

Treatment of Long Bones with a Universal Intramedullary Nail-System in a Developing Country at Hôpital Albert Schweitzer Haiti

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Abstract

Objective: To evaluate long bone fracture care in a resource-poor hospital by a European midterm volunteer orthopedic surgeon, using a tactile intramedullary nail system without intraoperative image intensifier or fracture table.

Methods: The first twenty cases treated by a single orthopedic surgeon using a universal intramedullary nail system (SIGN-nail) were analyzed using six-week to three-month follow-up series. Clinical follow-up occurred two weeks postoperatively with additional clinical and radiological follow-up at six-week and three-month timepoints.

Results: All twenty cases were negative for signs of infection, broken interlocking screws, or need for revision at respective three-month timepoints. All patients were at full weight-bearing capacity after six weeks. The SIGN-nail system also provided successful management of a complex 3D-correctionosteotomy case.

Conclusions: The SIGN-nail system is an effective, tactile system that can be used with satisfactory results without the need for an intraoperative image intensifier or fracture table. Its practical and minimalist nature makes it a favorable solution for long bone fracture care in resource-poor settings. A six-month time period seems to be adequate for midterm volunteer orthopedic-surgeons, as it allows adaptation to new settings and unfamiliar systems.

Keywords: Developing country; Haiti; Intramedullary nail-system; SIGN-nail

Introduction

Hôpital Albert Schweitzer (HAS), built in 1956, is a 130-bed, private, nonprofit facility that serves a population of roughly 340,000 in the Artibonite Valley of central Haiti. The mission of HAS is to reduce illness and death by providing primary and secondary health care, building wells and latrines, and supporting community development activities [1].

In 2011, a Surgical Project was established by the Bündner Partnerschaft Hôpital Albert Schweitzer Haiti (BPHASH). Following the horrific 2010 earthquake in Haiti, several significant projects for immediate support were started by large BPHASH fundraising activities in Switzerland and Germany, including the financing of the Pediatric Service running costs (Swiss Pediatric Program) and a Social Service Program that covers the cost of care for indigent patients. BPHASH set up the Surgical Project with the purpose of improving trauma surgery and anesthesia at HAS as well as sending Swiss surgeons and anesthesiologists to cooperate and train Haitian physicians, in collaboration with Swiss University Hospitals [<http://www.hashaiti.org/Partners>].

A universal nail-system (Surgical Implant Generation Network (SIGN)), a non-profit organization from America, is available at HAS

for the treatment of long bones (e.g., fractures and pseudarthroses). The SIGN system was designed for solid intramedullary fracture fixation in developing countries where patients could not afford commercial cannulated interlocking nails and where intra-operative imaging and fracture tables are often not available [2].

The nail's use, initially designed for tibial fractures, was eventually expanded to cover femoral shaft fractures [2]. SIGN has freely provided over 80,000 intramedullary (IM) nails and training for their use to HAS and to over 200 other hospitals in low- and middle-income countries since 1999 [3].

The purpose of this study was to evaluate a series of short-term outcomes in patients who received long bone treatment using the SIGN-nail system at a low-resource hospital in a developing country. For HAS, this translates into no image intensifier, fracture table and limited availability of a surgical assistants. Additional barriers can include language differences, worn out or missing instruments, or inadequate suture size or properties.

Materials and Methods

All long bone fractures treated with a universal intramedullary nail system (SIGN-nail) at HAS in January through March 2014 were selected (n=20). Surgeries were performed as a single-surgeon procedure by the senior author, involving a surgery team consisting of an anesthesiologist, scrub nurse, and orthopaedic surgeon. In all

cases, four interlocking screws (two proximal and two distal) were placed.

The mean patient age was 34.2 (14-77) years, and 14 patients were male and six female. Long bones treated with standard SIGN-nail included the tibia (13), femur (6) and humerus (1). Surgery was indicated for fractures in 12 cases involving motorcycle accidents, one case of pedestrian struck by motor vehicle, one case due to a sporting accident (soccer), one to secondary dislocation after external fixator, one to pathological fracture due to severely malaligned bone healing after initial conservative treatment, and four to pseudarthrosis (conservative treatment or external fixator performed in 2013).

Among the patients, three had severe polytrauma with additional fractures and head-injuries, eight had open fractures (Gustillo 1 to 3) and four were initially treated with external fixator until wound healing, and then were converted to intramedullary nail as a one-stage procedure.

Each Patient received a postoperative x-ray. All patients were controlled at two weeks postoperatively with additional clinical and radiological follow-up at six-week and three-month timepoints. Examinations followed SIGN-reporting-system criteria and emphasized the clinical signs of infection, radiological signs for implant/screw-breaking and secondary dislocation of fragments. Range of motion of proximal and distal joints (as measured by goniometer) was documented as was full weight-bearing ability without pain (six-week follow-up).

Results

The overall average operating time was 96 (45 to 180) minutes, which included 80 (45-150) minutes for tibia cases, 90-180 minutes for femur cases, and 150 minutes for the humerus case. In three cases, postoperative x-rays showed distal interlocking screws not matching to the holes in the nail. No revisions have yet been required, and no infections have been detected, with two remaining patients who have yet to complete a three-month follow-up due to missed follow-up appointments.

