CASE REPOSITORY

Physeal Bar Resection Under Guidance With a Navigation System and Endoscopy for Correction of Distal Radial Deformities After Partial Growth Plate Arrest

Yoshinori Takemura, MD, PhD,* Narihito Kodama, MD, PhD,* Hiroaki Ueba, MD,†
Kosei Ando, MD, PhD,‡ Kensaku Kuga, MD,* Shinji Imai, MD, PhD*

Partial growth plate arrest caused by trauma may lead to severe deformity and dysfunction. The Langenskiöld method is a surgical technique that involves resection of the physeal bar causing partial growth plate arrest. However, it is a technically demanding procedure. We used the Langenskiöld method under guidance with a navigation system and endoscopy and obtained good results in 2 cases. We consider that use of these tools can be a helpful adjunct to the carrying out this procedure. *(J Hand Surg Am. 2018;■(■):1.e1-e7. Copyright © 2018 by the American Society for Surgery of the Hand. All rights reserved.)*

Key words Endoscopy, Langenskiöld, navigation, physeal bar, radius deformity.

Online Exclusive

PARTIAL GROWTH ARREST AFTER trauma may be caused by the formation of an osseous bar across the physeal cartilage. Without treatment, the resulting angular and longitudinal growth disturbance will progress throughout the remainder of the child's growth. In 1967, Langenskiöld[1] introduced the concept of physeal bar resection to reestablish growth and to prevent progressive limb shortening and angular deformity. This method is indicated when less than 30% of the physis is damaged and more than 2 years of growth remain in the affected growth plate. However, this method is a demanding procedure and is not always successful. The extent and location of the physeal bar must be determined accurately. In addition, the physeal bar must be resected completely and the normal physis must remain undamaged.

Computed tomography (CT) and magnetic resonance imaging (MRI) may be useful in imaging the location and extent of the physeal bar. However, the precise extent of the lesion is difficult to identify using intraoperative fluoroscopy. Navigation systems have been introduced for intraoperative guidance to obtain better anatomical accuracy whereas endoscopy has been introduced to allow minimally invasive surgery. An endoscope has an intrinsic light source and the ability to magnify images of a narrow or closed space. The use of these 2 tools enables intraoperative identification of the extent of a physeal bar and allows more accurate surgery.

We describe 2 illustrative cases of premature distal radius physeal arrest treated by Langenskiöld's method[1] using a navigation system combined with endoscopy.

*From the *Department of Orthopaedic Surgery, Shiga University of Medical Science, Seta Tsukinowacho Otsu; the †Department of Orthopaedic Surgery, Omikusatsu Tokusyukai Hospital, Higashiyagura Kusatsu; and the ‡Department of Orthopaedic Surgery, Yasu Hospital, Koshinohara Yasu, Shiga, Japan.*

Received for publication August 22, 2017; accepted in revised form February 6, 2018.

No benefits in any form have been received or will be received related directly or indirectly to the subject of this article.

Corresponding author: Yoshinori Takemura, MD, PhD, Department of Orthopaedic Surgery, Shiga University of Medical Science, Seta Tsukinowacho Otsu, Shiga, Japan 520-2192; e-mail: takemura@belle.shiga-med.ac.jp.

