Orthopaedics & Traumatology: Surgery & Research 105 (2019) 1175–1179

Contents lists available at ScienceDirect

Orthopaedics & Traumatology: Surgery & Research

journal homepage: www.elsevier.com

Technical note

New femoral derotation technique based on guided growth in children

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ARTICLE INFO

Article history:
Received 18 January 2019
Accepted 7 June 2019

Keywords:
Torsional growth modulation
Guiding rotational growth
Children

ABSTRACT

Derotation osteotomy is the only available treatment for medial femoral torsion in paediatric patients. To eliminate the need for postoperative immobilisation and to allow immediate weight bearing, we suggest a new technique that guides femoral growth. The goal is to convert part of the axial growth into rotation by placing a system composed of two screws and a cable around the distal femoral physis. We used this percutaneous technique to treat 20 knees in 11 children. The preliminary outcomes indicate good efficacy with about 1.2° of derotation per month and a total mean derotation of 25° over 22 months. Postoperative stiffness was the main complication but resolved with physical therapy. This technique may therefore constitute an alternative to derotation osteotomy.

1. Introduction

Femoral derotation osteotomy is currently the only available treatment for correcting rotational malalignment [1–3]. Although effective, this method exhibits the drawbacks associated with all femoral osteotomies [4–10].

We drew inspiration from the use of epiphysiodesis to correct lower limb length discrepancies and coronal malalignment [11–13] to devise a percutaneous technique designed to guide femoral growth in a manner that gradually corrects rotational malalignment. This technique is less invasive and provides a better risk/benefit ratio compared to femoral derotation osteotomy. Results reported in 2013 by Arami et al. [14] established that torsional growth could be modulated in rabbits by positioning eight-plates on the distal femur, and similar findings were described by Lazarus et al. in 2018 [15].

2. Operative technique

The technique is designed to guide growth towards derotation by placing a system composed of two cannulated screws and a cable on either side of the distal femoral physis. Growth can only occur vertically, as is the case under normal conditions, and is therefore guided towards derotation. Fig. 1 shows the device on a left femur. The cable passes through the screws and is then locked on itself under tension. During growth, the tension of the cable causes a rotational movement (laterally in the example shown). Thus, part of the vertical growth is converted to rotational growth. Here, we describe the technique used to obtain lateral derotation, which is the most common situation.

The patient is supine. Fluoroscopic guidance is used. A guidewire is inserted alongside and parallel to the physis, in the middle of the bone in the sagittal plane (Figs. 2 and 3). An external fixator ring is centred on the guidewire on the antero-posterior and lateral views so that the centre of the ring coincides with the centre of the physis (Figs. 4 and 5).

A transfixing guide pin is then inserted percutaneously. The entry site is just distal to the growth plate and slightly lateral to the lateral edge of the trochlea. The pin is inserted in the anterior-to-posterior direction, at an angle of about 30° relative to the guidewire, and parallel to the physis. Care is taken to ensure that the guide pin exits the ring at a point exactly opposite the entry site. This precaution is important, as the pins must cross each other at the centre of the bone to eliminate the risk of axial deviation (Fig. 6).

Then, a second transfixing guide pin is inserted percutaneously through a lateral entry site located just proximal to the physis, at the junction of the posterior and lateral femoral cortices. The pin is inserted in the posterior-to-anterior direction at an angle of about 30° to the guidewire, parallel to the physis. As with the first guide pin, the pin is made to exit the ring opposite its entry site (Fig. 7).

