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Leg lengthening using intramedullay skeletal kinetic distractor: Results of 57 consecutive applications

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ABSTRACT

Background: Mechanically activated intramedullary lengthening nails are advantageous over external fixator. However, difficulties with the control of the distraction rate are the main drawbacks, which may in turn cause insufficient bone regenerate.

Patients and methods: A total of 57 lengthening procedures were performed using intramedullary skeletal kinetic distractor (ISKD) nail in 53 patients (femoral = 45 and tibial = 12). Average length gain was 4.3 ± 1.6 cm. The cause of shortening was post-traumatic (n = 33), congenital (n = 20), post-tumour resection (n = 1), cosmetic femoral lengthening (n = 2) and post-correction of distal femoral varus deformity (n = 1).

Results: The desired lengthening was achieved in all patients. The mean follow-up period was 23 ± 12 months. The healing index for patients with normal bone healing was 1.2 ± 0.32 months/cm. Complications in femoral lengthening were superficial wound infection (n = 1), premature consolidation (n = 4) and insufficient bone regenerate (n = 11), while in the tibial lengthening, two developed equinus contractures, one had compartment syndrome following implantation of the nail and one insufficient bone regenerate. Furthermore, nine runaway nails and three non-distracting nails were present in the femoral lengthening. One non-distracting nail responded to manipulation under anaesthesia, one required exchange nailing and accidental acute lengthening of 3 cm took place while manipulating the third nail. Patients with femoral lengthening and those with insufficient regenerate had significantly higher distraction rates (P = 0.006 and 0.003, respectively). Six out of the nine runaway nails developed insufficient bone regenerate. In addition, 10.7-mm tibial ISKD nails were found to have lower rates of runaway nails compared with other used diameters.

Conclusion: We emphasise the rule of distraction rates above 1.5 mm/day in the development of insufficient bone regenerate. Distraction problems with these nails are mostly due to dysfunction within the ratcheting mechanism, which may be related to the diameter of the nail. New designs for mechanically activated nails with a better control mechanism for the distraction rate are required.

During the last two decades, many developments were achieved in the field of limb lengthening surgery, in which the main goal was to increase patients' acceptance and comfort during lengthening. One important achievement is the use of totally implantable intramedullary lengthening nails.[2,3,7,10,16] In 2001, Cole et al.[3] reported their first experience with their mechanically activated lengthening nail—the intramedullary skeletal kinetic distractor (ISKD). ISKD nail lengthens by rotations of 3–9° through a ratchet mechanism around the longitudinal axis of the nail.[3,9,10]

Reported advantages of lengthening nails include elimination of external fixator-associated complications, earlier rehabilitation, reduced risk of deep infection, malalignment and refracture, reduced pain and more rapid return to normal joint motion and activity.[9,10,16] On the other hand, larger series of lengthening using ISKD nail had recently reported significant concerns and complications, in particular with the distraction mechanism and the resulting poor control of the distraction rate.[13,14,16] Reports of non-distracting or runaway ISKD nails are now present with an incidence of up to 45%; however, all of these reported difficulties were in femoral lengthening.[13,14,16]

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These distraction problems may, in turn, cause important complications as insufficient bone regeneration and nonunion.[13,16] We had already described the results of our first 37 femoral lengthening using this nail, and we proposed a classification system for insufficient bone regenerate (IBR), identifying important risk factors and proposing treatment guidelines.[13] On the other hand, published data about tibial lengthening using ISKD nail are still scant in number, and none had reported any difficulties with the distraction mechanism.[3,10,15]

We would like to describe our experience with the largest series of femoral and tibial lengthening using ISKD nail reported so far. Our study mainly aimed at answering the following questions: (1) What are the complications of femoral and tibial ISKD lengthening and are they different? (2) What are the incidence and risk factors of IBR in femoral and tibial lengthening? (3) What is the incidence of the distraction mechanism problems in tibial versus femoral lengthening?

Patients and methods

A prospective study was initiated in July 2002 at our institution to investigate the results of intramedullary lower limb lengthening using ISKD nail. During the period from July 2002 to July 2009, 57 lower limb lengthening procedures were performed in 53 patients using the ISKD nail (Orthofix, Valley, Germany). Three patients had two-stage lengthening procedures on the same bone. Another patient had bilateral cosmetic femoral lengthening. The mean length gain with each application was 4 ± 1.2 cm (2–7 cm) and the total length gain was 4.3 ± 1.6 cm (2–10 cm).

Thirty one patients had 33 ISKD nails for post-traumatic shortening (26 femoral and 7 tibial including 2 patients with 6.3- and 10 cm femoral shortening and two-stage femoral ISKD lengthening for each) (Fig. 1). Nineteen patients had 20 ISKD nails for congenital shortening (15 femoral and 5 tibial lengthenings including 1 patient with a 9 cm tibial shortening and two-stage tibial ISKD lengthening) (Figs. 2 and 3). One patient had femoral shortening after tumour resection (chondrosarcoma), 1 patient had bilateral cosmetic femoral lengthening for short stature and one had femoral shortening following valgus closing wedge corrective osteotomy of a distal femoral varus deformity. A total of 45 femoral lengthening and 12 tibial lengthening procedures were performed.

