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HISTORY OF MEDICINE

Ilizarov: The Man, The Myth, The Method: An Orthopaedic Inspiration

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ABSTRACT

There are many orthopaedic pioneers whose impact continues to live on today, teaching us valuable lessons, inspiring us to greatness, and touching the lives of generations of future patients. Professor Ilizarov, a nonsurgically trained general practitioner, represents such an important orthopaedic forefather for his instruction on how to grow bones and soft tissues that would otherwise face catastrophic deformity and dysfunction. A simple look at his life, his innovation, and astonishing legacy serves as an inspiration to all involved in the amazing field of orthopaedics.

Keywords: Gavril Ilizarov, Distraction osteogenesis, External fixation.

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INTRODUCTION

History is full of inspiring stories, and the history of orthopaedics is no exception. There are many orthopaedic pioneers whose impact lives on, teaching valuable lessons, inspiring us to greatness, and touching the lives of generations of future patients. In the Pantheon of orthpaedic greats, Dr Gavril A Ilizarov stands proud. Before the age of computer-navigated surgery and smart-phone clinical communication, our orthopaedic forefathers stepped out to perform the unthinkable in their time. Sir Charnley demonstrated the ability to replace a hip with pieces of metal and plastic. Our Swiss predecessors developed basic principles of fracture fixation to perfect the healing of broken bones. Even our own Dr Urbaniak developed the ability to bring dead bone back to life through free vascularized fibular grafting. And then we have Professor Ilizarov, a non-surgically trained, general practitioner who taught us how to grow bones and soft tissues that may otherwise face catastrophic deformity and dysfunction. A simple look at his life, his innovation, and astonishing legacy is an inspiration to all involved in the amazing field of orthopaedics.

THE MAN

Gavril Abramovich Ilizarov was born on June 21, 1921 in Belovezh, Poland.[1] He grew up in a large peasant, Jewish family including three brothers and three sisters. Life was not easy as Ilizarov spent time working in cattle fields instead of obtaining any formal education up until the age of 11.[2] In all actuality, the 'school' he attended was more plainly a vocational establishment designed to give peasant workers a chance for higher education. Ilizarov excelled in his education and eventually attended and graduated from Crimea Medical School in 1944, only to be sent to Siberia to work in a rural country hospital.[2,3]

It was the small industrial town of Kurgan, Siberia where Ilizarov began his medical career as a general practitioner after World War II. Russia had defeated the Nazis, but the casualties to the Red Army were catastrophic. The war was over, but millions suffered from nonunions, chronic osteomyelitis, skeletal deformity, and large segmental bone defects. With a paucity of antibiotics and no prior surgical or orthopaedic education, Ilizarov was faced with the ominous task: Amputate or find a solution for salvage. It was that impetus that led him to develop his concept of 'distraction osteogenesis'—a term to describe bone formation between two distracted fragments through the use of a modular external ring fixator and transosseous fixation wires[4] (Fig. 1). The introduction of his first American-published research simply and profoundly states: 'Gradual traction on living tissues creates stresses that can stimulate and maintain the regeneration and active growth of certain tissue structures. This principle is called the Law of Tension-Stress…the application of this principle has allowed control, for the first time, of both osseous healing and the shaping processes of bone and soft tissues in many situations.'[5]

In the 1950s, rumors of Ilizarov's unorthodox treatment began spreading across Russia and the patients flocked to him and his small, two-story hospital for wounded warriors. He became known as the 'Magician of Kurgan' and in 1971, he was appointed Director of the Kurgan Research Institute for Experimental and Clinical Orthopaedics and Traumatology[6] (Fig. 2). At the time of his death in 1992, he had authored over 600 publications, created 208 medical inventions, become a renowned orthopaedic leader throughout the world, and revolutionized orthopaedics through his methods to create new bone, correct deformities, heal infection, and unite fractures—all with a minimally invasive, inexpensive apparatus and technique that he developed.[1] For decades, these breakthroughs were hidden behind the iron curtain, but GA Ilizarov's brilliance, observation, and dogged determination of scientific discovery eventually shined through.