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https://doi.org/10.1016/j.otsr.2019.06.005
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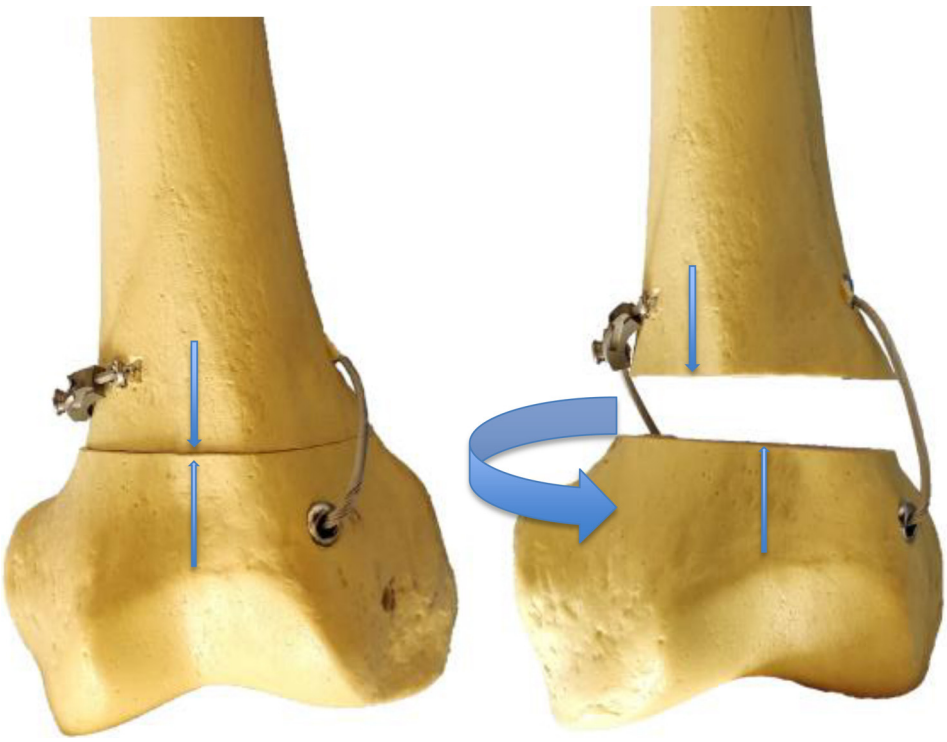

Fig. 1. As shown on this sawbone, physeal growth necessarily results in rotation.

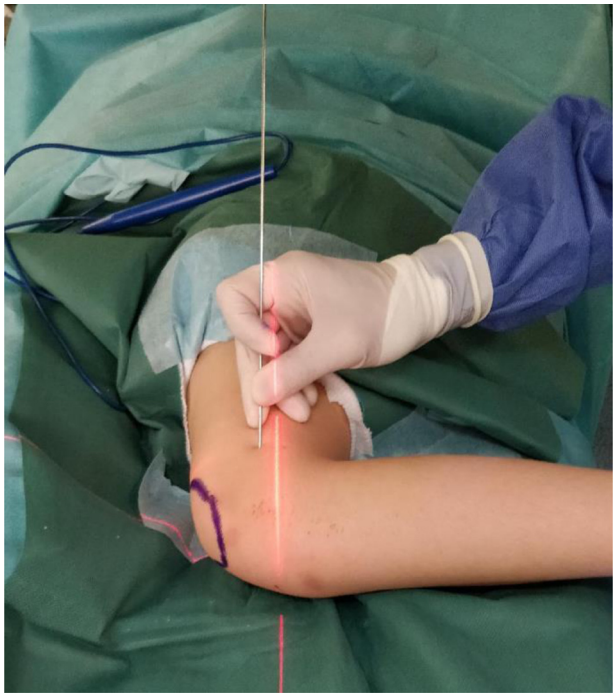

Fig. 2. Left knee, intra-operative photograph of lateral guidewire insertion.

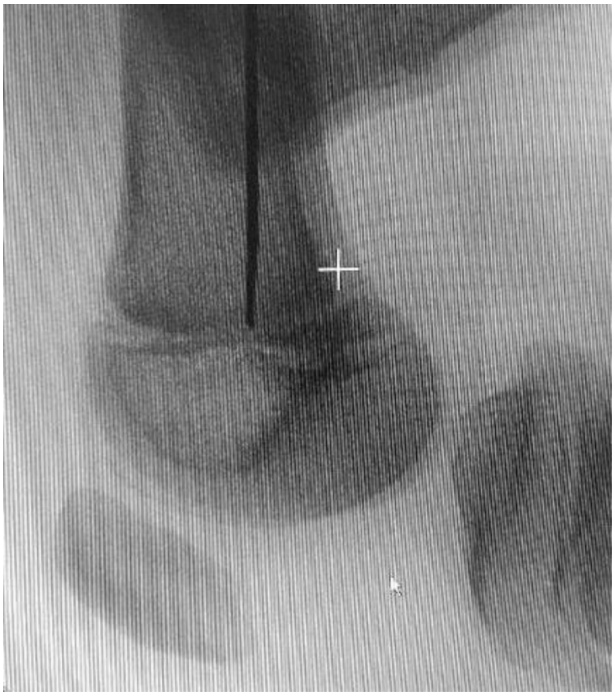

Fig. 3. Lateral fluoroscopic view of the guidewire.

