Ilizarov technique of lengthening and then nailing for height increase

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ABSTRACT

Purpose. To investigate the risks and types of complications associated with the Ilizarov technique of lengthening and then nailing in persons of normal height.

Methods. Records of 26 men and 6 women aged 21 to 47 (mean, 27) years with body height of 160 to 176 (mean, 170) cm who underwent tibial and fibular lengthening and then intramedullary nailing were reviewed. They were skeletally mature healthy persons, with no systemic/local bone disease, deformity or limb length discrepancy. Pain was assessed using the visual analogue scale (VAS). Patient satisfaction in terms of the treatment outcomes and expectations was also assessed. Complications encountered during or after treatment were recorded.

Results. The mean lengthening achieved was 7.6 (range, 3.5–12) cm or 26% (range, 10–40%) of the original length. The mean duration of external fixation was 96 (range, 45–135) days. The mean follow-up duration after intramedullary nailing was 38.7 (range, 24–93) months. The mean VAS pain score was 9.3 at week 1, 6.6 at week 4, and 5.7 at week 8. After intramedullary nailing, the mean VAS pain score was 2.6 at week 4, 0.9 at month 6, and 0.3 at year 1. 91% of the patients were satisfied with the outcome at week 6; 81% after intramedullary nailing, and 94% at the one-year follow-up. Four patients had revision operations: one for pin exchange owing to pin bending after a fall, one for adjusting external rotation of the tibia after nailing, one for bone grafting for delayed union, and one for drainage of a haematoma just after nailing.

Conclusion. Most complications related to patient discomfort and psychological stress, which were important issues in this type of patients.

Key words: body height; bone lengthening; external fixators; Ilizarov technique; leg bones; osteogenesis, distraction; tibia

INTRODUCTION

The Ilizarov technique enables osteogenesis and histogenesis for treatment of orthopaedic conditions.
Nonetheless, the long duration of discomfort, close monitoring, complications, and other obstacles are major problems to be considered in planning and patient selection.2,3

Short stature can be caused by many systemic diseases.4 This is a handicap and can be overcome by bone lengthening,5 depending on the needs of the individual.6 Not all patients are good candidates.7 Determining factors include medical condition, disease pathology, psychological state, patient determination and cooperation, social and financial support, educational level, and other factors.8 In some patients, fear of complications and problems during treatment prevents them from undergoing such surgery.9

Normal height persons (<170 cm in men or <160 cm in women) are not handicapped from a medical point of view. They can drive a car, sit on a chair, take a bus, and use regular furniture/appliances. Nevertheless, some opt to have height-increasing surgery owing to social/psychological factors, job requirements or self-image.10,11

The Ilizarov technique can control the lengthening rate, limb alignment, and soft-tissue tension.12 The external fixation can stay until consolidation of the new bone and soft tissues,13 or be removed earlier in cases of lengthening over nails,11 or lengthening and then nailing.14 Early removal of the external fixator provides more comfort to the patient and reduces the risk of pin-site complications.15 We investigated the risks and types of complications associated with the Ilizarov technique of lengthening and then nailing in persons of normal height.

MATERIALS AND METHODS

Records of 26 men and 6 women aged 21 to 47 (mean, 27; standard deviation [SD], 6) years with body height of 160 to 176 (mean, 170; SD, 4) cm who underwent tibial and fibular lengthening and then intramedullary nailing between November 2001 and November 2007 were reviewed (Fig.). They were skeletally mature healthy persons, with no systemic/local bone disease, deformity or limb length discrepancy. They were psychologically ready after consulting a psychologist and conferring with patients who had undergone such procedures. Patients were excluded if they had any systemic disease affecting bone healing, bone deformity, infection, limb length discrepancy, previous bone surgery, or previous height-increasing surgery (Ilizarov technique, unilateral external fixation, or femoral lengthening). One patient was excluded during treatment, because of severe pintract infection. Intramedullary nailing was cancelled; the pins were exchanged and retained until bone consolidation. The required height increase was achieved with no residual problem.

