INTRODUCTION

G. A. Ilizarov embarked on his remarkable medical career as a general physician in the small industrial town of Kurgan, east of the Ural Mountains in Siberia of the former Soviet Union (69,73,96). The year was 1944, and the majority of his patients suffered musculoskeletal injuries during World War II. Antibiotics, although available in the Western world, were scarce in Siberia, where chronic osteomyelitis with bone deficiencies, nonunions, and deformities were so common that Ilizarov found himself practicing orthopedics of necessity. In part through serendipity and in part through his own genius and tenacity, he developed the method that bears his name (69,73,96). Using modular ring external fixators and transosseous wires tensioned to the rings to stabilize the bone fragments, he introduced the concept of local bone regeneration using minimally invasive surgery (96). His clinical successes in salvaging preamputation limbs and returning completely disabled patients to normal activity levels eventually spread by word of mouth throughout the Communist bloc of countries (69,73). By 1981 a group of Italian orthopedic surgeons had learned of his technique, mastered it, and subsequently published it in didactic textbooks (9). In order to disseminate the device and the technique, these Italian orthopedic surgeons organized national societies under the title of A.S.A.M.I.—Association for the Study and Application of the Methods of Ilizarov (9). More recently, the method was introduced in North America, where it has been adopted primarily by pediatric orthopedic surgeons for limb lengthening (11,49,120,127). Some US orthopedic surgeons have expanded their practice to include the Ilizarov method for adults with severe deformities, nonunions, and bone deficiencies from trauma, infections, or tumors (39,42,43,46,76,78,99,114,124,129,142). Many research centers have utilized the method to study bone formation, in part corroborating Ilizarov’s own research and in part extending the insights into regeneration of both bone and soft tissues under mechanical distraction (8,9,55,107,174,179). More recently, use of the Ilizarov method came full circle geographically and historically, as a group of Croatian surgeons used it successfully to treat victims of the war in Bosnia, many of whom were afflicted by methicillin-resistant staphylococcal osteomyelitis (personal observation, April 20–21, 1995). This review summarizes the experimental and clinical experience with the Ilizarov method published in Western journals over the past decade.

INDICATIONS

Although the majority of Ilizarov’s applications may not be utilized in the Western world, it is worthwhile comparing the many indications that he found for his method to our currently accepted indications. Ilizarov practiced in an isolated area of the world, without access to the many technological advances of the four decades following World War II. As a result, he had to rely on his standard method to treat all musculoskeletal conditions.

Most acute fractures of both upper and lower extremities—closed as well as open, diaphyseal, metaphyseal and intraarticular, displaced and nondisplaced, and even hip and pelvis fractures—were
percutoaneously reduced and stabilized until healing using the Ilizarov device, self-assessed with relatively few complications. Some North American traumatologists, including Tucker (162), Taylor (110), and Watson (172), have used the Ilizarov method in acute trauma and found it to be superior to conventional technology for certain select indications: severely comminuted, open fractures with bone defects and highly comminuted intraarticular fractures with metaphyseal extension such as plateau and pilon fractures (161) of the tibia.

Following the war, Ilizarov found posttraumatic reconstruction of chronic limb deficiency and deformity to be the broadest application for his method. Bone transportation, perhaps his greatest clinical innovation, salvaged many of these preamputation limbs. He described successful treatment of nonunions (atrophic and hypertrophic, infected and noninfected, with and without intercalary bone loss or shortening), malunions, chronic osteomyelitis, and short amputation stumps. Reports from the Western literature have been promising for treatment of nonunions and intercalary defects and for lengthening of limbs and stumps (10,20,24,39,42,43,46,70,76,78,99,114,124,129,142,157). The Ilizarov treatment of osteomyelitis has been successful in the West as well, although the method has been combined with a variety of modern adjuvants such as free flaps, autogenous grafts, and antibiotics (both parental and local impregnated beads) (33,46,163).

Limb lengthening for both congenital and acquired conditions from childhood through middle-aged adults is probably the most common application of his method in the United States (11,28,51,127,140,141,150,157). Ilizarov expanded the clinical limits of lengthening (absolute and percentage), age limits, soft tissue limits (nerves, muscle, and adjacent joint contracture), as well as the indications to such conditions as dwarfism. He claimed to solve certain problems from congenital conditions such as proximal focal femoral deficiency, the hemimelias, and congenital pseudarthrosis of the tibia. Although his method initially enjoyed wide popularity and interest in the United States for treatment of these conditions, the complex and tedious nature of the method (127) and the frequency of complications (52,128) combined with overzealous claims of success engendered appropriate skepticism.

As a result of Ilizarov’s work, the indications for limb lengthening have been expanded, but Western experience has better defined the limitations of the technique and identified potential complications. Lengthening of flat bones such as the mandible, skull, and vertebrae has been demonstrated (94,95). Most of Ilizarov’s work in these areas was limited to experimental animal models. However, in the United States, patients have undergone successful deformity and nonunion treatment, while vertebral lengthening and mandibular lengthenings have also been accomplished clinically with some success (26,50,66,72,101).

Correction of clubfoot and other soft tissue deformities, including chronic knee or elbow contractures, pterygium syndromes, and syndactylie, as indicated by Ilizarov (95), though infrequently reported, has had some success (34,53,70,81,87,126). Cosmetic limb reshaping in clubfoot or polio, where a thin calf can be widened by transverse angular distraction of the tibia and fibula (93), has been attempted rarely in the United States, with potential complications limiting its application (128).

Vascular insufficiency in diabetes or thromboangiitis obliterans were reportedly cured by Ilizarov using transverse distraction osteogenesis of a local bone (94). Massive but transient increases in regional blood flow have been measured by Western investigators (13), but clinical application of this variation for diseases of small vessels has not been reported in the United States.

Creation of new ligaments (the anterior cruciate in the dog) has been reported using distraction techniques experimentally (22). Although it is intriguing to consider that the rate of distraction can either modulate bone or ligament formation, clinical applications are not yet reported.

HISTORY

Pre-Ilizarov Era

In order to appreciate the monumental contributions of Ilizarov to the field of orthopedic surgery, it is important to relate his achievements to preceding events historically. Three areas—limb lengthen-