The guidewire and ring are then removed (Fig. 8). This allows verification that the guide pins are properly positioned relative to the physis (Fig. 9).

Two cannulated screws 6.5 mm in diameter and measuring a few millimetres less in length than the width of the bone are inserted onto the guide pins (Fig. 10).

Two small medial incisions are made over the guide pin exit sites.

A braided steel cable measuring 18 mm is threaded in the medial-to-lateral direction through the proximal screw as the guide pin is being removed. The cable is recovered externally, passed under the soft tissues, and threaded in the lateral-to-medial direction through the distal screw. Finally, the cable is passed through

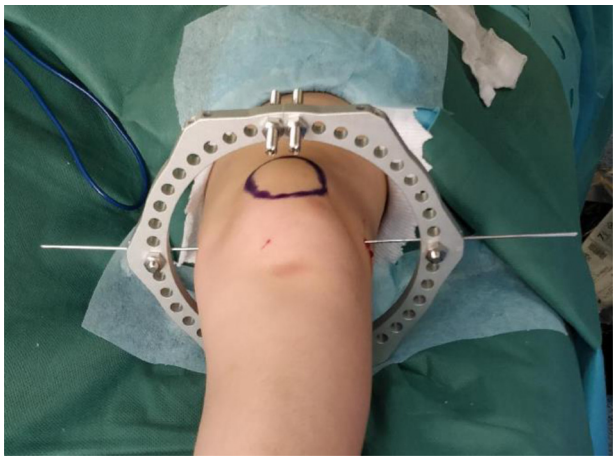

Fig. 4. Intra-operative photograph of the external fixator ring centred on the guidewire.

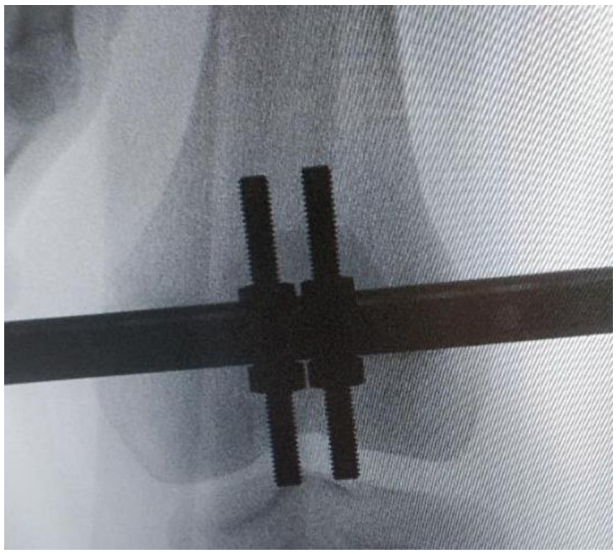

Fig. 5. Antero-posterior fluoroscopic view of the ring centred on the guidewire.

the medial soft tissues then locked on itself with a torque force of 100 Nm (Figs. 11 and 12). The knee is manipulated to release any adhesions.

Full weight bearing is resumed immediately after the procedure and physical therapy is provided to ensure early mobilisation.

3. Results and discussion

The patients were included prospectively starting in August 2015. In all, 20 knees in 11 patients were studied. The rotational malalignment was idiopathic in 60% of cases and due to neuromuscular disease in 40% of cases. The families were informed in great detail of the advantages and drawbacks of the technique and provided their informed consent to the procedure.

Mean age at surgery was 10.1 years (range, 8.6–12.7 years). Mean time to screw removal was 21.5 months. In practice, the screws were removed as soon as the malalignment was corrected or the screw angle fell below 15°.

