Intraoperative Measurement With a Smartphone App That Improves the Accuracy of Derotational Osteotomies

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ABSTRACT
Smartphone technology has created new opportunities to incorporate medical technology into daily clinical practice. Accurate intraoperative measurement of the desired derotation angle is a frequent challenge for the surgeon when performing derotational osteotomies. Divergent pins are commonly used proximal and distal to the osteotomy, which after derotation should remain parallel. However, the measurement of the derotation angle is usually performed by visual estimation, which could be unreliable. The aim of this study is to describe a technical detail that combines the application of divergent pins with intraoperative measurement by mobile phone to improve the accuracy of derotational osteotomies.
Key words: Derotational osteotomy; surgical technique; intraoperative measurement; smartphone; apps.
Level of Evidence: V

Medición intraoperatoria con una aplicación para teléfono inteligente que mejora la precisión de las osteotomías desrotadoras

RESUMEN
El desarrollo de teléfonos inteligentes ha creado nuevas oportunidades para incorporar la tecnología médica en la práctica clínica diaria. La medición intraoperatoria exacta de los grados necesarios de corrección es un desafío frecuente para el cirujano cuando realiza osteotomías desrotadoras. Por lo general, se utilizan clavijas divergentes colocadas proximal y distal a la osteotomía que, luego de la desrotación, deben quedar paralelas. Sin embargo, la medición de estos grados, en general, se hace por estimación visual, lo que suele ser poco preciso. El objetivo de este estudio es describir un detalle técnico que combina la aplicación de clavijas divergentes con la medición intraoperatoria mediante telefonía móvil para mejorar la precisión de las osteotomías desrotadoras.
Palabras clave: Osteotomía desrotadora; técnica quirúrgica; medición intraoperatoria; teléfono inteligente; aplicaciones.
Nivel de Evidencia: V

INTRODUCTION

The development of smartphones has created new opportunities to incorporate medical technology into daily clinical practice.[1,2] In 2015, around 90% of doctors in the UK used this type of device for the evaluation or treatment of their patients.[2] Smartphones present an innovative role within the trauma specialty.[3] The rapid growth and development of various applications in recent years have led to extensive research to evaluate their effectiveness and clinical benefit.[2] The incorporation of inclinometers and acceleration sensors in smartphones allowed expanding their use as digital goniometers to measure the range of motion of the elbow,[4] the knee,[5] the rotational deformity of the femur,[6] the rotation of the torso in patients with scoliosis,[7,8] and the metatarsophalangeal joint of the first ray,[9] among others.

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Multiple conditions require derotation osteotomies. Among the most frequent are obstetric brachial plexus palsy, lever arm dysfunction in patients with neuromuscular diseases, and patellofemoral pain or instability associated with deformity in the axial plane. The accurate intraoperative measurement of the necessary degrees of correction is a frequent challenge for the surgeon when performing these osteotomies. Some authors use divergent pins placed proximal and distal to the osteotomy which, after derotation, must remain parallel. However, the measurement of these degrees is generally done by visual estimation, which is usually not very precise.[10,11] The objective of this study is to describe a technical detail that combines the application of divergent pins with the intraoperative measurement using a smartphone to improve the precision of derotation osteotomies.

