

The Ilizarov Technology Revolution: History of the Discovery, Dissemination, and Technology Transfer of the Ilizarov Method



There are many myths and stories about the discovery and dissemination of the Ilizarov method. Having been involved in the transfer of this technology to the United States and many other countries in the world, I have researched and recorded many of the events over the years. I am writing this history to separate the myth from the actual historical events. To be as historically accurate, I personally interviewed most of the key figures that were involved in these events or those who had first hand knowledge of those key figures. While it is not possible to consider every person who had a role in this technology transfer, I have focused this review on the pivotal events and people. If there is any inaccuracy or distortion of history, it has occurred despite my best efforts. I have tried to paint these events around the backdrop of world history.

Most advances in medicine are disseminated by presentation at medical meetings, by publication, through observers, and through commercialization of related products. The Ilizarov method ultimately followed this same pattern. However, it took 30 years from its development until it was introduced in the West. The lengthy delay of its recognition by the West and even in the Iron Curtain countries is an intriguing story filled with serendipitous events of historical and even political significance. The transfer of this technology can be divided into information that was voluntarily given by Ilizarov *et al.*, information that was obtained in a stealth manner often against the direct wishes of Ilizarov, and information that was derived from personal experience of the early experts in the field. It is the history of this information transfer that is recounted in detail in this account. I have elected to tell this story in the third person (Paley) even as it relates to my own role.

Gavril Abramovich Ilizarov was born in Bialowieza, Poland, in 1921 (modern day Belovezh, Belarus), sixth child to a poor Jewish family. His father Abram Ilizarov was a Mountain Jew from the town of Qusar, Dagestan, USSR. His mother Golda was of Ashkenazi ancestry. Soon after he was born, his family moved back to Qusar. He began his formal school education there at the age of 11. He graduated from a pre-med program in Buynaksk, Dagestan, in 1939 and then moved to Simferopol, Crimea, to attend medical school. His medical school moved several times due to the invasion of USSR by Nazis in 1941. He finally graduated from medical school in 1944, in Kyzylorda,

Kazakhstan, beyond the war's reaches. After graduating, he was posted as a general medical doctor to the Kurgan region (Dolgovka – 150 km from Kurgan) (it was the norm in the USSR to post the doctors to different regions according to need). He organized a workshop for the development of medical instruments in 1946 for the purpose of treatment of the war-injured invalids that returned from the front. In 1946, through this workshop, he began working on the earliest prototypes of what would become known as an Ilizarov circular external fixator. The legend about bicycle spokes is not true. In 1950, he did some surgical training in Leningrad. He returned and obtained a position in the General Surgery Department of the Kurgan Regional Hospital [Figure 1], which included deployment with the air ambulance service. It is there that he registered his external fixator device patent in the USSR (Certificate of Authorization of Patent No. 98471 on June 9, 1952). Throughout the 1950s and 1960s, the applications of the fixator broadened to include limb lengthening, deformity correction, and nonunions. His device was initially used to fixate fractures; however, due to its modularity, it was used to acutely or gradually manipulate bone segments in space such as correction of contractures and bone angulation. The index distraction osteogenesis case was a lengthening of an amputation stump. Ilizarov was on vacation during part of the treatment and the patient continued to distract the bone segments. Ilizarov returned to notice that distraction osteogenesis developed between the bone ends. Ilizarov claims that he recognized the ability of distraction to produce bone after this case which occurred in the mid-1950s. It is unclear whether Ilizarov had access or was familiar with the work of previously published limb lengthening surgeons from the first half of the 20th century. We know that distraction osteogenesis was recognized in the world literature as early as 1904 by Codivilla and later by his disciple Putti in 1921 (who wrote in JAMA 77:934, 1921: "Elongation can be effected only by osteotomy, which, however, must be performed in such a way as to facilitate the formation of the callus") and all throughout the 1930s, 1940s, and 1950s from the publications of Dickson and Diveley (1932), Haboosh and Finkelstein (1932), Abbot and Sauders (1939), Allan (1948), Anderson (1952), and Bost (1956). Whether Ilizarov was aware of any of this literature is unclear. Notwithstanding this, he was clearly not the first to discover distraction osteogenesis. This is a

common misconception. His big contribution was to carry out animal and clinical research on the biologic principles and histologic mechanisms behind distraction histogenesis of bone and soft tissues. He was awarded his Doctorate of Science in 1968 in Perm, Russia, for his work in this field. His continued research defined the optimal rate and rhythm of distraction, the need for preservation of blood supply at the osteotomy site, and the various other parameters important to distraction osteogenesis. No one else had done this before him. Due to the versatility of his apparatus, he developed many new applications including physeal distraction, bone transport, distraction of nonunions, bone widening, contracture corrections, and foot and hand distractions. Word of his method spread and many patients with difficult limb reconstruction problems beat a path to his door.

Despite his successes, his method was not widely accepted in the Soviet Union (although Dr. Ceballos from Cuba told me that in the early 1960s, the Soviet military doctors were applying some types of Russian external fixator to patients in Cuba; it is not clear whether this was the Ilizarov device; the actual Ilizarov device was not introduced and used in Cuba until the late 1970s according to both Drs. Ceballos and Cambras). This occurred largely because of partisanship of different centers and the lack of manufacturing, marketing and distribution of Ilizarov's device. Many preferred to develop their own fixator. For example, Gudushauri, a contemporary of Ilizarov, developed his K-wire-based fixator around the same time or just before Ilizarov. The well-known Volkov–Oganesyan fixator developed in the 1970s was influenced by both of these fixators (the Ace-Fisher external fixator later marketed by DePuy in the US was the first circular external fixator introduced to the US, by David Fisher who had visited Volkov in the 1970s). Dr. Kalbernz and Dr. Wasserstein each developed their own circular external fixators in Riga, Latvia. Another factor limiting the dissemination of the Ilizarov device in the Soviet Union was the backwoods

location of Kurgan. Central institutions in Moscow and Leningrad (St. Petersburg) dominated academic and political Soviet orthopedics. Ilizarov's affiliation with a Leningrad institution may also have created some enmity with Volkov, the chief of Central Institute of Traumatology and Orthopedics (CITO) and one of the most internationally recognized Soviet orthopedic figures. Lee Riley Jr. at Johns Hopkins helped arrange for Volkov and Oganesyan to publish their distraction arthroplasty around the elbow work in the *Journal of Bone and Joint Surgery* in 1975. Clearly, Americans were familiar with some of the Soviet orthopedic work in central cities such as Moscow and Leningrad.

Kurgan being a closed city, which foreigners were not allowed to travel to, was off the grid for exposure to the West and was clearly even ostracized within the Soviet Union. Ilizarov attended national orthopedic meetings and was frequently subjected to criticism and ridicule. Wasserstein, a contemporary of Ilizarov, from Riga, Latvia, told me (I visited with him in 1986 when he was living in Germany) that he was present when Kalbernz and Volkov publically humiliated Ilizarov at an orthopedic meeting in the 1960s.

The singular event that lead to Ilizarov's national recognition was the treatment of Valery Brumel in 1967 [Figure 2]. Valery was the Soviet Olympic silver (1960) and gold (1964) medalist high jumper who held the world record of 2.28 m (7 feet 6 inch). He fractured his leg in a motorcycle accident while inebriated. Brumel was treated at the famous CITO but ended up with a fracture that failed to unite and shortening of the leg. Brumel was recommended an amputation. One of the junior orthopedic surgeons at CITO, Vladimir Golyachovsky who had visited with Ilizarov, secretly recommended Brumel to leave CITO before he lost his leg and to go to Kurgan to seek treatment by Ilizarov. Brumel was successfully treated by Ilizarov in 1967. Brumel returned to competition and jumped 2.06 m (6 feet 9 inch). Ilizarov jumped to fame with the successful treatment of Brumel. He and Brumel remained close friends. He was the best man at his wedding to Olympic equestrian Elena Petushkova [Figure 3].