Epidural anaesthesia was used, with catheter insertion to control postoperative pain. The proximal and distal tibiofibular joints were fixed by two 4.5-mm AO screws. This syndesmotic screw can preserve the relationship between the tibia and fibula at both ends during and after lengthening. The screw crossed the fibula and one cortex of the tibia, so as to avoid the need for removal in the future.16,17 Kirschner wires were not used for protecting the tibiofibular syndesmosis, because the external fixator was expected to be removed early (before bone consolidation), which could lead to subluxation at the tibiofibular joint and a secondary knee or ankle problem.18 In addition, not using the wires can decrease patient discomfort.19

The external fixator (composed of 4 rings) was applied to the osteotomy site (mid-shaft of the tibia and fibula) between the second and third rings. No prophylactic foot fixation was performed. Prevention and treatment of ankle stiffness or equine deformity during lengthening was mainly by intensive physical therapy.

Postoperatively, epidural anaesthesia was maintained for 3 days. At day 10, physical therapy and full-weight bearing were allowed, so as to enhance flexibility, range of movement, muscle strength, and bone healing. The lengthening rate was 1 mm per day. Pin care was performed 5 times a day by the patients, using normal saline and alcohol. No dressing was used to cover the pin sites. Patients were followed up once a week. C-reactive protein was checked every 20 days to exclude any pin-site or wound infection.

After achieving the required length, the second-stage surgery was performed under epidural anaesthesia. A third-generation cephalosporin was given at induction. Both lower limbs with the external fixator were sterilised. Percutaneous Achilles tendon lengthening was performed using 3 punctures. The length of the distraction segment was measured by an image intensifier C arm. The external fixator was removed, and a reamed interlocking nail was inserted. Swabs taken from different pin sits were sent to laboratory to exclude any hidden infection. After distal locking, extra-hammering on the nail was performed to achieve more lengthening (after soft-tissue tension release by Achilles tendon lengthening) and to avoid any distraction callus collapse. After proximal locking, the length of the distraction segment was re-measured.
Postoperatively, antibiotics were continued for 7 days. Physical therapy (muscle stretching and strengthening exercise) was allowed at day 7. At week 4, weight bearing with crutches was allowed. At weeks 8 to 10, full weight bearing was allowed based on bone consolidation and the extent of lengthening.

Pain was assessed using the visual analogue scale (VAS). Patient satisfaction in terms of the treatment outcomes and expectations was assessed. Complications encountered during or after treatment were recorded.

RESULTS

The mean lengthening achieved was 7.6 (SD, 1.7; range, 3.5–12) cm or 26% (range, 10–40%) of the original length. The mean duration of external fixation was 96 (range, 45–135) days. The mean external fixation index was 0.38 (range, 0.36–0.42) month/cm. The mean consolidation index was 34.7 (range, 29–49) days/cm. The mean follow-up duration after intramedullary nailing was 38.7 (range, 24–93) months.

The mean VAS pain score was 9.3 at week 1, 6.6 at week 4, and 5.7 at week 8. After intramedullary nailing, the mean VAS pain score was 2.6 at week 4, 0.9 at month 6, and 0.3 at year 1. Before Achilles tendon lengthening, the mean ankle dorsiflexion was 16° (SD, 6°; range, 10° to -20°). This improved significantly to 19° (SD, 3°; range, 15°–25°) at week 4, 20° (SD, 3°; range, 16°–26°) at month 6, and 20° (SD, 3°; range, 15–26) at year 1.

91% of the patients were satisfied with the outcome at week 6; 81% after removal of external fixator, and 94% at the one-year follow-up. Those who were not satisfied wanted to gain more height.

Complications

All patients had complained about increased discharge and discomfort (but no redness or
hotness) at the pin sites during lengthening. The C-reactive protein level was not increased. Low-grade pin-site infections were treated by more frequent pin care and oral antibiotics for 10 days. No patient developed septic arthritis or intramedullary nail infection.