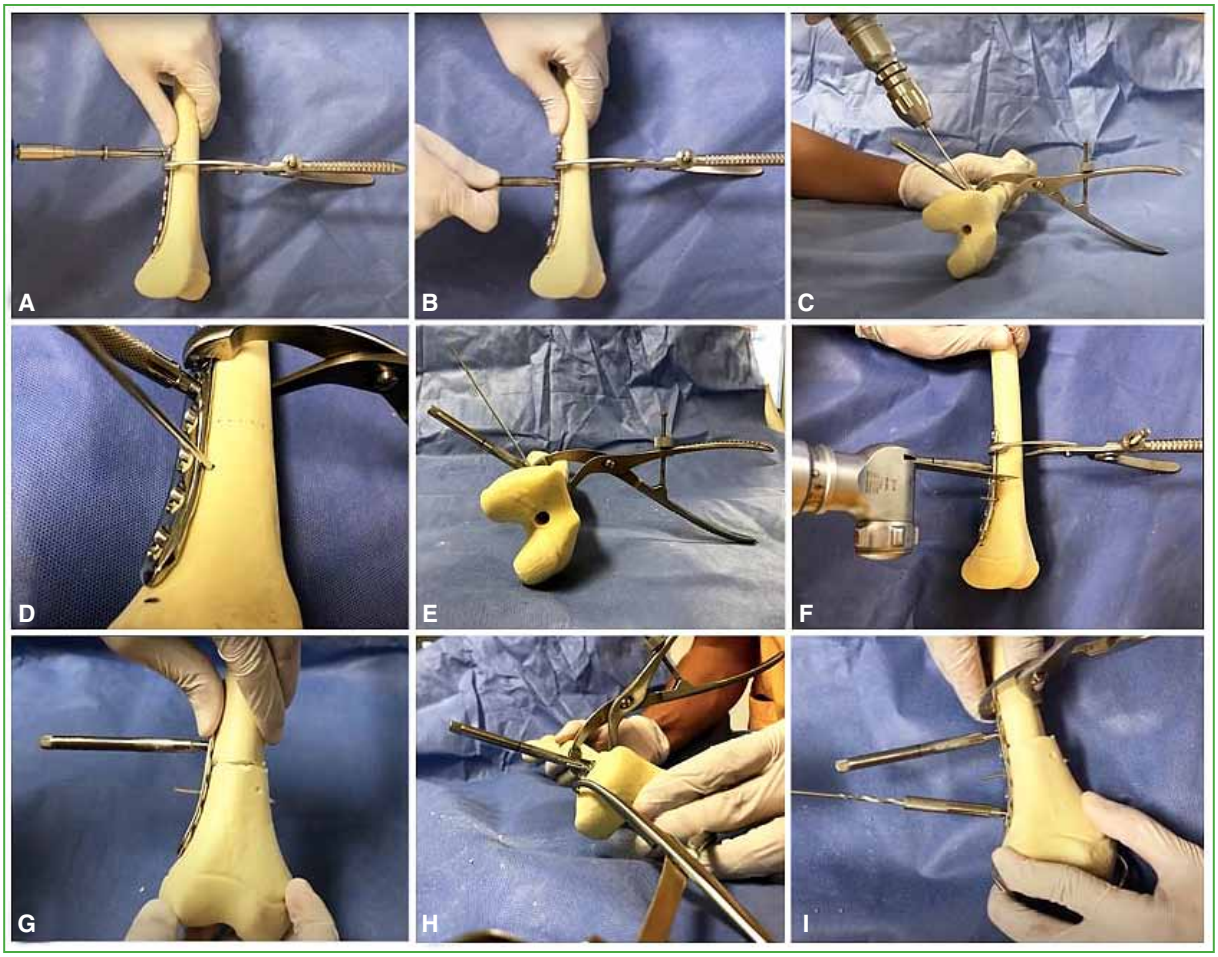

Figure. Simulation of the technique with a plastic femur bone. **A.** Fixation of the plate to the bone. **B.** Placement of the locking guide to use as a reference. **C.** Divergent pin, forming an angle with the previous guide. **D.** The pin should be adjacent to a hole in the plate, distal to the osteotomy site. **E.** Optimal arrangement for taking measurements with the smartphone app. **F.** Planned osteotomy. **G.** Derotation of the distal femur fragment, aligning the pin with the corresponding hole in the plate. **H.** Checking that the pin and the guide are parallel. **I.** Fixing the plate with the remaining screws.

Description of the technique

In the video that accompanies this article, the step-by-step technique used is analyzed in detail (Video).

The pertinent surgical approach is performed according to the affected segment and is advanced until the osteotomy site is identified. The periosteum is neatly elevated so that it can then be closed. An LC-DCP plate of the appropriate size is placed. The plate is fixed with the corresponding screw in one of the holes proximal to the osteotomy site (Figure A). The locking screw guide is placed in the proximal hole closest to the future osteotomy (Figure B). Next, a pin is placed divergent from the previous guide (Figure C), with an approximate angle to that calculated before surgery. It must enter at the level of one of the holes distal to the osteotomy (Figure D). To measure the degrees of correction, a smartphone application (Navi-gator, under development) is used. An assistant takes the photograph necessary to measure the angle between the pin and the locking guide. This can be done by carefully placing the phone in a sterile plastic bag or directly from outside the surgical field (Figure E). If it is not the planned angle: remove the pin, reposition it in another position, and repeat the measurement. Once the desired angle is obtained, the pin is cut 2-3 cm from the bone. The osteotomy is performed with a mallet and chisel or oscillating saw (Figure F). Once the osteotomy is complete, the derotation is performed by translating the distal fragment to match the pin with the corresponding hole (Figure G). After verifying that the locking guide and pin are parallel (Figure H), the plate is fixed in the desired position with bone holding forceps, and the remaining plate screws are placed (Figure I). Then we proceed to the closure by planes.

DISCUSSION

Derotation osteotomies are a common surgical procedure to treat various orthopedic conditions. The degree of derotation required is usually evaluated by the surgeon, during surgery, through visual estimation. To assess the degree of correction, some surgeons use divergent pins, make saw marks on the affected bone, or assess the passive range of motion under anesthesia.[12] Kozin proposes using a pin adjacent to the hole in the plate distal to the osteotomy, which, after derotation, would remain aligned with the plate when entering the corresponding hole.[13] Although this gesture is very useful to keep the limb aligned until the final fixation is made, the author does not describe the measuring method of the angle to be corrected. In this article, we report the use of an application for mobile phones that allows the angle formed between the pin and the plate locking guide to be measured. This enables an accurate evaluation of the angle in the axial plane to be corrected.