Over the next few years, Ilizarov received a lot of lay and medical recognition within the Soviet Union (e.g., he treated famous composer Shostakovich, famous cellist Mstislav Rostropovich, and others). His achievements even in the backwoods of Siberia could no longer be ignored within the Soviet Union. In 1978, he was awarded the Lenin prize for Medicine. The height of this publicity resulted in an international news blitz in 1972 about the Magician from Kurgan. This resulted in the first two publications in the English language about Ilizarov one in a nursing journal (1972) and one in a podiatry journal (*J Am Podiatry Assoc* 63: 12, Dec 1973). As a result of this publicity blitz, Professor Monticelli of the University of Rome was asked by a journalist, what he thought about the Russian claims that



Figure 1: Ilizarov with staff at Hospital in Kurgan (© 1950's). He had a workplace romance with the woman on the bottom right (radiologist) who later became his wife

limbs could be lengthened by 15 cm or more. He answered that in the Italian experience, this was not possible. Curious about this possibility, he assigned his young assistant Dr. Renato Spinelli to research this topic. Spinelli discovered Ilizarov's publication on physal distraction (*Ortopedia, Tavmatologia I Protezovanea*, 1967). Based on this, he began his personal *in vivo* research on physal distraction in sheep. In 1977, he was awarded funding for a traveling fellowship from the *Societa Italiana Ortopedica e Traumatologica (SIOT)* to go to Kurgan to study with Ilizarov. Visa problems delayed his visit until a connection in the Italian communist party enabled him to finally go to Kurgan in 1980. To my knowledge, Spinelli was the first Western Orthopedic Surgeon to visit Ilizarov in Kurgan [Figure 4]. He reported on his trip to the SIOT that year. Soon after, Monticelli presented their research work at *société internationale de chirurgie orthopédique et de traumatologie (SICOT 1981)* in Brazil with no reference or credit to Ilizarov.

Spinelli remembers this moment as the point of no return with respect to Kurgan. They proceeded to develop their own circular tensioned wireframe, which was commercialized by Howmedica (now Stryker) in 1986. In his visit to Kurgan in 1980, Spinelli discovered that Ilizarov was using a technique called corticotomy instead of physal distraction. Spinelli returned home and began to use corticotomy. He published on this technique in the *International Orthopedics* in 1983. Spinelli is generally not credited with the introduction of the Ilizarov method to the West because no lasting link to Ilizarov (the man) or the KNEIKOT (the Institute) or the original Ilizarov apparatus (the device) was established. Despite this, Spinelli was the first in the West to apply the concepts of gradual distraction according to Ilizarov. He has always referenced Ilizarov in his publications.

Although Spinelli got to Kurgan first, the Western World's introduction to the Ilizarov method is related to another Italian. Carlo Mauri was a famous Italian mountaineer, explorer, and photojournalist from Lecco, Italy. Mauri traveled with the famed Norwegian explorer Thor Heyerdahl on the *Ra I* 1969, *Ra II* 1970, and *Tigris* 1977 expeditions. In 1961, while working as a skiing instructor, he suffered an open tibial fracture and despite surgical treatment resulted in an infected nonunion with an equinovarus deformity and shortening of the tibia. Carlo managed with an orthotic device on all of Heyerdahl's expeditions and even in following the route of Marco Polo for the Italian state broadcaster RAI. In 1977, during the final reed boat expedition with Heyerdahl, the *Tigris* expedition around the Arabian peninsula, Yuri Senkevich (a Soviet physician and explorer who had sailed with Mauri on the *Ra* expeditions; Senkevich became Russia's longest-serving talk show host until his death in 2001) offered to introduce Mauri to Ilizarov in the Soviet Union to treat his leg (this account was reported to Paley by Norman Baker, American explorer on the same expedition, who Paley personally



Figure 2: Valery Brumel Gold Medal winner Tokyo Olympics 1964



Figure 3: Ilizarov as best man at Brumel's wedding to 1972 Olympic Gold Medal equestrian and Biologist Elena Petushkova



Figure 4: Dr. Renato Spinelli, 1986

interviewed) [Figure 5]. In March 1980, Mauri went to Kurgan and was operated by Professor Ilizarov on April 4, 1980 [Figure 6]. Ilizarov distracted his stiff nonunion by 2 cm, healing the pseudarthrosis, correcting the equinus deformity by distraction, and lengthening his leg. Carlo Mauri's treatment in Kurgan, serendipitously, coincided with Spinelli's visit to Kurgan. Carlo returned to his home

town Lecco, Italy, where he shared his experience with his longtime friend, orthopedic surgeon Dr. Angelo Villa. In November 1980, Dr. Villa arranged for Mauri to report to orthopedic surgeons of the Hospital of Lecco (Dr. Roberto Cattaneo, Dr. Maurizio Catagni, and Dr. Tentori) and Dr. Bianchi-Maiocchi from Milan. This coincided with an interview of Carlo Mauri in the Italian newspapers by Alexander Alexandrovich Bangharski.

Prof. Antonio Bianchi-Maiocchi (President of AO Italy) and Prof. Roberto Cattaneo (the Chief of Orthopedics at the Hospital of Lecco and the Chairman of the AO Italy Club Meeting of 1981) invited Prof. Ilizarov as a guest speaker at the 22nd AO Italy Club Conference in Bellagio, June 12–14, 1981. The title of the conference was Prophylaxis and Treatment of Bone Infections [Figure 7]. This was Ilizarov's first visit to a western country. Prof. Ilizarov (accompanied by his daughter Svetlana) presented three lectures (the treatment of open fractures; the treatment of post-traumatic osteomyelitis; and bone lengthening) to an audience of >200 Italians, Swiss, French, and Austrians. Notable attendees at this conference were Prof. Renato Bombelli, Busto, Italy; Prof. Giorgio Monticelli, Rome, Italy; Prof. Trojan, Vienna, Austria; Prof. Pietro Regazzoni, Basel, Switzerland; and Prof. L. Kinzl, Ulm, Germany. The lectures were received with awe and were followed by a 10-min standing ovation. Despite these presentations, there was an air of suspicion and disbelief typical of this cold war era. Curiously, Ilizarov's trip was sponsored by a furniture manufacturing company CS & RB (they were also sponsors of some of Mauri's journeys). This company also bought from Ilizarov a large set of his fixator components and presented them to the Hospital of Lecco. Surgeons at the Hospital of Lecco began using the method in 1981 [Figure 8]. Before returning home, Ilizarov operated on an achondroplastic patient at the Hospital in Lecco the first procedure performed with the Ilizarov apparatus in Western Europe. The surgeons from the Hospital of Lecco began performing this type of surgery following Ilizarov's

visit. They based their initial experience on Ilizarov's lectures, discussions, and slides (Behind the scenes while Ilizarov was lecturing, the Italian surgeons managed to secretly copy his slides).

In April 1982, a group of Italian Orthopedic Surgeons Antonio Bianchi-Maiocchi from Milan, Giovanni Benedetti from Bergamo (a former President of AO Italy), Angelo Villa, and Maurizio Catagni from Lecco accompanied by Carlo Mauri went to Kurgan, USSR, for the first time [Figure 9]. They attended at surgeries and observed the postoperative follow-up. On returning, the surgeons at the Hospital of Lecco and at the Mateo Rota Hospital in Bergamo began using the method with increasing frequency. At the Hospital of Lecco, the surgeons involved were Drs. Cattaneo, Villa, Tentori, and Catagni. In Bergamo, Drs. Benedetti and Argnani performed this work. Carlo Mauri died in November 1982.