A total of 20 procedures of 45 femoral lengthenings were performed using tibial ISKD nails due to narrow medullary canal (Table 1). The osteotomy for lengthening was performed at the level of a previous fracture or surgery in 11 patients (10 femoral and 1 tibial). Acute correction of associated deformities was performed through the same osteotomy in 28 patients (24 femoral and 4 tibial). In 27 patients, deformities ranged from an average of 6° varus to 9° valgus and 17° of internal rotation to 17° of external rotation. Our patient who had femoral shortening following tumour resection suffered from a complex deformity of 15° varus, 68° procurvatum and 14° of external rotation. Six patients were smokers (5 femoral and 1 tibial). The patient who had congenital tibial shortening and two-stage tibial ISKD lengthening underwent ankle fusion for complex ankle deformity 6 months after the first tibial lengthening, and just before the second stage.

Limb length and deformity parameters were preoperatively assessed using computed tomography studies and long-standing radiographs. The lengthening osteotomies were performed in the shaft area using percutaneous multiple drill hole technique followed by medullary overreaming by an average 1.5–2 mm. All femoral nails except three were inserted through antegrade portals and three femoral nails were inserted in a retrograde direction (to correct an associated 5° distal femoral varus deformity through a distal femoral osteotomy in 1 patient, another patient had a retrograde femoral nail which was removed and then the ISKD nail was inserted through the same portal and in a third patient due to ipsilateral hip arthroplasty and associated post-traumatic shortening of 7 cm). In cases of tibial lengthening, a bony segment (1 cm in length) was excised from the fibular shaft at the level of the tibial osteotomy and a syndesmotic screw was inserted distally to prevent subluxation of the distal tibiofibular joint during lengthening. This screw was removed under local anaesthesia at the end of the distraction phase.

All patients were allowed partial weight bearing from the first postoperative day and were instructed to monitor the distraction process five times daily with the help of the external monitor of the nail, aiming at a distraction rate of 1 mm/day. Postoperatively, all

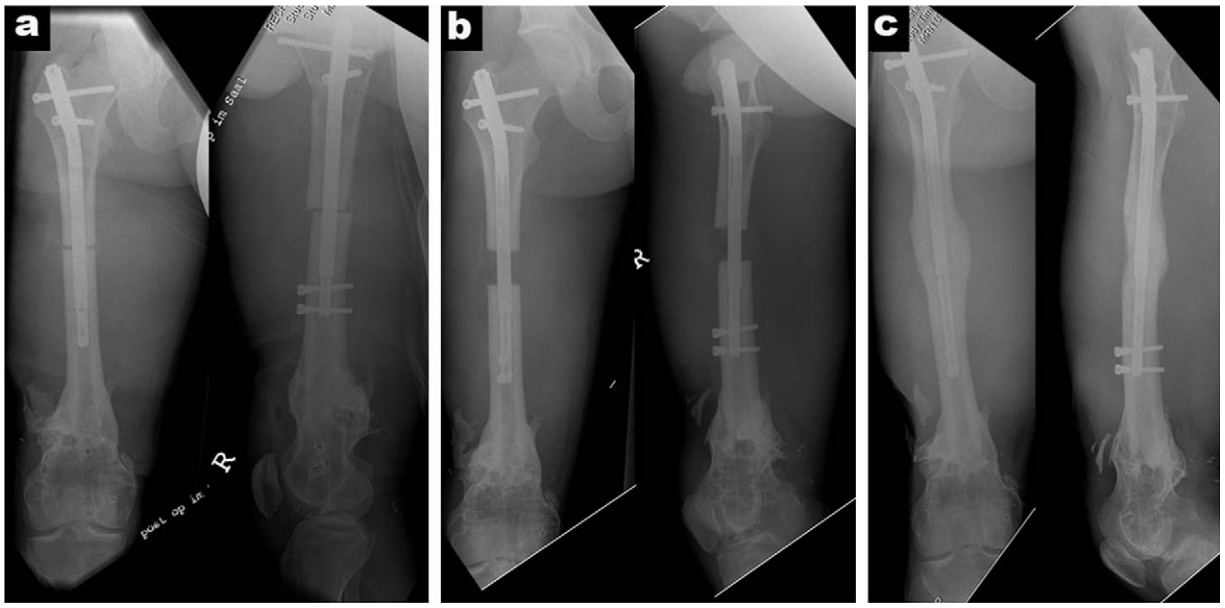

Fig. 1. Femoral lengthening of 5 cm in a 25-year-old patient with post-traumatic shortening. (a) Postoperative ap and lat radiographs of the affected femur with the ISKD nail in place. (b) 3 Weeks follow-up ap and lat radiographs after implantation of the ISKD nail with a distraction rate 1.4 mm/day. (c) 11 Months follow-up ap and lat radiographs showing full consolidation of the newly formed regenerate.