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Use of Ilizarov External Fixation Without Soft Tissue Release to Correct Severe, Rigid Equinus Deformity

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ABSTRACT

The purpose of the present retrospective study was to report the correction of severe, rigid equinus deformities using an Ilizarov external fixator alone, without adjunctive open procedures. Ten feet in 10 patients with rigid equinus deformities were enrolled and underwent gradual correction using an Ilizarov external fixator alone, without additional open procedures. The range of ankle joint motion was measured preoperatively and at the last follow-up visit. The radiographic outcome was assessed using the lateral tibiotalar angle on ankle radiographs taken preoperatively, immediately after removal of the Ilizarov fixator, and at the last follow-up visit. The mean duration of external fixator treatment was 40.1 ± 13.5 days. The preoperative mean ankle range of motion was −55.5° ± 22.2° of dorsiflexion and 63.0° ± 20.8° of plantarflexion. At the last follow-up visit, the mean dorsiflexion had increased to −2.5° ± 6.8° and the mean plantarflexion had decreased to 30.5° ± 12.6°. The mean lateral tibiotalar angle was 152.9° ± 19.7° preoperatively, 103.9° ± 9.4° immediately after removal of the Ilizarov external fixator, and 113.9° ± 11.6° at the last follow-up visit. Immediately after fixator removal, all the patients had clinical correction of their deformity to a plantigrade foot using the Ilizarov external fixator alone, with a mean correction of 49.0° ± 17.4°. Some recurrence was noted at the last follow-up examination, with a final mean correction of 39.0° ± 18.0°. The present study has demonstrated successful correction of severe, rigid equinus deformity with the use of an Ilizarov external fixator without the need for adjunctive soft tissue procedures. This method can be effective for patients with a high risk of complications after open procedures owing to their poor soft tissue envelope.

Equinus deformity is associated with congenital disorders, trauma, burns, neuromuscular disease, and limb lengthening (1–3). A rigid equinus deformity will result in a tip-toe gait, making ambulation difficult. Conservative treatment, such as stretching exercises, dynamic splinting, and serial casting, can be attempted for mild equinus deformities (4). If conservative treatment does not result in adequate heel weightbearing or a compensated toe gait, surgical options should be considered (5–7). The surgical options for correction of equinus deformities include soft tissue release, tendon transfer, osteotomy or wedge resection, and hindfoot fusion (4,8–18). These procedures are technically challenging and the risk of complications is high, in particular, in the setting of associated infection or poor soft tissue envelope (8,12).

In such cases, an Ilizarov external fixator with the concept of distraction histogenesis has been used as a less-invasive attempt to correct equinus deformities (19–23). Most of the existing studies have reported the use of an Ilizarov external fixator combined with open procedures such as soft tissue release (11,24–27). Experience with correction of equinus deformities using an Ilizarov external fixator alone without adjunctive soft tissue procedures is limited.

Thus, we hypothesized that the ankle range of motion would significantly improve both clinically and radiographically using an Ilizarov external fixator alone in cases of severe rigid equinus deformity. Our primary aim was to evaluate the extent of correction possible using an Ilizarov external fixator alone, without adjunctive soft tissue procedures, in patients with a rigid equinus deformity and to investigate the extent to which equinus deformities recur after correction.

Patients and Methods

Our institutional review board approved the present study, and all patients provided informed consent. Ten feet in 10 patients with an equinus deformity were enrolled from March 2000 to October 2012 and underwent placement of an Ilizarov external fixator alone for gradual correction. Of the 10 patients, 8 were male (80%) and 2 were female (20%), and the mean age at correction was 28 (range 15 to 55) years.

All patients were ambulatory preoperatively, with varying severity of limp due to the tip-toe gait. The etiology of equinus deformities was spastic type cerebral palsy in 2

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(20%), congenital neuromuscular disease (hereditary spastic paraplegia) in 1 (10%), chronic osteomyelitis after an open tibia fracture in 3 (30%), pyogenic Achilles tendinitis in 1 (10%), peroneal nerve palsy in 1 (10%), limb lengthening in 1 (10%), and tumor excision on the calf in 1 patient (10%). None of the patients showed improved ankle dorsiflexion, even after flexion of the knee joints. No patient had previously undergone surgical treatment of the equinus deformity. The mean duration of the equinus deformity was 7.4 (range 1 to 21) years. A mean of 3.5 (range 0 to 11) operations had been performed for the treatment of the causes of the equinus deformities but none for correction of the equinus deformity itself. The skin condition was poor in almost all patients because most of the previous surgeries had been performed on the ankle or around the foot.

The mean follow-up period from the removal of the Ilizarov external fixator was 1 year, 3 months (range 12 months to 2 years, 2 months). The clinical results were evaluated using the range of ankle joint motion. The heel weightbearing ambulation was measured preoperatively and at the last follow-up examination. The radiographic outcomes were measured using the lateral tibiotalar angle (lateral angle between the long axis of the tibia and the long axis of the talus) on weightbearing lateral ankle radiographs taken preoperatively, immediately after removal of the Ilizarov external fixator, and at the last follow-up visit. In addition, the Wilcoxon signed rank test was used to identify whether significant ankle dorsiflexion and plantarflexion improvements had occurred postoperatively. A p value of $\leq .05$ was considered statistically significant. All statistical analyses were performed by a statistician using the SPSS statistical software, version 13.0 (SPSS Inc, IBM Corp, Armonk, NY).