Prof. Emeritus Bianchi-Maiocchi's role was to be different than the rest and pivotal. Bianchi-Maiocchi retired from clinical practice in 1978. He owned a company (Medical-Plastic) that manufactured wound drainage systems. He sought to manufacture the Ilizarov apparatus under licensure agreement with the Soviets. In December 1982, he returned to the Soviet Union to meet with the Licensintorg and Medexport the official government agencies that assigned licenses for all Soviet patents and inventions and that regulated exports and imports. An agreement was reached giving Medico-Plastic the exclusive right to manufacture and distribute the Ilizarov apparatus in Italy, France, Switzerland, Spain, Portugal, Greece, Belgium, Netherlands, Luxembourg, and Iran. The agreement included translation of KNEIKOT's publications into Italian and Ilizarov's travel and lectures to Italy with honorarium paid by Medical-Plastic. The Italian version of the apparatus was identical in all its details but was made from better medical grade stainless steel (the Russian device was not as well made and frequently



Figure 5: Thor Heyerdahl's International group of explorers: far right Carlo Mauri, far left Yuri Senkevich, second left Norman Baker, center Thor Heyerdahl



Figure 6: Carlo Mauri in the operating room immediately after the surgery (under spinal anesthesia) to apply his fixator. He and Ilizarov are having a smoking break

rusted). Medical-Plastic added some new components and a graduated wire tensioner to the set. Eventually, they added the Catagni-Cattaneo modification (an arch system which fixated to the bone with half pins). Bianchi-Maiocchi's foresight and his agreement with Licensintorg were largely responsible for dispersion of Ilizarov's method around the world and especially to the West.

Before the 1982 trip to Kurgan, the Italian surgeons organized the Associazione Studio Metodica Ilizarov (ASMI), chosen by Ilizarov in Russian and translated into Italian. The Italians incorporated the association on January 13, 1982, and modified the name to Associazione per lo Studio Fissatore Esterno de Ilizarov [Figure 10]. The name was later changed to Associazione per lo Studio e l'Applicazione del Metodo di Ilizarov (ASAMI). Prof. Roberto Cattaneo was chosen as its first president. The first order of business of the association was to organize the first course in the West on "The Theoretical and Practical Application of Ilizarov's Methods" in Longone al Segrino (near Lecco) in June 1983. The course was directed by Ilizarov and his assistant Dr. Vladimir Ivanovich Shevtsov. There were over 300 participants including two American-honored guests Drs. Augusto Sarmiento and G. Dean MacEwen. Just before this meeting in March

1983, Bianchi-Maiocchi published the first of ASAMI's several books on the Ilizarov method. Bianchi-Maiocchi hired Marinella Combi an editor and a Russian-to-Italian translator (1985) that was to remain his faithful assistant until his death (December 2003). Combi translated many of the original Russian scientific publications into Italian. Compiled together, this first book included many of the original clinical cases and frame mountings copied (without permission) from Ilizarov's slides, cross-sectional anatomy illustrations copied (without permission) from Stuart Green's textbook *Complications of External Fixation*, translated Russian articles, and the first clinical cases from Lecco and Bergamo. This book published in Italian became the first manual on the Ilizarov method.

With the method and apparatus now recognized and available in Italy and France and to a lesser extent in Portugal, Spain, and Switzerland, Ilizarov organized his first International Congress on Transosseous Osteosynthesis in Kurgan in September 1983. This conference drew participants mostly from Iron Curtain countries but for the first time also from Western Europe. The conference was also marked by the official opening of the new hospital and research center of the KNEIKOT. This was a 1000-bed hospital whose footprint resembled a snowflake [Figure 11]. With its 18 operating rooms divided into three wings, and multiple departments, it bragged the latest research equipment and facilities. The original institute was built in 1972 and was converted to the animal research facility and the outpatient surgery and follow-up center.

Following this conference, Bianchi-Maiocchi published the second of several books on the Ilizarov method based on the abstracts and lectures of the conference (July 1985). In July 1984, ASAMI put on the second instructional course in Dorga (near Bergamo), Italy, organized by Professor Benedetti. Drs. Ilizarov, Shevtsov, and Shved



Figure 7: The brochure of the first meeting in Western Europe that Ilizarov attended was the 22nd AO Italian Club meeting on Prophylaxis and Treatment of Bone Infection, in Bellagio, June 12–14, 1981. Ilizarov spoke at this meeting to a standing ovation



Figure 8: First Conference with Ilizarov. The conference was sponsored by a furniture company CS & RB. Dr. Roberto Cattaneo is holding their brochure. To the left of the picture also holding the brochure is Carlo Mauri. In the back going from left to right is Angelo Villa, Antonio Bianchi-Maiocchi, Gavril Ilizarov, unknown, and finally in the foreground is owner of CS and RB presenting a check for the purchase of the first Ilizarov set for the Hospital of Lecco. Note that this picture has an original signature of Ilizarov



Figure 9: The Italians visited Kurgan in April 1982. This picture was taken in his apartment. From left to right along the back row: Antonio Bianchi-Maiocchi, Maurizio Catagni, Carlo Mauri, Giovanni Benedetti, and Angelo Villa. In front of them is Ilizarov on the right and a member of the communist party next to him



Figure 11: The snowflake-shaped KNEIKOT seen from the air. There are three wings of operating theaters (six in each wing) which are on the top floor. The rest of the hospital buildings are patient rooms

from Kurgan were there. ASAMI presented their results of more than 600 cases treated. Of note, this conference was also attended by Dr. Gianni Maistrelli of Toronto, Canada, and Dr. James Aronson of Little Rock, Arkansas, both of whom were Dr. Renato Bombelli's clinical fellows. Also in attendance was Maurice Mueller of Bern, Switzerland, the President of SICOT and the Founder of AO International. Through 1985, the Ilizarov method spread to parts of Continental Western Europe. Ilizarov attended a conference in Barcelona on February 4, 1985, and the first French Course on the Theoretical and Practical Aspects of the Ilizarov Method in Strasbourg, France, on October 1985.

In February 1985, Dr. Victor Frankel, Chief Surgeon of the Hospital for Joint Diseases, saw the Ilizarov method on display at a conference in Barcelona, Spain. A patient of Frankel's was a relative of Bianchi-Maiocchi. Through these connections, in May 1985, Frankel accompanied by Jack Blair (President of Richards Medical, Memphis, Tennessee) sought out Bianchi-Maiocchi at a conference in Milan, Italy. Bianchi-Maiocchi took them to an outpatient

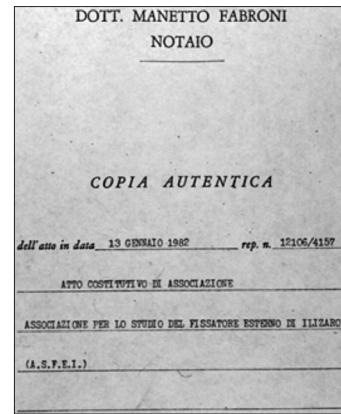


Figure 10: The original charter of the forerunner of Associazione per Studio e l'Applicazione del Metodo Ilizarov (ASAMI) was called Associazione per lo Studio Fissatore Esterno de Ilizarov (ASFEI), founded January 13, 1982

clinic at the Hospital of Lecco for half a day. Frankel returned to New York, obtained an Ilizarov apparatus, and began testing the apparatus in his biomechanics lab.