0363-5023/18/■■-0001$36.00/0
https://doi.org/10.1016/j.jhsa.2018.02.013

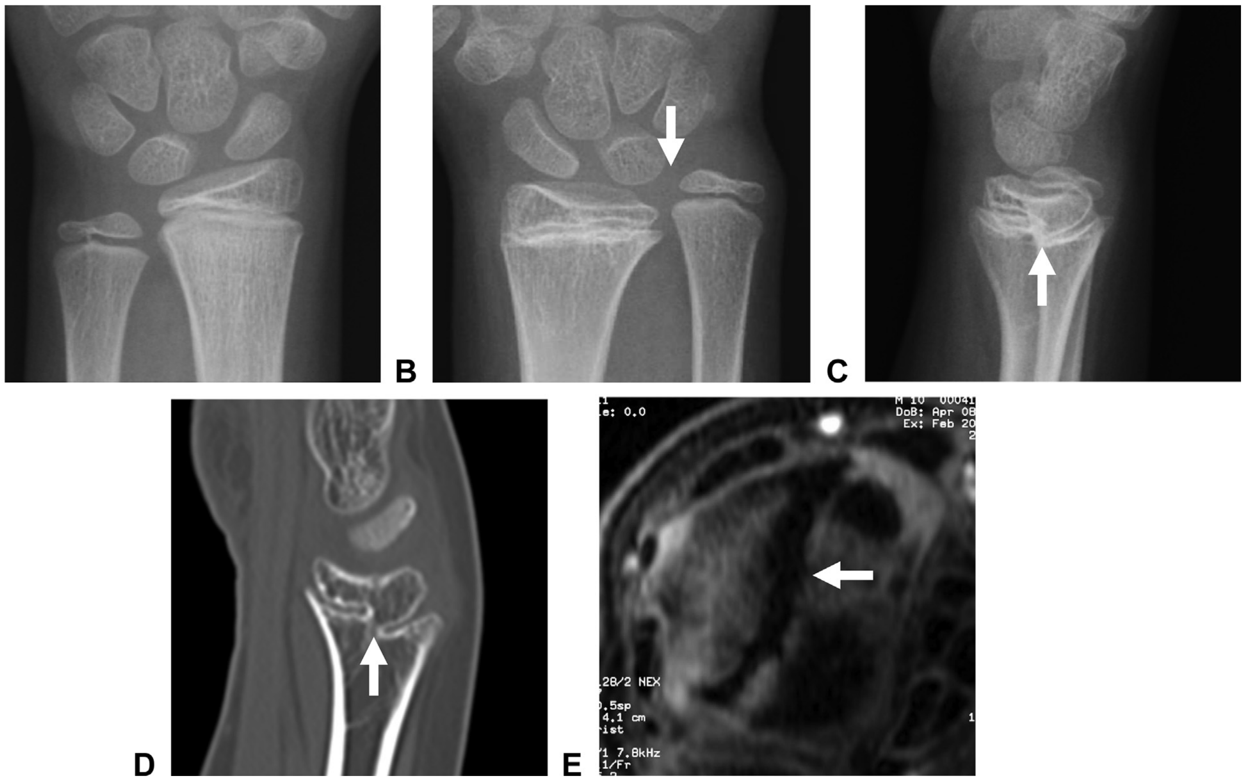

FIGURE 1: **A** Radiograph of the left hand of the patient in case 1, contralateral side. **B** Radiograph of the right hand of the patient in case 1 demonstrates complete growth plate arrest. Ulnar variance was negative (arrow). **C** Radiograph of the right hand demonstrates clearly the formation of a physeal bar (arrow). **D** A CT scan sagittal image clearly shows physeal bar formation (arrow). **E** T1-weighted axial MRI. The physeal bar (arrow) extends in a radioulnar direction. This is the linear type according to Peterson's classification.[3]

CASE REPORT

Case 1

A 10-year-old boy was brought to our institution because his mother was concerned about right hand deformity. At age 6, the boy had injured the physis of the right distal radius after a fall from a bicycle. The fracture was treated by closed reduction and a cast for 4 weeks. After removal of the cast, the patient did not follow-up. We noted clear deformity, with the ulnar head protruding dorsally; however, there was no pain and no dysfunction with daily activities. Anteroposterior and lateral radiographs and CT scan demonstrated partial physeal arrest of the radius with noticeable shortening (Fig. 1A–D). To determine the location of the physeal bar, we performed MRI. T1-weighted axial images showed an area of low signal intensity in the physis that extended in the radioulnar direction (Fig. 1E). This low-intensity area indicated the physeal bar, which comprised 27% of the area of the growth plate.

Before surgery, we attached adhesive markers to the patient's right hand and forearm and obtained CT images with unenhanced 0.6-mm-thin slices. During the operation, we used a CT-based navigation system (Kolibli navigation station 2.0; BrainLAB, Feltkirchen, Germany) with the preoperative CT scan data. The operation was performed under general anesthesia. After we made a skin incision a few centimeters long on the radial side of the forearm, 2 threaded pins were inserted into the shaft of the radius. A fixed-based tracker was connected to these pins. We performed point registration between the navigation images and the forearm markers. A high-speed handpiece attached to a 4-mm-diameter drill used for screw insertion was connected to the universal tracker. Using this navigation system, we were able to identify the location of the physeal bar and the direction of drilling in 3 dimensions (axial, coronal, sagittal) (Figure E1, available on the *Journal*'s Web site at www.jhandsurg.org). A 1-cm skin incision was made on the radial styloid, and the drill was passed into the physis along the physeal bar under navigation (Fig. 2A; and Figure E2, available on the *Journal's* Web site at www.jhandsurg.org). Because the physeal bar must be completely resected, the bone was penetrated on either side of the physis by drilling. However, there was likely to be navigation error because of the distance between skin and bone, so we used an endoscope to increase the accuracy of drilling direction and identification of the physeal bar.