All patients endured a decreased range of ankle dorsiflexion (equinus), which was treated by intensive physical therapy and percutaneous Achilles tendon lengthening. Nine patients had knee flexion deformity (10°–15°), which was improved after physical therapy. No patient had joint subluxation or dislocation.

Three patients had transient peroneal nerve neuropaxia (indicated by weak toe extensors [grade 4/5] and numbness) and were managed by slowing the lengthening rate (0.5 mm per day) in 2 patients, and stopping lengthening in one.

No patient had the pin cut-through or intramedullary nail breakage, premature consolidation, fibular subluxation, limb length discrepancy, fracture at the distraction callus, or collapse of the regenerate. Four patients had an angular deformity of >10° during lengthening, which was corrected after nailing. One patient had rotational deformity (owing to intramedullary nailing of the tibia with the distal fragment in external rotation) that was revised by surgery. Two patients had slow healing of the distraction callus; one of whom required longer duration of protected weight bearing with crutches and a tibial brace, whereas the other had bone graft surgery. Eight patients had persistent anterior knee pain one year after nailing.

In 4 patients, lengthening was terminated early, before achieving the required length. One was due to transient peroneal nerve neuropaxia, and 3 due to psychological problems. The decision to cease treatment was taken after discussion with the family and the patient in the presence of a neuropsychiatrist.

Four patients had revision operations: one for pin exchange owing to pin bending after a fall, one for adjusting external rotation of the tibia after nailing, one for bone grafting for delayed union, and one for drainage of a haematoma just after nailing.

In all patients, surgical wounds healed in <14 days, except in 3 who needed 16 to 21 days. Antibiotic ointment was used with a view to enhance healing and prevent infection; all wounds healed with no infection. Six months after removal of the external fixator, 3 patients were not happy about their residual skin scars. At the one-year follow-up, the number decreased to 2, one of whom had plastic surgery to remove the scars 18 months after removal of external fixator.

No patient sustained any nerve or vascular injury, compartment syndrome, or fat embolism. One patient had transient hypertension during the lengthening that was treated with anti-hypertensive drugs. 12 patients had mild behavioural disturbances (depression and difficulty sleeping), which were treated with anti-depressant drugs.

**DISCUSSION**

Bone lengthening is the only available option for skeletally mature persons to increase body height, owing to closure of long bones growth centres after adolescence. Residual skin scars may be considered a complication of such treatment. In patients with congenital deformity or non-union, residual scars are not necessarily regarded as complications. In our study, most complications were obstacles or minor problems that did not result in permanent disability. Nonetheless, these types of patients had low tolerance for problems/complications.

In traditional leg lengthening using the Ilizarov technique with no early removal of the external fixator, the mean duration of use was 285 (range, 210–540) days and the mean lengthening achieved was 7 cm. In our study, corresponding figures were 96 (range, 45–135) days and 7.6 cm. Early removal of the external fixator provided more comfort to patients and fewer complications. In 54 patients undergoing traditional leg lengthening, 12 had residual bone deformity after removal of their external fixators. Our patients did not sustain distraction callus collapse, angular deformity, limb length discrepancy, or callus fracture, because they underwent intramedullary nailing after lengthening.

The technique of lengthening and then nailing has advantages over the technique of lengthening over nail. A nail of proper length and diameter can be inserted after bone lengthening to avoid having a nail that is too short or small. The risk of intramedullary nail infection can be minimised, because the nail is inserted after exclusion of pin-site infection. In lengthening over nail, if there is a deep pin-site infection, the risk of intramedullary nail infection is high.

The technique of lengthening and then nailing may be less comfortable than the use of intramedullary lengthening devices. Lengthening with an external fixator is more reliable than intramedullary skeletal kinetic distractor in cases of long-distance or bilateral lengthening, with less chance of mechanical failure or nail jamming. Motorised nails (e.g. Fitbone) are effective but expensive alternatives.
REFERENCES