Although Southern Continental Western Europe was now familiar with the Ilizarov method, North and South America, the British Isles, and Northern Europe remained ignorant or disinterested in it. In the US and Canada, despite the exposure of MacEwen, Sarmiento, Aronson, Maistrelli, and Frankel to it by 1985, the method did not gain interest. Dana Mears in his book on External Fixation wrote in 1983 "While the Ilizarov design provides an academic curiosity for potential innovators, it would not appear to be of interest for Western Surgeons. With its complex connectors, it requires highly skilled engineers for erection and adjustment."

The introduction of the method to North America is credited to Dr. Dror Paley of Toronto, Canada. Paley first heard about the Ilizarov method in November 1983 while he was a fourth-year orthopedic resident at the University of Toronto. Dr. Renato Bombelli, a world-renowned hip surgeon and disciple of Maquet and Pauwel's, was in Toronto as a Guest Professor of the Annual Rehabilitation Conference. After the conference, Bombelli was a guest at the Toronto East General Hospital. Paley presented a case of a tibial bone defect. Bombelli discussed this case and commented that in Italy, they would treat such a case with the Ilizarov method in which bone would be shifted gradually from one end of the defect to the other (Bombelli was describing bone transport). Following his explanation, there were no questions. Paley felt ignorant not knowing about this Russian method that obviously everyone else in the audience knew about. He quietly asked Bombelli about this during the coffee break. Bombelli drew a diagram to explain the methodology. Paley soon realized that no one in the room had understood what Bombelli was talking about but had been too polite or embarrassed to ask. Paley wrote Bombelli asking for literature on the subject, while at the same time, he performed a literature search. The

latter yielded numerous Russian language references on the Ilizarov method. Paley was surprised to find an enormous body of scientific literature on Ilizarov, even though as far as he could tell no one had ever heard of him. Paley sought out Bombelli at the 1984 American Academy of Orthopedic Surgeons (AAOS) meeting. Bombelli gave Paley Italian literature on the Ilizarov method which stimulated him to visit the Italian centers at the end of his residency in 1985.

In August 1984, a seemingly unrelated event played an important role in the importation of the Ilizarov method to America. Paley presented two papers at the Richards Orthopedics Resident Conference and won first prize for both and was awarded \$10,000 for research for each paper by the President of Richards, Jack Blair. In June 1985, Paley called Blair to access the funds for a biomechanics research project on the Ilizarov apparatus, comparing it to other fixators. Blair had just been to Lecco a month earlier and had seen the device with Victor Frankel. Blair agreed to fund Paley's research but asked him to visit Frankel. Paley visited Frankel in July 1985. This began a collaboration of a very senior world-renowned orthopedic surgeon with a completely unknown recently graduated orthopedic surgeon. Frankel encouraged Paley to pursue the study of this Ilizarov method. That summer Paley also visited Dr. Dean McEwen (Wilmington, Delaware) who had a copy of the Italian Ilizarov book. Having learned as much as he could from the published literature (none of which was in English) and from doctors who had seen the device Paley decided that he had to go to Italy to see the surgery. In September 1985, Paley spent a week in Lecco and Bergamo observing surgery and seeing patients, believing that 1 week was enough to learn most surgical procedures and the Ilizarov should be no exception. After seeing the wide variety of applications, he realized he needed a longer stay.

On return to Canada, Paley organized a 6-month European Traveling Fellowship at the Hospitals of Lecco and Bergamo and other limb lengthening and external fixation centers in Europe, including Kurgan to visit Professor Ilizarov. Richards Medical agreed to help fund this traveling fellowship. A Richards Ilizarov task force was set up headed up by Richard Treharne, PhD. In June 1986, together with his pregnant wife, Wendy, and 2-year-old son, Ben, Paley departed for Europe for 6 months. The biggest challenge of organizing the trip was obtaining a visa to the USSR and getting approval to visit Kurgan.

Serendipitously, Ilizarov was hosting the Second International Conference on Transosseous Osteosynthesis scheduled for September 1986. Through Dr. Bianchi-Maiocchi, Paley received an invitation to attend and therefore was able to procure a visa. Having a Canadian rather than an American passport probably also helped. At that time, Kurgan was a closed city. This meant you could not go there on a tourist visa. Had it not been for the conference Paley doubts he would have been able

to get the visa. Bianchi-Maiocchi, while already retired from clinical practice, had a very important role in the learning curve of Paley and many others. Paley visited him regularly during the 6 months in Europe, always learning many untold secrets of Ilizarov that Bianchi-Maiocchi's assistant had translated from Russian or had copied from Ilizarov's original slides. Bianchi-Maiocchi was the first to recognize that introduction of the apparatus to the US was the key next step in the dissemination of the method. He offered Paley the exclusive rights to the Ilizarov apparatus for North America. Paley was 30 years old, and rather than accept this generous offer, he put Bianchi-Maiocchi in contact with Jack Blair from Richards. This began the negotiation and relationship between Medical-Plastic and Richards, which remains until this day with Smith and Nephew. Paley refused to accept any payment, consulting relationship, or royalty from Richards or Medical Plastic for brokering this deal. Paley's itinerary in Europe is worth mentioning because it became the basis of future collaboration and of the technology transfer that was to occur in 1987 onward. He was influenced by some of the most experienced limb lengtheners of Europe.

While 3 months of the fellowship was spent training at his home base in Lecco, Italy, with Drs. Cattaneo, Villa, and Catagni, the rest of the trip was also very pivotal. None of these surgeons spoke English, so his initial communication was all in French, which was the common language Paley and the Italians spoke. Over the course of the first 3 months, Paley became fluent in Italian which facilitated and cemented his everlasting ties and relationships to the Italian surgeons. His fellowship began in Rome with Monticelli and Spinelli for 2 weeks, followed by 3 weeks in Verona with De Bastiani, Aldegheri, and Renzi-Brivio followed by time in Lecco and Bergamo. By the time he got to Lecco, he was already quite conversant in Italian. He spent a few days in Davos with Tepic and Perren and then visited Wasserstein in Eberbach, Germany. This was followed by the trip to Russia for 5 weeks visiting Ilizarov in Kurgan and Kalbernz in Riga in October 1985. From the USSR, he went to visit Hammer in Sweden and Kenwright in the UK. He even crossed the Berlin wall to unofficially visit with Dr. Paul Marks a young Ilizarov innovator at the Charite Hospital. Paley could not have chosen a better 6 months to go to Europe to study the Ilizarov method since coincidental with this time period there were several important conferences that added to his knowledge and exposure immensely; Second International Conference on Transosseous Osteosynthesis, Kurgan, USSR, September 1986; International Biomechanics Conference, Riga, Latvia, USSR; Orthofix External Fixator Meeting, Riva del Garda, Italy October 1986; Hoffman External Fixator Meeting-Garmish Partingken, Germany, October 1986; ASAM! Italy Scientific Meeting-October 30–31, 1986, Florence, Italy (Paley presented his paper here in Italian); SOFCOT (French National Meeting) Paris, France,

November 1986 dedicated to the Ilizarov experience in Europe; and Achondroplasia Meeting-Rome, November 1986 (Ilizarov was the guest speaker in both). During these conferences, he also had the opportunity to meet and discuss topics and be influenced by notable external fixation and limb lengthening experts including Wagner, Villarubias, Canadel, DePablos, Kopits, Morandi, Canuti, Tranquilli-Leali, Ascani, and Green as well as repeatedly interact with Ilizarov who attended most of these meetings. The repeated meetings with Ilizarov and his improving Russian language ability helped solidify Paley's relationship with Ilizarov over the course of the last 3 months of 1986.