There are few reports on the application of smartphones during surgery. Peters et al.[14] evaluated the orientation of the acetabular component of hip prostheses using a goniometry application by placing the smartphone inside a sterile bag during surgery. Graham et al.[15] compared the measurements between two divergent pins placed in plastic bones with three measurements: by visual estimation, with static metal guides with 10° of progressive difference, and with the digital goniometer of a smartphone, and used the measurements obtained by tomography as the actual value. In this way, they showed that angle measurements with smartphones improved accuracy and precision, compared to conventional techniques.

The use of angle measurement applications available for smartphones could improve the accuracy of derotation required for patients with rotational limb deformities. Clinical studies comparing the traditional technique by visual estimation with the one proposed in this technical note are required to validate its usefulness.

Conflict of interest: The authors have no conflicts of interest to declare. The Navi-gator iPhone smartphone application used in this study is a development version owned by RO. It is not available for general use and was only given free of charge to those responsible for field tests (JM and AF).

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REFERENCES

1. Franko OI. Smartphone apps for orthopaedic surgeons. *Clin Orthop Relat Res* 2011;469:2042-8. https://doi.org/10.1007/s11999-011-1904-0
2. Mobasheri MH, King D, Johnston M, Gautama S, Purkayastha S, Darzi A. The ownership and clinical use of smartphones by doctors and nurses in the UK: a multicentre survey study. *BMJ Innov* 2015;1(4):174-81. https://doi.org/10.1136/ bmjinnov-2015-000062
3. Al-Hadithy N, Gikas PD, Al-Nammari SS. Smartphones in orthopaedics. *Int Orthop* 2012;36(8):1543-7. https:// doi.org/10.1007/s00264-012-1527-4
4. Behnoush B, Tavakoli N, Bazmi E, Nateghi Fard F, Pourgharib Shahi MH, Okazi A, et al. Smartphone and universal goniometer for measurement of elbow joint motions: a comparative study. *Asian J Sports Med* 2016;7(2):e30668. https://doi. org/10.5812/asjsm.30668
5. Ferriero G, Vercelli S, Sartorio F, Muñoz Lasa S, Ilieva E, Brigatti E, et al. Reliability of a smartphone-based goniometer for knee joint goniometry. *Int J Rehabil Res* 2013;36(2):146-51. https://doi.org/10.1097/ MRR.0b013e32835b8269
6. Shen YF, Huang JH, Li XL, Gao H. Evaluation of the smartphone for measurement of femoral rotational deformity. *ANZ J Surg* 2019;(89):E422–E427. https://doi.org/10.1111/ans.15384
7. Franko OI, Bray C, Newton PO. Validation of a scoliometer smartphone App to assess scoliosis. *Pediatr Orthop* 2012;32:e72-e75. https://doi.org/10.1097/BPO.0b013e31826bb109
8. Balg F, Juteau M, Theoret C, Svotelis A, Grenier G. Validity and reliability of the iPhone to measure rib hump in scoliosis. *J Pediatr Orthop* 2014;34:774-9. https://doi.org/10.1097/BPO.0000000000000195
9. Otter SJ, Agalliu B, Baer N, Hales G, Harvey K, James K, et al. Reliability of a smartphone goniometer application compared with traditional goniometer for measuring first metatarsophalangeal joint dorsiflexion. *J Foot Ankle Res* 2015;8:30. https://doi.org/10.1186/s13047-015- 0088-3
10. Delgado ED, Schoenecker PL, Rich MM, Capelli AM. Treatment of severe torsional malalignment syndrome. *J Pediatr Orthop* 1996;16(4):484-8. https://doi.org/10.1097/00004694-199607000-00012
11. Kolp D, Ziebarth K, Slongo T. [Rotation or derotation osteotomy of the tibia]. *Oper Orthop Traumatol* 2017;29(2):163-72. [German] https://doi.org/10.1007/s00064-016-0473-5
12. Bae DS, Waters PM. External rotation humeral osteotomy for brachial plexus birth palsy. *Tech Hand Up Extrem Surg* 2007;11(1):8-14. https://doi.org/10.1097/01.bth.0000248359.14448.e6
13. Kozin SH. Medial approach for humeral rotational osteotomy in children with residual brachial plexus birth palsy. *Oper Tech Orthop* 2007;17:88-93. https://doi.org/10.1053/j.oto.2007.01.006
14. Peters FM, Gree R, Goldstein N, Frey CT. Improving acetabular cup orientation in total hip arthroplasty by using smartphone technology. *J Arthroplasty* 2012;27(7):1324-30. https://doi.org/10.1016/j.arth.2011.11.014
15. Graham D, Suzuki A, Reitz C, Saxena A, Kuo J, Tetsworth K. Measurement of rotational deformity: using a smartphone application is more accurate than conventional methods. *ANZ J Surg* 2013;83:937-41. https://doi.org/10.1111/ans.12371