THE MYTH AND THE LEGEND

Ilizarov developed his innovative technique almost by accident through trial and error and the fame of a Russian

Fig. 1: Examples of external ring fixators with different configurations

Fig. 2: Statue of Dr Ilizarov standing near the entrance of the institute

athlete.[2] An orthopaedist by necessity rather than training, he made ingenious use of the available resources. As an industrial town, Kurgan was home to both a bicycle factory and a tank factory that exists to this day. Not surprisingly, the first fracture external fixation construct consisted of frames made from gaskets cut from old tanks and wires that were actually bicycle spokes drilled through the bone.[6]

Dr Ilizarov first recognized the power of distraction osteogenesis while treating a war veteran. The patient was left with a malunited tibia and Ilizarov had intended on creating a gap in the tibia with plans to place an allograft in the defect to reproduce the length. Per standard procedure, he inserted tensioned wires, made a careful corticotomy, attached the frame, and instructed the patient to vertically lengthen the frame daily. By chance, once the wide gap in bone had been created, Ilizaorv failed to remove the external fixator before leaving on vacation for a month. At the delayed follow-up, a radiograph of the tibia did not show any gap for allograft, rather, newly formed bone tissue in the gap—limb lengthening by distraction osteogenesis was realized.[6]

Despite the novel innovation and stories of unbelievable success, it took decades for even Ilizarov's own country to recognize his techniques. In 1968, he successfully treated Valery Brumel, the Soviet Union's world record holder and gold medalist high jumper. Brumel had broken his tibia and fibula in a motorcycle accident and had underwent 20 unsuccessful operations over a 3-year period only to have persistent nonunion and osteomyelitis. Through distraction osteogenesis, Ilizarov was able to not only heal the nonunion but also correct his shortening by lengthening the athlete's tibia 3.5 cm.[2]

The success propelled the Professor to national prominence. However, the Cold War era kept the technique from reaching Europe and Western surgeons and patients. It took a Norwegian explorer, a Soviet sailor, an Italian mountaineer, and an expedition across the Indian Ocean on a replica of a prehistoric reed boat.[7]

Thor Heyerdahl, the Norwegian explorer best known for his book Kon Tiki, sought out to prove that prehistoric Mesopotamian civilizations (modern day Iraq) could travel to and trade with the Indus Valley civilization (modern day Pakistan) using reed boats known to be used, at least for river travel, at that time.[7] To prove that these river boats were seaworthy for thousand miles journeys across the Indian Ocean, and as a statement toward international peace, Heyerdahl assembled an international crew. The journey of the Tigris, now a book and television movie, may not have brought about world peace, but a chance encounter played a key role in opening up Ilizarov's knowledge to the world. Aboard the boat, was the Italian explorer and mountaineer, Carolo Mauri who suffered from a chronically infected tibial nonunion, for which Italian surgeons had long given up hope for salvage. Yuri Senkevich, an explorer from the Soviet Union, told Mauri all about the 'Magician of Kurgan' during their successful 5 month expedition.[7]

In 1980, with the Tigris expedition complete, Mauri traveled to Kurgan. Once again, Ilizarov succeeded where so many others had failed—lengthening the tibia by 2 cm, healing the pseudarthrosis, and correcting an equinus deformity. Italian orthopaedic physicians were so impressed that they eagerly invited him to speak at the Italia AO Conference in Bellagio—it was the first time Ilizarov ever presented outside the 'Iron Curtain.'[2] From there, the Ilizarov technique gained a life of its own as surgeons were eager to hear about this new method to address the most challenging orthopaedic cases. The art and science of distraction osteogenesis continues to be advanced by nearly 150 orthpaedic surgeons in the United States today.[8]