At the end of the treatment period, the mean values of all the clinical and radiological parameters were significantly improved,

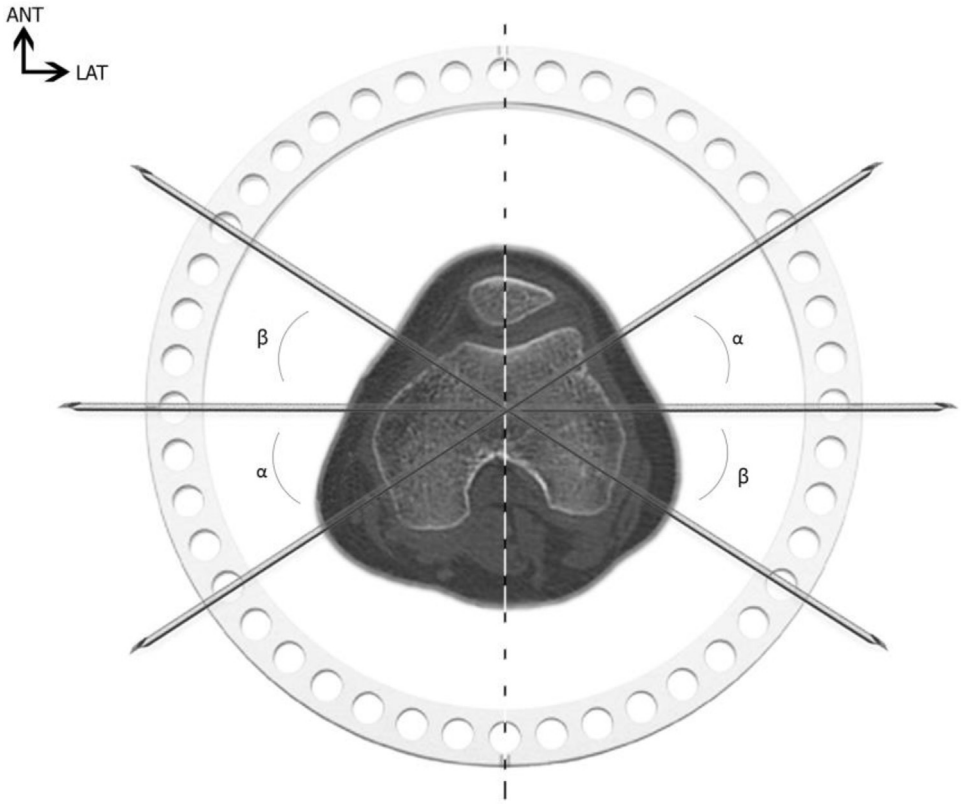

Fig. 6. Axial view showing the optimal position of the two guide pins.

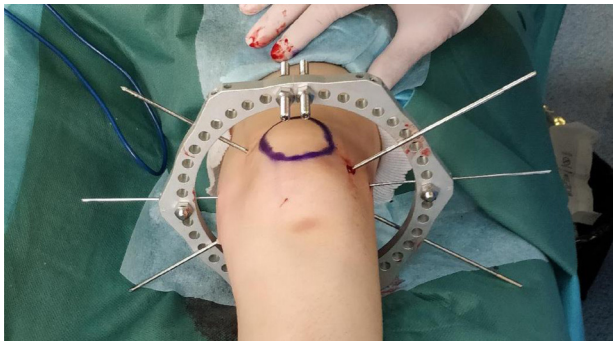

Fig. 7. Intra-operative photograph of the two percutaneously inserted guidepins and of the ring.

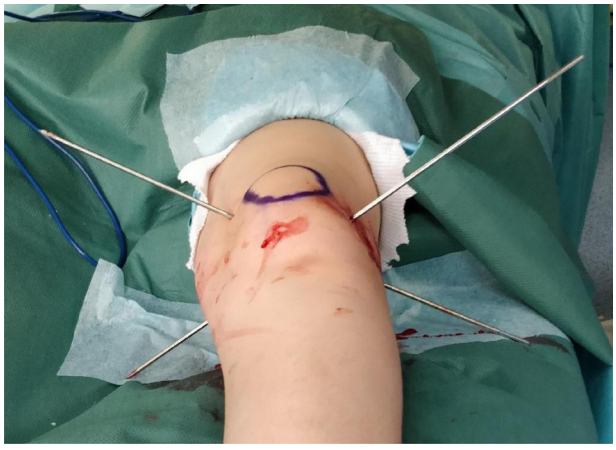

Fig. 8. The guidewire and ring have been removed.

