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Blocking screws for alignment control in intramedullary limb lengthening

Julian Fürmetz*, Stefan Bösl, James Schilling, Florian Wolf, Nikolaus Degen, Peter H. Thaller

3D-Surgery, Department of General, Trauma and Reconstructive Surgery, Munich University Hospital LMU, Germany

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ABSTRACT

Simultaneous deformity correction in the frontal and sagittal plane becomes more and more an important part of intramedullary lengthening to avoid further operative procedures. Such as in fracture treatment blocking screws can be used for alignment control if osteotomy is performed in the metaphyseal bone. 31 intramedullary lengthening procedures between 2009 and 2011 were retrospectively analysed for precision of simultaneous deformity correction. The average planned correction to the HKA was 2.4° (0.1°–8.0°) and the final results after lengthening deviated an average of 1.7° (0.0°–8.1°) from the planning. With blocking screws a higher degree of deformity (mean 3.2° vs. 1.7°; $p < 0.05$) was corrected with a slightly higher precision (mean 1.5° vs. 1.9°; $p = 0.48$) compared to patients without blocking screws. Placed on the concave side of the deformity blocking screws are a helpful tool to successfully address leg length discrepancy and other deformities with one single operation.

Introduction

In 1994, Krettek et al. identified the blocking screw (Poller screw) as a useful aid for intramedullary nail fixation of tibial and femoral fractures [1,2]. Because in some cases where the intramedullary fixation is insufficiently stable, the force of muscular tension exerted on individual bone fragments leads to misalignment in both the frontal and sagittal plane [3]. This is especially relevant in fractures of the metaphyseal portion of the femur or the tibia near to the knee joint, as there is no direct contact between the medullary nail and cortical bone. Blocking screws placed next to the medullary nail can prevent postoperative axis deviation and stabilize the nail in the metaphyseal part of the bone. When metaphyseal tibial fractures were supplemented with blocking screws, very good postoperative leg alignment and bone consolidation was achieved [4,5].

In deformity surgery, the intramedullary nail can be a helpful tool for achieving a correct mechanical alignment [6]. However, just like in fractures in the metaphysis, an osteotomy performed in this region of bone can be prone to instability. Blocking screws provide stability and secure the achieved deformity correction.

Surgical limb lengthening using fully implantable intramedullary lengthing nails can also require osteotomy in metaphyseal regions of bone in order to achieve optimal bone formation and to correct malalignment. Limb length discrepancy is corrected via intramedullary lengthening, followed separately by a second procedure to correct malalignment in many cases [7]. Unfortunately, intramedullary limb lengthening frequently results in unintended malalignment [8]. But, ideally, when using a intramedullary lengthening nail, malalignment and limb length discrepancy can be corrected in one single operation [9,10]. Using this method, it becomes essential to correctly and securely position the nail within the metaphysis. The larger the extent of the malalignment correction, the greater the muscle forces pulling the bone fragments towards their original position. Securing the intramedullary lengthening nail with one or more blocking screws near the osteotomy site like in a fracture case brings stability for better bone healing and secures the intended deformity correction. Recently this technique was described by Muthusamy et al. [11].

This retrospective study evaluates the precision of simultaneous malalignment correction in intramedullary limb lengthening with and without the use of blocking screws. A detailed explanation about the application of blocking screws in deformity correction is given.

Patients and methods

We retrospectively reviewed 31 patients treated with ISKD intramedullary lengthening nails from 2009 to 2011. Preoperative planning on a long standing radiograph was compared to the final

* Corresponding author at: Nußbaumstraße 20, 80336 München, Germany.
E-mail address: Julian.Fuermetz@med.uni-muenchen.de (J. Fürmetz).

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long standing radiograph after finishing treatment. We analysed the intended and achieved lengthening and the intended and achieved alignment correction by measuring the leg length, the hip knee angle (HKA), the mechanical axis deviation (MAD), the mechanical lateral distal femoral angle (mLDFA) and the mechanical proximal tibial angle (mPTA). Patients with blocking screws and without were divided into tow groups. Differences between groups were analysed by students-t Test.

Our detailed standardized protocol for intramedullary limb lengthening of the femur or the tibia is already published [9,10]. Preoperative planning was performed using CorelDRAW Graphic Suite X4, which had been modified to best suit our evaluation. Preoperative planning was conducted with the end point first method where we first define the desired outcome after lengthening, then work backwards from there to determine the optimal height for the osteotomy and position of the implant (see.1b). In order to intraoperatively evaluate femoral torsion, two temporary Schanz pins are positioned proximally and distally to the osteotomy. Tibial torsion is evaluated based on the position of the patient's foot. Additionally torsion control is easily addressed by a intramedullary nail. The osteotomy is performed via a 1 cm stab incision with a drill and chisel.

