9604-5
12. Shi Shuai, Ji Xinyu, Hu Yuanhui et al. The influence of Daodejing on the formation of TCM diagnosis and treatment thinking. *Tianjin Traditional Chinese Medicine*, 2020, vol. 37, no.10, pp. 1147-1149.
13. Gubin A.V., Borzunov D.Y., Marchenkova L.O., Malkova T.A., Smirnova I.L. Contribution of G.A. Ilizarov to bone reconstruction: historical achievements and state of the art. *Strategies Trauma Limb Reconstr.*, 2016, vol. 11, no. 3, pp. 145-152. DOI: 10.1007/s11751-016-0261-7
14. Tang Peifu. Construction and trend of intelligent orthopedic ecosystem. *Chinese Journal of Orthopedics*, 2020, vol. 40, no. 23, pp. 1567-1573.
15. Qin S., Guo B., Jiao S., Zang J., Zhang L., Wang Y., Zheng X., Shi L., Qin X. [Data analysis of 8 113 cases of limb deformities corrected by external fixation]. *Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi*, 2018, vol. 32, no. 10, pp. 1241-1248. (in Chinese) DOI: 10.7507/1002-1892.201807055
16. Gubin A.V., Borzunov D.Y., Malkova T.A. The Ilizarov paradigm: thirty years with the Ilizarov method, current concerns and future research. *Int. Orthop.*, 2013, vol. 37, no. 8, pp. 1533-1539. DOI: 10.1007/s00264-013-1935-0
17. Qin S., Zang J., Paley D. Origin, theoretical breakthrough and technological progress of limb lengthening. *Chinese Journal of Orthopedics*, 2020, vol. 40, no. 11, pp. 749-754.
18. Hosny G.A. Limb lengthening history, evolution, complications and current concepts. *J. Orthop. Traumatol.*, 2020, vol. 21, no. 1, p. 3. DOI: 10.1186/s10195-019-0541-3
19. Li G., Viridi A.S., Ashhurst D.E., Simpson A.H., Triffitt J.T. Tissues formed during distraction osteogenesis in the rabbit are determined by the distraction rate: localization of the cells that express the mRNAs and the distribution of types I and II collagens. *Cell Biol. Int.*, 2000, vol. 24, no. 1, pp. 25-33. DOI: 10.1006/cbir.1999.0449
20. Ilizarov G.A. Clinical application of the tension-stress effect for limb lengthening. *Clin. Orthop. Relat. Res.*, 1990, no. 250, pp. 8-26.
21. Chen Y., Kuang X., Zhou J., Zhen P., Zeng Z., Lin Z., Gao W., He L., Ding Y., Liu G., Qiu S., Qin A., Lu W., Lao S., Zhao J., Hua Q. Proximal Tibial Cortex Transverse Distraction Facilitating Healing and Limb Salvage in Severe and Recalcitrant Diabetic Foot Ulcers. *Clin. Orthop. Relat. Res.*, 2020, vol. 478, no. 4, pp. 836-851. DOI: 10.1097/CORR.0000000000001075
22. Qin S., Zang J., Zhang Y. The Sixth World Limb Lengthening and Reconstruction Conference will be held in Beijing. *Journal of Practical Orthopedics*, 2017, no. 10, pp. 872-872.

Received: 08.04.2021

#### Information about the authors:

1. Sihe Qin,  
Rehabilitation Hospital of National Research Center for Rehabilitation Technical Aids, Key Laboratory of Human Motion Analysis and Rehabilitation Technology of the Ministry of Civil Affairs, Beijing, China,  
Qinsihe Orthopedic Institute Beijing, China,  
Email: qinsihe@163.com
2. Jiancheng Zang,  
School of Population Medicine and Public Health, Chinese Academy of Medical Sciences/Peking Union Medical College, Beijing, China,  
Qinsihe Orthopedic Institute Beijing, China
3. Baofeng Guo,  
Chuiyangliu hospital of Tsinghua University, Beijing, China,  
Qinsihe Orthopedic Institute Beijing, China