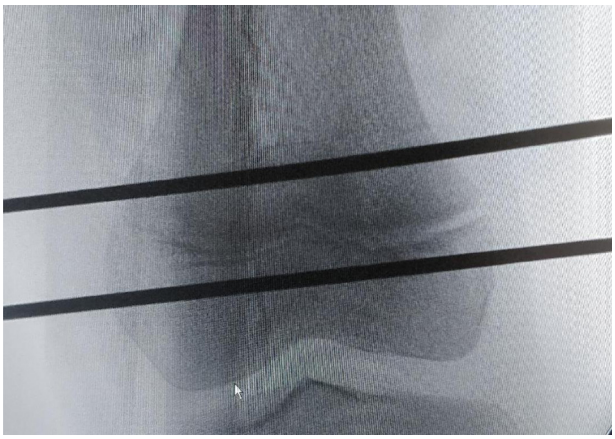

Fig. 9. Fluoroscopy view to check proper guide pin position.

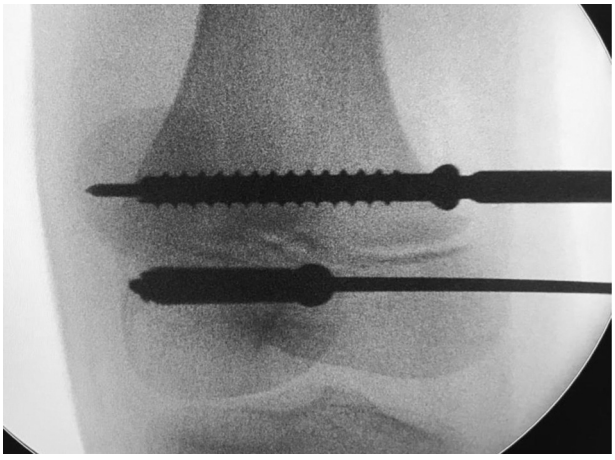

Fig. 10. Insertion of the screws.

with p values below 0.0005. Thus, external hip rotation increased by 23°, internal hip rotation decreased by 31°, radiological femoral anteversion decreased by 28°, and the angle between the screws decreased by 25.4° (example in Fig. 12). These data confirm the efficacy of the technique, with a mean derotation of 1.2° per month.

The mean change in the distance between the two screws was 12 mm, versus a theoretical variation of 22 mm, suggesting a loss of length of about 12 mm over 2 years. Thus, part of the linear growth was converted to rotational growth (example in Fig. 13).

The main postoperative complication was knee stiffness, which occurred in nearly all the cases, probably due to the presence of the cable. Cautious gentle manipulation under general anaesthesia was performed on 6 knees. For the 14 other knees, physical therapy was sufficient to gradually restore full range of motion. Mild recurvatum deformity of less than 10°, with no clinical consequences, developed in 8 knees, probably due to excessively anterior positioning of the screws. This complication occurred mainly in the first patients, who were treated before the technique was fully standardised. The patients in whom the procedure was performed bilaterally had no coronal malalignment or limb length discrepancy.