The nail position is determined by reaming the metaphyseal part of the bone with rigid reamers. To correct a varus deformity rigid reaming starts at the entry point and ends lateral at the osteotomy site either in the femur or the tibia (see Fig. 2). To correct valgus deformity reaming is done to the medial cortex (see Figs. 1–3). Sagittal deformities like femur procurvatum or recurvatum and slope pathologies of the tibia can be addressed in the same way (see Fig. 3). As we use straight rigid reamers for the straight lengthening nails excessive over-reaming which leads to instability can be avoided. Next, a dummy nail is temporarily inserted into the medullary cavity and the resulting leg axis is verified using a x-ray-grid. The alignment of the hip, knee and ankle joint can be controlled by the x-ray-grid method during surgery. A thin radiolucent x-ray-grid is permanently positioned under the patients lower limb. With the centre of the ankle and the hip joint lying on one of the reference lines in the grid we can assess the deviation of the mechanical axis and compare this to the preoperative planning. In the event that the desired outcome could not be achieved due to suboptimal medullary nail stability, blocking screws were implemented to secure the medullary cavity and to achieve the correct alignment. Main outcome measurement of the alignment during operation is the mechanical axis deviation in the knee joint.

Due to the customized dummy nails in all sizes corresponding to the ISKD the positioning of the screws could be close to the nail. The blocking screws are placed perpendicular to the plane of the corrected deformity and at least 2 cm away from the osteotomy to avoid propagation of a fracture line [12]. This method constricted the medullary cavity around the medullary nail, making it more secure and less prone to positional shift. In addition, the use of

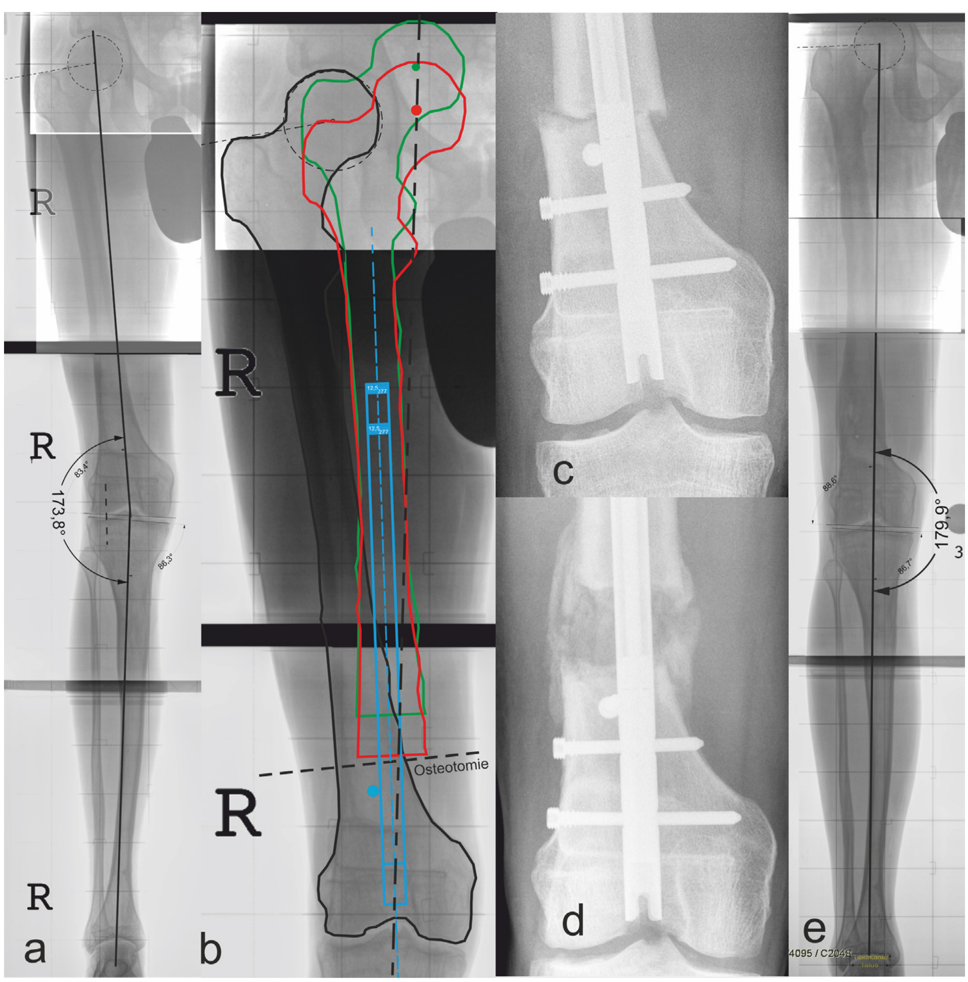

Fig. 1. a) Preoperative long standing radiograph with 6.2° valgus deformity and 28 mm shortening b) preoperative planning of the femur using the end point first methode (red = postoperative condition, green = post lengthening condition, blue = blocking screw and lengthening nail c) postoprative radiograph with inserted lengthening nail (ISKD) and blocking screw d) post lengthening radiograph e) long standing radiograph at the end of treatment with normal alignment and joint angles.

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