Physiotherapy during Ilizarov fixation

Stuart A. Green, MD

A limb stabilized in an Ilizarov external fixator must be used in a physiologic manner for the entire time that the frame is in place. Weight-bearing for lower extremity applications and the functional use of upper limbs are essential for the proper maturation and ossification of either a fracture callus or a lengthening distraction gap. Progressive weight-bearing begins on the day following application of the fixator. Any reason for a decline in a patient's ambulatory capacity during treatment (eg, pain, wire sepsis, contractures) must be corrected. Likewise, during any Ilizarov procedure involving movement of bone segments—whether lengthening, deformity correction, or bone transport—myofascial tissues resist elongation, leading to either gradual deformity at the site of a corticotomy or joint contractures that can progress to subluxations and dislocations. For this reason, intensive physiotherapy, dynamic and static splinting, and proper night positioning must be employed for the entire time a patient is in fixation.

For a successful application of the Ilizarov method, a limb stabilized in an external fixator must be used in a physiologic manner throughout the time when the frame is in place. Mechanical stimulation is essential for the proper ossification of the newly formed regenerative bone in a distraction gap and for the optimum maturation of healing fractures and pseudarthroses.

To achieve this goal, a patient must bear weight on a lower limb in an external fixator and use upper extremities in fixator frames as normally as possible. Implicit in this requirement is the need to preserve joint mobility through the strategic placement of fixator wires and pins when the fixator is applied. Moreover, the configuration should be stable enough to eliminate movement of the bone with respect to the fixator, which is a source of patient discomfort, pin loosening, and decreased neo-osteogenesis.

AMBULATION

Graduated gait training begins on the first postoperative day. The patient should be encouraged to bear as much weight as tolerated on the operated limb with the aid of crutches or a walker (Fig 1). A natural rhythmic walking pattern is probably more important than the actual amount of weight on the limb at the beginning of the rehabilitation program. With time, the patient must progressively increase the load on the limb. Toward the end of treatment, the patient should be able to get around with one crutch or a cane. At the time of fixator removal, the limb must be able to support the patient without ambulatory aids (Fig 2). Constant encouragement by the physical therapist and surgeon will do much to ensure rapid ossification of healing bone.

If, during the course of postoperative fixator management, a patient's walking ability decreases, the surgeon must immediately determine the cause. Usually, there is a clear-cut reason why the patient is having difficulty with ambulation. Most commonly, wire or pin site sepsis will be the source of pain with weight-bearing. At times the infection may not drain to the surface, but the patient will indicate which implant is causing the pain. The surgeon must not ignore such a development. If antibiotics cannot control the infection, than the offending pin or wire should be changed.

Whenever a patient wearing an external fixator stops walking, bone density decreases. Osteoporosis reduces anchorage of wires or pins in the bone, leading to loss of fixation; pin-bone motion encourages microbial invasion, which becomes the source of more sepsis, pain, and a further decline in ambulatory capacity. This vicious cycle should not be allowed to begin. Every pin or wire site infection must be treated aggressively. A loose fixator must be reapplied (Fig 3).

SAG: Clinical Professor, Department of Orthopaedic Surgery, University of California at Irvine, Irvine, California. Reprints: S. A. Green, Rancho Los Amigos Hospital, 7601 E. Imperial Highway, Downey, CA 90242.

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JOINT MOBILITY

Intensive physiotherapy is also necessary to prevent the joint contractures and subluxations often associated with limb elongation and the correction of deformities. Even if the fixator is applied to deal with a fracture or a nonunion—conditions not ordinarily associated with stretching of tissues—irritation of muscles impaled by pins or wires can lead to restriction of joint mobility. Thus physical therapy has an important place in the management of all patients in external fixation.

Whenever bone fragments are moved with respect to one another, soft tissues are placed under tension: The greater the movement, the greater the tension. For this reason, it is important for the surgeon to consider every Ilizarov fixator application that involves movement of bone fragments as a form of limb lengthening even if the extremity does not end up longer as a result of the procedure. Every deformity correction, for example, stretches the shortened soft tissues on the concave side of the angulation; these tissues will resist elongation. Likewise, every bone transport operation designed to overcome a segmental defect is actually a fragment lengthening; tissues attached to the moving fragment are being stretched during transport. Therefore, the physiotherapy strategies developed to maintain joint mobility during limb lengthening must also be employed during most other Ilizarov-type treatment plans. Indeed, constant stretching of tightening tissues is the hallmark of proper postoperative management of a patient wearing an Ilizarov fixator (or, for that matter, any device that is lengthening soft tissues).

Every lengthening, deformity correction, or bone transport case can result in a severe deformity or contracture of an adjacent joint. As it turns out, myofascial tissue resists elongation more than any other limb structure during lengthening. For this reason, each level of every long bone being lengthened tends to deform in a characteristic direction, with the apex of the deformation being opposite the greatest muscle mass. When a tibia is lengthened through a proximal corticotomy, for example, the resistance of the calf muscles tends to produce knee flexion contractures, ankle equinus, and antecurvatum at the corticotomy site. Simultaneously, tension on the anterior compartment muscles can cause valgus deformation of both proximal and distal tibial corticotomies. The combination of a valgus deforming force with an antecurvatum
Fig 4. A canvas strap to prevent equinus.