At the Orthofix External Fixation Meeting in Riva del Garda in October 1986, Paley was sitting next to Stuart Green of Rancho Los Amigos Hospital, during Dr. Cattaneo's talk on forearm lengthening. Green commented to Paley that the material Cattaneo was presenting was incredible. Paley told him that he was working as a fellow in Lecco and would be happy to introduce him to Cattaneo. Green accompanied Paley to Lecco the next day and attended the outpatient clinic with Dr. Angelo Villa. Paley translated for Green from Italian to English. At the end of the visit, Dr. Villa showed Dr. Green the first ASAMI book. In it, Green saw the cross-sectional anatomy drawings that had been copied without permission from his own book. Understandably, Green was upset since he had never given permission to reproduce these figures. Furthermore, the source of the figures was not referenced in the bibliography. He left Lecco abruptly for Germany, threatening to sue the Italians. Paley went to Milan to speak to Bianchi-Maiocchi, the editor of this book. Bianchi-Maiocchi wrote a letter of apology to Dr. Green, made him a present of his two books, and invited Green to write a chapter for his new third book. Paley hand delivered these letters to Green at the Hoffman conference in Garmish Partenkirchen. Green accepted the apology and thus began his longstanding relationship with the ASAMI Italy group. Later examining Dr. Green's 1980 book, Paley was struck by the mention and illustration of the Ilizarov apparatus. While Green had not yet used the Ilizarov apparatus or visited Kurgan, he was aware of Ilizarov and the existence of his apparatus long before most in America. Stimulated by what he had seen in Europe, and an external fixation expert in his own right, sent Ilizarov a copy of his book by mail expressing an interest in visiting Kurgan. Facilitated by Paley, he received an invitation and thus was granted a visa. In May 1987, together with Victor Frankel, they became the first two American citizens to visit Kurgan. Paley, an American citizen since 1994, was a Canadian citizen at the time he visited Kurgan, having been there twice before Green and Frankel's first visit. Of note, Green began to apply the Ilizarov concepts with the Ace-Fisher circular fixator. His first case was a nonunion distraction in November 1986, while in New York, Victor Frankel applied an Ilizarov fixator during the same month.

Before going to Europe in 1986, Paley performed a biomechanical comparison of the Ilizarov apparatus at the

University of Vermont. Paley presented this work at the International Conference in Kurgan. As the only delegate from North America, Ilizarov invited Paley to speak with him privately in his office. Ilizarov was quite interested in the dissemination of his method in America. Paley spoke for over an hour through an interpreter. While Paley was learning Russian, it was not good enough yet to communicate solo with Ilizarov. Paley invited Ilizarov to a conference in New York for 1987, a conference he was to organize together with Frankel (in June 1986, Paley met with Victor Frankel at the Canadian Orthopedic Association meeting in Edmonton). He told him he was going to Kurgan in October. Frankel suggested inviting Ilizarov to a conference in New York for 1987 to coincide with the Jones Lecture at the Hospital for Joint Diseases on October 31. He sent Paley a formal invitation letter to present to Ilizarov. After the 3-day conference, Paley was invited by Ilizarov to meet with him in his office [Figure 12]. The exchange with Ilizarov went very well until Ilizarov suggested to Paley that he cancel his trip to visit Dr. Victor Kalbernz in Riga, Latvia, the following week, and stay at the Institute instead. Kalbernz was a known rival of Ilizarov's. Paley knew the history of the two men which allowed him to convert the tense situation into an invitation to return to Kurgan the following year for a month-long visit. Ilizarov was not used to being told no, especially from a 30-year-old orthopedic surgeon who had no known accomplishments. It was probably Paley's understanding of the Soviet internal orthopedic politics that saved the day. Ilizarov explained that he did not trust Western Orthopedic surgeons since Spinelli had come to Kurgan and had returned without crediting Ilizarov's method. Paley's knowledge of the Spinelli story further broke the ice, defusing what was becoming a very tense standoff between Ilizarov and Paley. Paley describes this as the first glimpse of Ilizarov's paranoia, which was based on many years of being shunned by the big professors of Moscow, Leningrad, Riga, etc., He was constantly afraid of having his method stolen from him, without credit. He felt this had happened with the Volkov-Oganesyan Apparatus, the Kalbernz Apparatus, the Wasserstein Apparatus, and many others. He was upset by his faith in Spinelli (who by the way also taught himself Russian as Paley did to learn the Ilizarov method). In fact, the only group that Ilizarov trusted was Bianchi-Maiocchi and the Italian surgeons that founded ASAMI. They had demonstrated their allegiance by repeatedly inviting him, honoring him, and paying him. The cornerstone of this trust and therefore the link with Ilizarov and the KNEIKOT was the commercial agreement between Medical-Plastic and Medexport. Paley had come as part of the Italian team and thus received special recognition and attention by Ilizarov.

Paley also carried out three research projects using material at the Hospitals of Lecco and Bergamo. The



Figure 12: Ilizarov's first meeting with Dr. Dror Paley in his office on October 8, 1986. There are two translators in attendance

hospitality, warmth, and sincere friendship he experienced from the orthopedic surgeons and their families built an everlasting bridge between Italy and Paley. By 1986, nearly 1000 patients had been treated by the Ilizarov method in Lecco and Bergamo. Numerous errors were made and many complications occurred. Rather than abandon the method, these surgeons learned from their mistakes and moved forward, advancing on their learning curve, and improving the method as they did. Ilizarov had never told them how to avoid or treat complications. These pitfalls lead many European surgeons to lose their initial enthusiasm and to give up the method rather than to work through the obstacles. This was most evident at the SOFCOT meeting in Paris in November 1986. The French surgeons presented paper after paper of disastrous results with the Ilizarov method with Professor Ilizarov in attendance. It was the first of many times that Ilizarov was to say "that is my apparatus but not my method." Many switched to monolateral fixation blaming the Ilizarov apparatus for the failures rather than themselves. Fortunately, the group in Lecco and Bergamo persevered where others failed. Paley had the good fortune to learn from the Italian mistakes and therefore start his experience higher up on the learning curve. One notable event that happened during his sojourn in Lecco helped create a radical difference in the teaching of the method. The Russian technique of applying the apparatus was to insert the wires first and apply the rings next. Centering one ring to the next is quite difficult this way. The Italians copied this method. Paley preconstructed an apparatus for a case in Lecco and returned to North America to preconstruct all the Ilizarov frames before application. Invention of preconstruction made the Ilizarov method easier to teach.