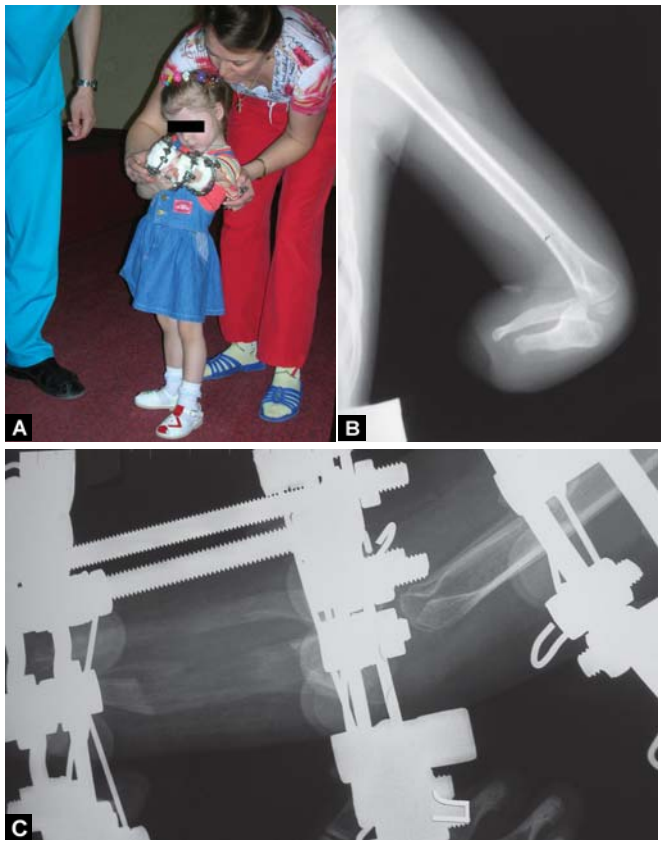
THE METHOD

Ilizarov's work was preceded by many other clinician scientists aiming to answer the toughest orthopaedic questions. Alessandro Codivilla, 'the father of limb lengthening', first reported lengthening shortened extremities in 1905 by applying acute and frequent traction in stages with a calcaneal pin after a femoral osteotomy often times without the use of narcotics.[4] Following in his footsteps was Codivilla's student, Putti. He developed a spring-loaded construct that allowed for more gradual and controlled distraction in the 1920s. Variations occurred in external fixation and distraction devices as did ideas about timing and frequency of distraction techniques. In 1963, the Wagner method of lengthening gained popularity in which there were three separate procedural stages: (1) A diaphyseal osteotomy with acute distraction and application of a monolateral external fixator. (2) The desired limb lengthening was accomplished as rapidly as tolerated. The poor regenerate formation was bone grafted and a plate was applied. (3) the third operation consisted of removal of the plate. While results from this method were notable, they came at the expense of multiple complications and suffering of patients.[9]

At the same time, Professor Ilizarov was studying the underlying process of bone and soft tissue growth through distraction, which he termed 'transosseous osteosynthesis.'[9] He introduced the concept of a corticotomy, a low-energy osteotomy to preserve blood supply to the periosteum. Ilizarov proposed his own external fixator device for bone fracture consolidation in 1951 to the USSR. Often known as 'the Ilizarov apparatus' he used a ring fixator with crossed, tensioned wires attached to the ring. This proved more rigid despite its minimal invasiveness and extremely low cost in most countries. He developed the 'theory of tensions' where he reproducibly established the ability of bone and soft tissues to regenerate through controlled, mechanically applied tension stress.[1] He used canine tibial models to further define the exact rate and rhythm of distraction which would produce spontaneous bone formation—0.25 mm at a time, 4 times per day totaling 1 mm per day.[7] The net effect of Ilizarov's work resulted in the biological phenomenon of distraction osteogenesis. This remains a beautiful example of basic science, clinical and surgical orthopaedics (Figs 3A to C).

THE INSPIRATION

Today, nearly 9,000 patients annually seek treatment and rehabilitation from the Russian Ilizarov Scientific Center for Restorative Traumatology and Orthopaedics for a range of complex musculoskeletal diseases and injuries (Fig. 4).



Figs 3A to C: Young girl being treated at the institute. Amniotic band syndrome had left her forearm too short to fit prosthesis (A), radiographs prelengthening (B), and postlengthening with visualized corticotomies and regenerate bone formation (C)

Fig. 4: Coffee shop near the Ilizarov center where the patients have become quite comfortable with their frames. They can be seen waiting in line for coffee. Nurses make custom fabric covers for the patients' frames for a fee

The Ilizarov center has grown into a clinic that evaluates 250 patients/day and houses an 800 bed hospital (the world's largest orthopaedic hospital). It also houses an experimental department, an animal surgery facility, and a factory for creating the rings, bolts, nuts, and wires. From infants to the elderly, all patients are welcomed to apply for treatment at the center with Ilizarov's vision as the constant mission statement: 'To prevent bone injury sequelae and resolve bone diseases in early childhood'.[1]

Ilizarov's life and career illustrates the hard work, perseverance, and dedication that should reside deep within each of us as orthopaedic surgeons. His legacy was built one day, one observation, and one patient at a time—and we, too, are constantly creating our own legacy which will impact our colleagues and the lives of our patients. At the completion of his first American lecture at the Hospital for joint diseases in 1987, an auditorium overflowing with orthopaedic patients, scientists, residents, and surgeons came to their feet to give a nearly 10-minute ovation to the 'Magician from Kurgan' for his unparalleled contribution to the specialty.[2] GA Ilizarov, with few resources and minimal training, was confronted with some of orthopaedic's most challenging patients. He rose to the occasion with clinical ingenuity and scientific persistence. In doing so, he not only healed patients in rural Siberia, he changed the field of orthopaedics over the entire world.

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