Fig 6. A Dynasplint attached to the frame.

Fig 5. Dynamic dorsiflexion with an elastic strap.

effect causes a resultant tibial deformity with the apex located anteriomedially.

The femur tends to deform toward varus proximally and valgus distally (although occasionally varus distally as well). In the sagittal plane, the femur deforms with its apex anterior. The humerus angulates anteriorly both proximally and distally. In addition, proximal humeral corticotomies deform varus. The ulna and radius both usually deform apex anteriorly because of the pull of the elbow flexors.

As a rule physiotherapy alone cannot prevent the deformities that can angulate lengthening bone; instead, the external fixator itself must have the capacity either to prevent the deformation or to correct for it during lengthening. The important elements of every postoperative physical therapy treatment plan designed to prevent deformities and contractures include elastic splinting, passive stretching, active use of the limb, and appropriate nighttime positioning.

Splinting

Both static and dynamic splinting have a role in the management of patients undergoing elongation of soft tissues. Static splints include fixed-position orthoses and straps, ropes, and other nonelastic devices that hold a limb in position. We frequently use a canvas strap to connect a patient’s footwear to the front of the fixator frame (Fig 4). Such devices are especially helpful at night, when the constant pressure of a dynamic splint can become uncomfortable for the patient.

Dynamic splinting can be as simple as an elastic band from the foot to the fixator (Fig 5) or as elaborate (and expensive) as a spring-loaded, clamp-on dynamic extension splint (Fig 6). In either case, dynamic splinting should always be a part of any application involving muscle stretching.

Ankle equinus and knee flexion contractures are the two most common types of deformities that occur with lower limb elongation; hip flexion contractures can develop during femoral lengthening. These deformities should not be allowed to persist or worsen while the frame is in place. If a knee flexion contracture is not corrected, progressive tightening of the hamstrings can lead to posterior subluxation of the knee. If the subluxation is not recognized and corrected, a frank dislocation of the joint
may occur. In the hip, this problem is most likely to occur in a patient with femoral neck valgus deformation at the start of femoral lengthening.

There is a tendency for the toes to curl during distal lengthening of the tibia or whenever a segment of bone is transported from distal to proximal in the lower leg (Fig 7). To prevent such deformities, we often attach little slings to the toes; the slings are tensioned to the frame (Fig 8). At times it may be necessary to insert K wires into the toes for the same reason.

**Stretching**

Passive muscle stretching is another essential measure designed to prevent contractures. The physical therapist must teach patients and family members how to stretch the calf, the hamstrings, and other muscle groups. At least 2 or 3 hours a day should be devoted to this activity, especially in cases involving substantial lengthenings. In fact, the greater the anticipated elongation, the more time per day that must be devoted to passive muscle stretching.

Interestingly, active muscle exercises do not help much in preventing contractures. For example, active dorsiflexion of the ankle is not nearly as effective as passive stretching of the calf musculature in limiting equinus contractures (Fig 9).

**Night positioning**

The 7 or 8 hours that an individual spends in bed may be the most important hours of the day for the patient wearing an external fixator. During that time, joints allowed to fall into suboptimal positions will resist correction during the day. For most lower extremity applications, the foot must be supported and prevented from dropping into plantarflexion. Likewise, the knee joint should be gently forced into full extension, usually by the proper placement of pillows. If left alone, a ring fixator surrounding the lower leg will flex the knee and permit the foot to drop into plantarflexion when a patient is supine (Fig 10a). Propping the fixator under its most distal ring will extend the knee; a shoe on the foot tied up on the frame can support the ankle (Fig 10b). With thigh lengthenings, the tendency for hip flexion at night can be overcome by placing the patient prone (a special mattress may be needed if the fixator is located anteriorly). A pillow under the knee extends that joint.

**Functional use**

Ambulation and upper extremity use not only promote ossification of the regenerate but also help prevent contractures, subluxations, and dislocations. Weight-bearing, for example, serves as a means of passive calf muscle stretching while maintaining tone and stimulating circulation in the limb. Eating, hair combing, gymnastics, dance therapy, and other similar activities are also
Fig 10. Night positioning. (a) Night position that causes ankle equinus and knee flexion contractures. (b) Proper night positioning with the foot dorsiflexed and the knee extended.

Fig 11. Cycling, an excellent exercise for the knee and ankle.

useful adjuncts to therapy. The rhythmic movements involved with swimming, cycling, and walking are among the best therapeutic exercises available (Figs 11 and 12).

If the surgeon and physiotherapist cannot overcome an evolving joint contracture with splinting, hands-on passive stretching, or any other strategy (such as extending the fixator across the joint), the wisest course is to abandon the goal of treatment, stop whatever bone movement is occurring, and commence a course of intensive physiotherapy. For this purpose, the patient may have to be admitted to the hospital for supervised care. If the contracture does not improve the fixator may have to be modified into a contracture correction configuration, and the bone elongation or deformity elimination may have to wait until a second fixator application to complete the course of treatment.

It is evident that physiotherapy is the key to a successful application of the Ilizarov method. Ambulation and functional loading are essential for ossification of the regenerative bone, and stretching and preserving range of motion are the keys to preventing contractures, subluxations, and dislocations.
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