Paley returned home to Toronto, Canada, on December 21, 1986, to the birth of his second son Jonathan the next day. On January 1, 1987, he started his fellowship in pediatric orthopedics with Dr. Walter Bobechko at the Hospital for Sick Children (HSC). Bobechko who was the Chief of Orthopedics allowed Paley to order Ilizarov equipment

directly from Italy. This was a pivotal event. First of all, it represented the first official importation of the Italian Ilizarov apparatus produced under licensure to North America. Second, it paved the way for the subsequent agreement between Richards and Medical-Plastic. Third, it began the largest experience to date of Ilizarov applications in North America. Prof. Ilizarov sent Paley a personal invitation to revisit Kurgan in February–March 1987. With Dr. Bobechko's permission, Paley returned to Kurgan for a month and delayed using the Ilizarov device until he returned from a second trip to Kurgan. It was during this month that Paley's Russian language improved to the point that he could converse, read, write, and even lecture in Russian. Learning Russian proved to be a key step in learning how the Ilizarov method was performed. A veil of secrecy existed in Kurgan. Many of the questions asked by foreigners on previous trips were answered in no uncertain terms by the word "secret." By speaking and reading Russian, Paley was able to get along without an interpreter. Without a go-between and therefore a witness most of the doctors were much more open. Furthermore, as Paley was befriended by many of the surgeons, he was able to discuss more about the method. Since Paley could read Russian, he would scan the daily operating room schedule and see which operations he was interested in attending. On the other hand, these were usually not the operations he was permitted to see. Paley would slip from one room to the next to observe different surgeries. Widening of the leg, foot, and hand and angiography surgeries were not permitted. Observing these had to be done in a clandestine manner. Evening was a particularly useful time to discover some of the secrets behind the method. Gorbachev had created a restriction on the purchase of alcohol. However, at the hotel, there was no restriction for foreigners. Paley would frequently invite Russian friends to drink and eat with at the Hotel Moskva. Vodka had an amazing effect on the information they were willing to share. Paley's curiosity and enthusiasm in the method were infectious and there was an outpouring of unsolicited help that he received from many parties to share what they knew. The research staff even provided Paley with original photomicrographs of Ilizarov's original experiments and explained many of the biologic findings that have subsequently been rediscovered by Western researchers. The level and depth of their basic research were impressive. The individuals at the institute could be divided into two groups: the survivors and the nonsurvivors. The former was obviously and intentionally evasive even about common subjects. Nevertheless, the survivors were the ones that advanced in their positions. Some of the survivors were privately helpful but publicly evasive. The second group was the dissidents. These were the individuals who went out of their way publically and privately to teach Paley. Many of these were subsequently demoted or had to leave the institute. One of these dissidents, Dr. Katayev had already been demoted by Paley's second visit to Kurgan. Katayev who used to work

in the patent office (highest level of trust) was relegated to teaching the Russian students (lowest level of trust) because he had openly criticized Ilizarov. Paley attended his outstanding lectures with the Russian doctors and later was invited to lunch with Katayev at his apartment, in the same complex as Ilizarov's apartment. Ilizarov was petrified that Paley might learn some of the "secrets." He interrogated both Paley and Katayev regarding this the following day (each in a separate room going back and forth between them). Paley was so disgusted by this behavior that he decided to leave Kurgan. In a panic the Deputy Director of the Institute, Yevgeny Sochnev came and told Paley that Ilizarov wanted to invite Paley to stay an extra week. Sochnev and Paley had become very good friends, cross-country skiing each morning, eating caviar, with bread, butter, and vodka while discussing politics in Russian each evening. Paley recently found out that Sochnev was a member of the Communist Party and KGB. Despite this, Paley claimed that he was always treated well by Sochnev. Katayev undaunted by Ilizarov brought Paley numerous internal Institute publications to smuggle out of the Soviet Union.

While numerous European surgeons had been to Kurgan, none had stayed more than a week to 10 days and all teaching was done through an interpreter. Their programs were heavily regulated and organized and most had no previous experience with the method so that the questions they had were less focused. Paley went to Kurgan the first time in this manner. Paley went to Kurgan the second time having observed and worked with the method and other methods for 6 months. He also had the advantage of speaking Russian, which he had taught himself for this very purpose. Before going to Kurgan, Paley had obtained many of the peer-reviewed Ilizarov publications that were available in Canada. Paley also had the opportunity to use the KNIIEKOT's library. This library had a lot of the internal publications of the institute that were unavailable elsewhere. Paley spent many hours with a Russian Medical Dictionary translating these articles into English. Since there were no photocopy facilities, he photographed a lot of this material in his hotel room. At the time, it was illegal to remove internal Soviet publications from the USSR. Paley smuggled many such internal publications and monographs out of the Soviet Union. Fortunately, he was not stopped or searched at customs when leaving the Soviet Union. Before leaving Kurgan for the second time, Paley wrote prophetically in Ilizarov's visitors book on March 20, 1987 [Figure 13]: "Without question your method is a Revolution in Orthopedics, especially from the biologic standpoint. While your apparatus is the most modular and versatile external fixator ever developed, even more important are your biologic methods and principles, which are apparatus independent and therefore will be everlasting. While apparatuses change biologic principles do not, and for this reason, I think your cumulative work of the last

37 years is worthy of the highest honors even the Nobel Prize."

Paley returned home at the end of the second Kurgan visit at the end of March 1987. In April 1987, Paley performed his first Ilizarov case at the HSC. From April to October 1987, he treated 52 patients with the apparatus. In addition to the better-known applications of the method for deformities, lengthening, and transport, he began to perform techniques that were not being done in Western Europe yet such as V and U osteotomies for the foot, double-level lengthening, leg widening, and angiology distraction. While the Europeans were following Ilizarov's axioms of closed treatment of pseudarthrosis and in particular congenital pseudarthrosis, Paley had observed the open treatment of this in Kurgan. All four initial cases of this pathology that he treated in Toronto healed without difficulty. Having had 7 months of fellowship training before beginning paid off. There were still complications. The opportunity to begin this work in Canada and not in the more litigious environs of the USA was another advantage. Finally, the ability to siphon off the most difficult cases at HSC from the referrals of most of the staff there gave Paley an unparalleled initial clinical experience. His frustration and need to put the hinge at the correct level led to the development of what later would be termed the center of rotation of angulation (CORA) method as early as May 1987. In June 1987, Richards Medical began the commercialization of the Ilizarov apparatus in North America by importation of the apparatus from Medical-Plastic.

Following Frankel and Greens trip, Drs. Frankel and Paley began organizing the first Ilizarov conference on the Ilizarov method in the US. Sponsored by Richards and by the Hospital for Joint Diseases, Paley was able to invite numerous European experts on the Ilizarov method to speak. The conference was cochaired by Frankel and Paley and took place at the Roosevelt Hotel on November 1–3, 1987 [Figure 14]. There were 150 participants.

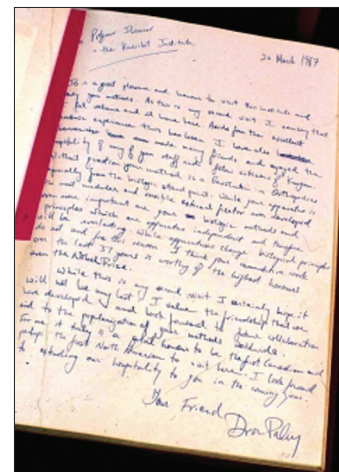


Figure 13: Page from Ilizarov's visitors book that was filled in by Dror Paley on his second visit to Kurgan on March 20, 1987. Many of the words are quite prophetic

The program had to be modified on a daily basis to accommodate for Professor Ilizarov's longer than expected lectures. The conference concluded with a presentation of the HSC Experience by Paley, the first North American experience. This was followed by a west coast mini-course organized by Stuart Green. One of the most significant lectures at the NY Conference was by James Aronson. He demonstrated that he had reproduced the biological findings that Ilizarov talked about. This added tremendous credibility to Ilizarov's talks.