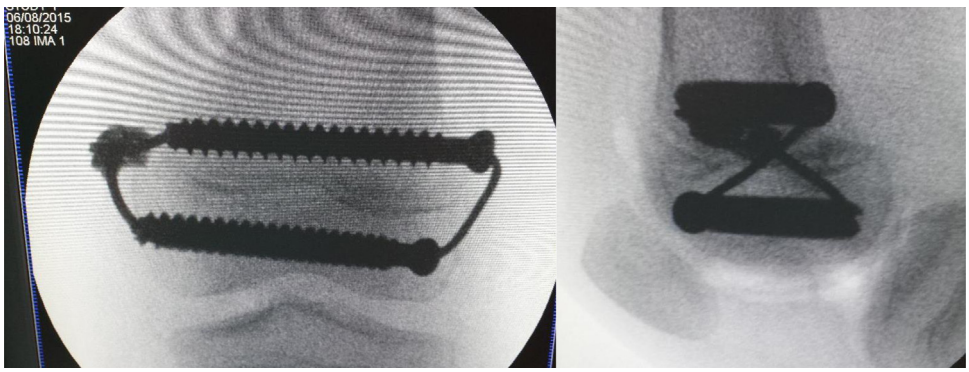

Fig. 11. Antero-posterior and lateral views of the final construct.

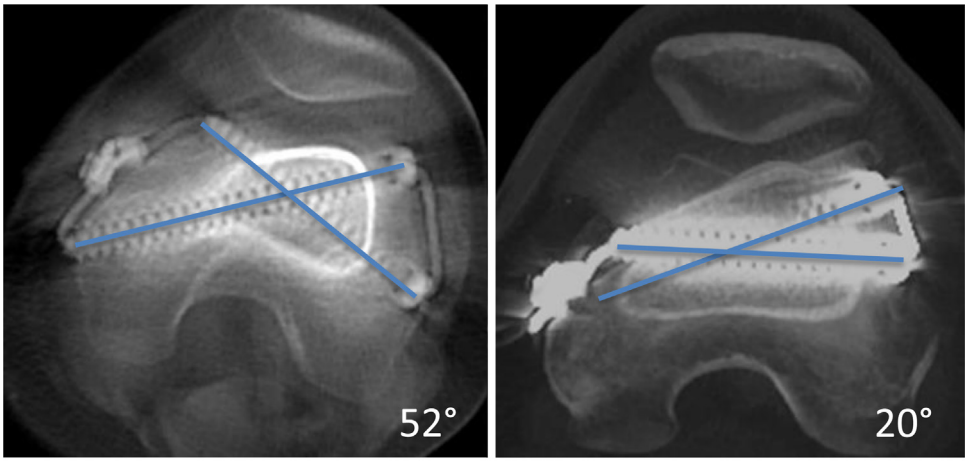

Fig. 12. Merged axial views showing the change in the angle formed by the two screws between the immediate postoperative period (A) and the end of the treatment period (B).

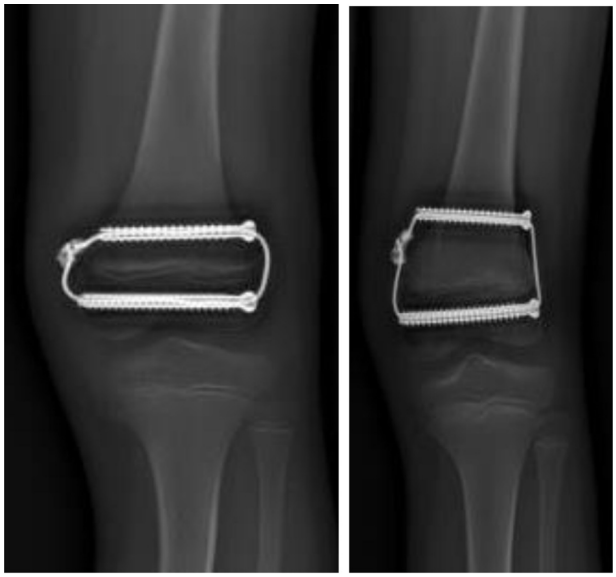

Fig. 13. Change in the distance between the two screws from the immediate postoperative period (A) to the end of the treatment period (B).

4. Conclusion

Guided growth protects the patient from the risks associated with osteotomy and internal fixation. This simple percutaneous technique is effective and allows immediate full weight bearing with no immobilisation. Knee stiffness is the main complication but resolves with time.

This technique may therefore constitute an alternative to femoral derotation osteotomy if the outcomes reported here are confirmed in a larger number of patients with longer follow-up times.

Disclosure of interest

The authors declare that they have no competing interest.

Funding

None.

Contributions

JDM wrote the manuscript.
LD collected the data.
DD collected the data, performed the statistical analysis, and prepared the manuscript.

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