Surgical Technique

The procedure was performed with the patient under general or spinal anesthesia. With the patient in the supine position and the leg under tourniquet control, a pillow was placed under the hip to rotate the ankle internally. Two rings were mounted to the tibia using 2 tensioned wires. The tibial rings were considered as the base for distraction. The calcaneus was fixed with a wire and a half ring. A wire was passed through the midshaft of the first and fifth metatarsals. An additional wire was added just proximal to the metatarsal wires. The 2 wires used on the metatarsal bones were fixed to the straight plates connected to the half ring of the calcaneus, and another forefoot half ring was connected to the distal part of the straight plate to which the metatarsal bone wires were fixed. The calcaneal half ring was connected to the tibial ring using 3 rods: 1 posterior and 2 on each side (medial and lateral). From the anterior aspect, the forefoot half ring was connected to the tibial ring, again using 1 rod placed in the central hole of the half ring. One plane hinge was placed on the medial and lateral rods to pivot on the talus center. We used uniplane hinges in most patients (Fig. 1).

Gradual correction was started 1 week after application of the Ilizarov external fixator. Initially, correction was performed 4 times daily to the maximal extent that was not painful to the patient. When the patients began to feel pain, correction was advanced at a rate of 3 to 4 mm daily, or 1°. If the pain intensified, correction was briefly suspended until the pain had subsided. After receiving training on pin site dressing, the patients performed the dressing changes themselves on a daily basis. A radiographic examination was performed every 2 weeks to check for anterior translation of the talus. Clinically, correction with the Ilizarov fixator continued until ≤5° of ankle dorsiflexion had been achieved. After correction of the deformity, the Ilizarov external fixator was maintained for a period equal to that required to achieve correction. When pin site infection was observed, the Ilizarov external fixator was removed earlier and replaced with a short leg cast or a brace for the remaining treatment period. At completion of the fixation period, full weightbearing ambulation was gradually attempted for several weeks with the brace in place. The patients used an ankle foot orthosis after completion of the correction.

Results

The mean duration required for correction of equinus deformity using the Ilizarov external fixator was 40.1 (range 28 to 58) days. The mean duration of maintaining the corrected ankle with the Ilizarov external fixator or cast after completion of the correction was 37.5 (range 28 to 59) days. The preoperative mean ankle range of motion demonstrated rigid equinus deformity, with −55.5° (range −80° to −15°) in dorsiflexion and 63° (range 15° to 90°) in plantarflexion. These had significantly changed at the last follow-up visit to −2.5° (range −20° to 5°) in dorsiflexion ($p = .003$) and 30.5° (range 0° to 40°) in plantarflexion ($p = .003$; Fig. 2). The overall mean ankle range of motion showed statistically significant improvement from 7.5° (range 0° to 30°) preoperatively to 28° (range 5° to 40°) postoperatively ($p = .011$). At the last follow-up visit, ankle dorsiflexion was 5° in 1 patient (10%), 0° in 6 patients (60%), −5° in 2 patients (20%), and −20° in 1 patient (10%). All the patients, except for the patient with −20° of dorsiflexion, were able to achieve adequate correction to allow heel walking during gait (Fig. 3). All patients were ambulatory without assistance at the final follow-up visit.

The mean lateral tibiotalar angle on the weightbearing radiographs of the ankle was 152.9° (range 114° to 170°) preoperatively and had improved to 103.9° (range 89° to 120°) after removal of the Ilizarov fixator. The mean radiographic correction was 49° (range 14° to 72°). Some recurrence was seen at the final follow-up visit, with a

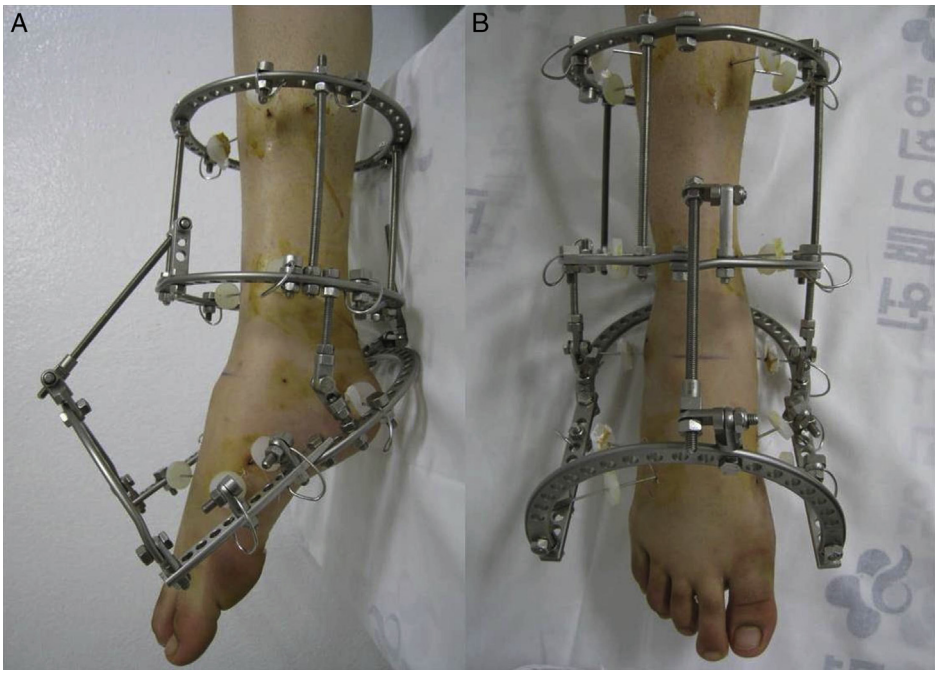

Fig. 1. (*A* and *B*) Clinical photographs of an applied Ilizarov external fixator.