A great deal of credit for the introduction of the Ilizarov apparatus and method to America should go to Jack Blair, President of Richards Medical Co., (Now Smith and Nephew Orthopedics) who had the vision to see the future of this methodology [Figure 15]. From the beginning when Blair went to Lecco with Victor Frankel and when Paley called him to get funding for Ilizarov research and then an Ilizarov fellowship, he was very supportive of bringing the Ilizarov method to the US. Early on, he assigned the project to one of his research people Richard Treharne Ph.D. Just before the first NY course, Treharne hired Alex Lu Kianov to run the commercial side of the product which was now FDA approved. Alex's infectious personality and superb managerial ability allowed Ilizarov to become a separate division at Richards and have a separate budget. Those were the golden years and during the 2 years that this special status existed the product grew and spread by leaps and bounds. New product parts were designed according to the advice of many surgeons. Alex left Richards to work for Danek in January 1990. Richards maintained its commitment to Ilizarov, but the product line was taken over by the Trauma division. Its autonomy was lost. Nick Zelensky and his superior Frank Navarra assumed responsibility for the product. It is through their leadership and commitment that new developments to the product line occurred. These include the

hybridization of the device using half pins (a system developed by Stuart Green (RANCHO system); hinge distraction fixators for the elbow and finger (Compass Hinge) developed by Dr. Robert Hotchkiss; the Spatial Frame for complex deformity correction developed by Charles Taylor; and lengthening over nails developed by Dror Paley.

In January 1988, an article entitled Current Techniques in Limb Lengthening appeared in the Journal of Pediatric Orthopedics, authored by Dror Paley. This classic article was the first review article on the biology and clinical applications of distraction osteogenesis. In May 1988, Paley organized the second conference on the Ilizarov method, which was held in Vienna, Virginia. There were over 175 registrants. This was the first course in which preconstruction was the method taught and videos were used for the laboratories. Further, in May 1988, Prof. Mihran Tachdjian invited Paley to organize a Limb Lengthening Course as part of his Pediatric Orthopedic Symposium. The faculty of this course was all of the various experts Paley had met during his traveling fellowship. This course introduced Ilizarov and his method to the most prominent US and international pediatric orthopedic surgeons who were in attendance as the faculty of this well-known symposium. This one meeting had a huge long-term impact on the future introduction of this technology around the world. Frequent phone discussions between Paley, Aronson, and Green lead to the terminology subsequently to be used in the English language publications and presentations (e.g., distraction osteogenesis, bone transport, interzone).

In September 1988, Paley and Green [Figure 16] led the Richards Medical first English-speaking course on the Ilizarov method in Kurgan. This was attended by over 50 Americans and Canadians. It was the first of many annual Kurgan courses to follow. In December 1988, Frankel and Paley cochaired the third Ilizarov Conference in New York. This was to be the last of the independently organized courses. All subsequent courses were organized through Richards although the scientific program was always



Figure 14: Victor Frankel with Ilizarov. On the far left is Michael Samchukov who travelled with Ilizarov and then immigrated to the US and works at Texas Scottish Rite in Dallas. On the far right is Al Grant, also one of the first adopters of the Ilizarov method who worked at the Hospital for Joint Diseases with Victor. Ilizarov regularly visited with Victor Frankel in New York during his US trips. Victor even arranged for him to undergo emergency vascular surgery in New York



Figure 15: Jack Blair, president of Richards. C. 1986. Jack was the visionary that recognized the uniqueness of the Ilizarov Technology

independently organized by the surgeons. The next year saw a flurry of resort-based courses and the first advanced course. The first Advanced Deformity course was chaired by Paley in Baltimore in June 1989. It was the last regular course Ilizarov was to attend. Following that, Ilizarov's attendance was more sporadic as the Americans took more of the responsibility to teach his method. The first advanced course was the prequel to the now famous annual Baltimore Limb Deformity conference that Paley organized on an annual basis until 2009 when it was taken over by John Herzenberg.

The day before this first advanced course, on June 25, 1989, Paley organized a town meeting of key opinion leaders to form ASAMI North America [Figure 17]. The charter was founded and the bylaws chosen. Paley was elected the first president of ASAMI North America (later renamed Limb Lengthening and Reconstruction Society). Ten papers were presented with Prof. Ilizarov and Shevtsov in attendance. Both were made honorary members.

Supported by the Richards Company, many international courses were sponsored including the UK, Germany, South Africa, Australia, New Zealand, Thailand, Singapore, Malaysia, Taiwan, Japan, South Korea, and Israel. Most of these were taught by Catagni and Paley. In addition, many developing nations locally sponsored their own courses to which Catagni and/or Paley with or without Ilizarov were invited. These included Brazil, Argentina, Egypt, Chile, Mexico, Zimbabwe, Pakistan, India, Cuba, Tunisia, Saudi Arabia, Bahrain, and others. A running joke at the time was that Ilizarov was invited to show the magic tricks and Paley was invited to explain the magic tricks. Through these courses, the experience developed in Lecco and in Baltimore was transmitted around the globe in only a few years.

The development of the method in America proceeded rapidly after 1989 with many more courses and many more experts in the field. It would be impossible to credit everyone or every event since then. Many authors from around the world have contributed significantly to the

literature (e.g., Natsuo Yasui from Japan, Michael Saleh from UK, Joachim Pfeil from Germany). There are a few exceptional events that are worthy of separate mention:

In 1987, Paley was invited by Dr. Marshall Urist to edit a Symposium of Clinical Orthopedics and Related Research entitled "Modern Techniques of Limb Lengthening." This was published in January 1990 and contains some of the classic articles on this subject to date: e.g., problems, obstacles, and complications of limb lengthening. Urist met Ilizarov in LA at Dr. Green's symposium in November 1987. He invited Ilizarov to submit his articles to the journal. Ilizarov consented and while in LA as he got out of his cab to catch his flight home and gave Dr. Green his slides and his lecture to put together into an article. Green wrote the article based on the poor translation of the lecture he had received from Ilizarov. Furthermore, he printed Ilizarov's slides and then cleaned them up in his own home darkroom (Green is also a professional photographer) to submit for publication. The three articles that resulted are Ilizarov's only publications in the English language peer-reviewed literature. Ilizarov was so pleased with Green's work that he invited Dr. Green to edit the book Transosseous Osteosynthesis he was writing for Springer-Verlag. Green met with Ilizarov several times including a special trip to Kurgan to work with him on the book. This must have been a work of love since Ilizarov was not the easiest person to work for. On several occasions, Green almost quit and went home. Green's selfless commitment to this effort is perhaps the greatest contribution he could have made in this field. The manuscript that resulted is Ilizarov's final testament and a permanent record of his work for years to come. Had Green not done this, Ilizarov's work may never have been published in English. Just before the publication of the Ilizarov book, Paley helped translate Bagnoli's book, The Ilizarov Method, from Italian to English, published in 1990. In parallel, James Aronson of Little Rock, Arkansas, assisted Bianchi-Maiocchi in editing his newest book a manual on use of the Ilizarov apparatus. The Aronson edited book



Figure 16: Stuart Green co-lead the Richards Medical first trip to Kurgan with Dror Paley in September 1988. Stuart is seated next to Ilizarov and beside Dror Paley. On the left are Al and Ellen Grant. The picture was taken in Ilizarov's apartment



Figure 17: Inaugural ASAMI North America, June 25, 1989, with Ilizarov (center, holding the inaugural plaque) and Shevtsov (far left) attending. From left to right: James Aronson, Stuart Green, Deborah Bell (Stanitski), Oleg Gorbachov (translator), Gavril Ilizarov, Dror Paley, Wally Lehman, Vladimir Schwartzman

became the first manual on the Ilizarov method. Clinical Orthopedics continued to support publication of research on the Ilizarov method through a special issue edited by Green in 1992 and by Aronson in 1994. A special symposium was also published in 1993 in *Orthopedic Clinics of North America* edited by Green and the following year another one by Paley and Tetsworth. The *Bulletin of the Hospital for Joint Diseases* was very supportive due to the patronage of Victor Frankel and hosted numerous publications and symposia on the Ilizarov method. Eventually, the *Journal of Bone and Joint Surgery (British)*, and subsequently, the American version published research papers on Ilizarov techniques. All of these publications and the many presentations at local, regional, national, and international meetings gave the Ilizarov method the legitimacy that it lacked previously. James Aronson's Kappa Delta award on the biology of distraction osteogenesis was a crowning moment that this was now mainstream. The Ilizarov method is now a standard accepted orthopedic method and is even occasionally the correct answer on in-training and board examinations. This almost 70-year-old method that had difficulty getting accepted outside of Siberia is now accepted and used worldwide. It was a great adventure and honor for all those who participated in its dissemination and development.

Ilizarov died in 1992 at the official age of 71 and the unofficial age of 72 (he was likely born 1 year before the officially stated birth date). His accomplishments were extraordinary irrespective of where he came from lived and worked. He had countless publications in Russian literature and many in the International literature. He had authored 208 Russian patents. He was decorated with numerous awards and titles including [Figure 18] Honored Inventor and Doctor of the USSR, Deputy of Supreme Soviet Party, Member of Order of Red Banner, Order of Lenin (highest Soviet award), and Hero of Russia. He had achieved what few doctors ever achieve, celebrity status as a national folk hero. He developed a whole new field of biology and clinical orthopedics. His method had helped innumerable patients in the USSR and around the world. His personality was entertaining to those being hosted, stimulating to those being taught, but frightening and frustrating to those who had to work for him. In his own little world, he was a very powerful man and ran his institute in an authoritarian style acceptable in his place and time. He kept his methodology a secret for both practical and egotistic reasons and was always paranoid that others might steal his ideas or steal the limelight from him. His paranoia given his early years, when he was treated unkindly and when he suffered betrayals such as by Spinelli, was justified. He was desperately trying to protect his intellectual property while at the same time opening it up to the world.

One of Ilizarov's greatest proponents was Roberto Cattaneo. After Ilizarov's death, Cattaneo proposed creation of International ASAMI. He called the first organizational

meeting at the SICOT in 1996; Paley volunteered ASAMI North America to organize the first International ASAMI meeting, which took place in New Orleans, Louisiana, in March 1998. Since then, the ASAMI International meeting took place every 2 years until it underwent a schism after the St. Petersburg Russia meeting in 2008, over the option of uniting with the World Congress of External Fixation (WCEF was a resurgence of the old Hoffmann External Fixation group restarted by Dr. Alfredo Aybar from Peru). The ASAMI International Organization broke into two groups; ASAMI International and Bone Reconstruction and the International Limb Lengthening and Reconstruction Society, which merged with WCEF. In November 2015, due to the diplomacy and leadership of Paley, a combined meeting of the ASAMI International and BR, ILLRS, and WCEF was held in Miami, Florida. Since then, two more combined meetings have been held leading up to this year's, combined meeting in Liverpool, UK. The fact that people care so much about the politics of limb lengthening that such a schism could even occur may be a sign of how healthily entrenched the Ilizarov method and its offshoots are in International Orthopedics.

At the Miami combined meeting, Dr. Milind Chaudhary of Akola, India (Dr. Paley's first International Fellow 1988), presented the first issue of the *Journal of Limb Lengthening and Reconstruction*. This Journal is now the official Journal of the Combined Societies. The dissemination of the Ilizarov Method is on autopilot now. This new field of orthopedics is not so new anymore. It remains to future generations to take it to new frontiers. Whether it is called ASAMI in Ilizarov's name or LLRS as a more generic name, limb lengthening, and reconstruction will always be associated with the Ilizarov legacy.

Author's Note

I have written this account in the third person intentionally even though a lot of the later history is about my own role. I will intentionally switch now to the first person for this final personal account. I hold Professor Ilizarov in the highest respect despite how blunt and honest I have been about some of the vignettes



Figure 18: Ilizarov with all his official awards and decorations

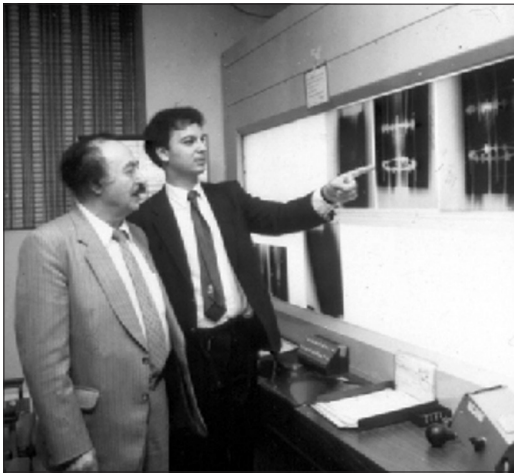


Figure 19: Paley consulting with Ilizarov at the University of Maryland, May 1988

in this account. I do not write this out of malice or disrespect. I feel I have had the rare privilege to know a great and very unique person. We had a relationship of mutual respect. Ilizarov was my Maestro, Sensei, Guru, and Gaon (Sage in Hebrew). I had the privilege of showing him my results when he came to University of Maryland Hospital in 1988 [Figure 19] and Kernan Hospital, Baltimore, in 1989. As a guest in my house on two occasions, my family and I have had the opportunity to get to know him on a personal level because I spoke Russian. I got to tell him that my father, Zvi also a Polish Jew was also exiled to norther Kazakhstan during the war and lived in near proximity to Kurgan from 1940-46. I saw how down to earth he was, when he played basketball with my two sons [Figure 20]. He was succeeded by his student, personal assistant, and friend Vladimir Shevtsov. Shevtsov's challenge was to keep the momentum that the KNEIKOT Institute generated in the 1980s into the 21st century. This challenge was multiplied by the lack of funding that they faced after the collapse of the Soviet Union. Shevtsov erected a memorial to Ilizarov on the main walkway to the Institute and created a journal called Genii (genius to credit Ilizarov's genius). Unlike Ilizarov, Shevtsov frequently gave credit to others. He organized a celebration of the 25th anniversary of the formation of the Institute in October 1996 (also the 45th anniversary of the discovery of the method and the 75th birthday of Ilizarov demonstrating that his institute and his method were alive and well). Dr. Shevtsov retired recently and the Institute is now headed by Dr. Alexander Gubin since 2010. Gubin who did not train in Kurgan has brought new blood and direction to the Institute. I returned to Kurgan in June 2018. The Institute has transformed to a general orthopedic hospital offering arthroscopy and arthroplasty. It maintains the Ilizarov legacy



Figure 20: Ilizarov playing basketball with Benjamin and Jonathan Paley at Dr. Paley's House in May 1988. Dr. Shevtsov is in the back

with continued clinical and basic science research. It has fathered many new centers around the world and can indirectly lay claim to the innovation in the biology and technology in this field today. Although limb lengthening and distraction osteogenesis predate Ilizarov by 50 years, the Revolution he sparked with his basic science and clinical work has rightfully earned him the role and name of Father of Limb Lengthening.

Dror Paley

Director, Paley Institute, West Palm Beach, FL 33407, USA

Address for correspondence:

*Dr. Dror Paley,
MD FRCSC,*

Director, Paley Institute, 901 45th St., West Palm Beach, FL 33407, USA.

E-mail: dpaley@paleyinstitute.org

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

Access this article online	
Quick Response Code:	Website:
	www.jlimblengthrecon.org
	DOI:
	10.4103/2455-3719.253395

How to cite this article: Paley D. The ilizarov technology revolution: History of the discovery, dissemination, and technology transfer of the ilizarov method. *J Limb Lengthen Reconstr* 2018;4:115-28.