Knee flexion of more than 90 degrees was possible in all tibia and femur cases. Free hip flexion was possible in all femur cases and greater than 90 degrees of shoulder and elbow flexion in the humerus case.

At the six-week and three-month follow-up visits, x-rays showed no secondary dislocation, no implant failure and no breaking of interlocking screws. All patients demonstrated full weight-bearing capacity at six weeks without pain. Satisfactory results were even achieved in a complex proximal femur case with 3D-correctionosteotomy performed to a severe malalignment after conservative treatment of a pathological proximal femur fracture.

Case: 14-Year-Old Boy with Pathological Fracture of Proximal Femur

A 14-year-old male patient presented to the outpatient clinic six weeks after conservative treatment of a pathological fracture of the right proximal femur. Treatment at the time of injury in November 2013 was performed with a Spica-cast, as there was no available orthopedic surgeon at HAS. At the time of presentation, the fracture showed partial healing, but severe malalignment (Figure 1).

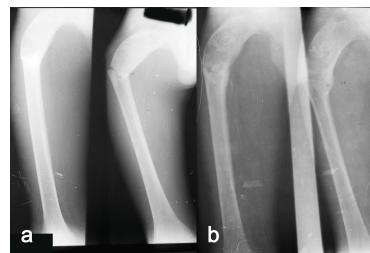


Figure 1: Preoperative x-rays a) Non-traumatic pathological fracture of proximal femur caused by fibrous dysplasia (shepherd's crook deformity) b) Malalignment after six weeks of conservative treatment with Spica-cast

Despite the chance of complete fracture healing, the deformity risked causing a secondary fracture due to the disadvantageous leverarm and weakened bone. Pathology of the femoral bone was suspected to be fibrous dysplasia (shepherd's crook deformity), although this could not be confirmed, as there is no available CT-Scan, MRI, or histological evaluation at HAS.

The decision was made to do a 3D-correctionosteotomy and internal fixation with a SIGN-nail.

Intraoperatively, the deformity was more severe than anticipated from the preoperative x-rays, consisting of a greater than 50 degree adduction deformity with a greater than 40 degree flexion of the proximal femoral fragment.

Surgery was performed as a single-surgeon procedure. During surgery, rotation was controlled by two K-wires placed within the fragments before resection of a 3D-Wedge for correction (placement was done by estimation, as there were no tools to control). The intramedullary canal was reamed with handreamers, and a SIGN-nail was placed with customary distal interlocking screws. After retrograde compression, the proximal screws were placed as proximal as possible to obtain maximal stabilization of the femoral neck. The overall surgery-time was 120 minutes with minimal blood loss and no need for blood transfusion. Postoperative gross images of the right thigh demonstrate normal anatomical shape as compared to preoperative images (Figure 2).

As there was no intraoperative radiological control available, the postoperative x-ray displays the impressive offset-correction caused by the performed 3D-correctionosteotomy (Figure 3).

The patient was discharged postoperatively from HAS after one week and was able to ambulate well on crutches with non-weight-bearing restrictions. His six-week follow-up x-ray shows partial healing with no dislocation or malalignment, and he was advanced to full-weightbearing status (Figure 4a).

His three-month follow-up x-ray shows consolidation of the fracture (Figure 4b).

Clinically, the patient showed equalized leg length and successfully performed a single leg stance test (Figure 5).

Discussion

To date, the overall results show no signs of postoperative infection. This is an excellent outcome, as resource limitations often preclude

optimal sterility standards held in more developed countries. For example, old, worn out sterile drapes often contain holes and flying insect's occasionally land on sterile equipment or on an open wound intraoperatively. Our results further substantiated other reviews that have found infection rates to be as low as 1% in patients treated with intramedullary SIGN-nails in low- and middle-income countries [3].

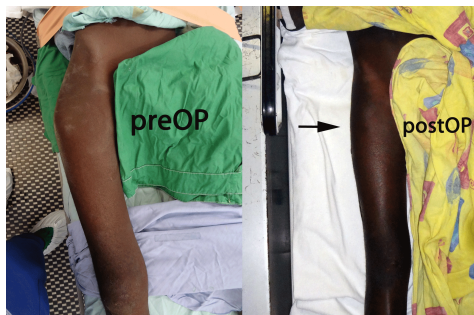


Figure 2: Depiction of the preoperative and postoperative clinical image Preoperative severe deformity of thigh with consecutive shortening of right limb of more than 3 cm, right image shows postoperative normal anatomical shape of the right thigh.

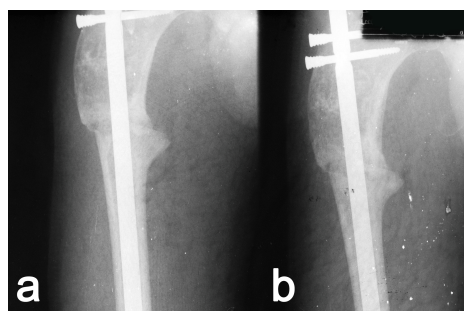


Figure 3: Postoperative x-rays at area of correction a) Roughly oblique view (lateral view requested) shows the impressive offset caused by the performed 3D-correctionosteotomy and realignment. b) AP-view of the corrected area.

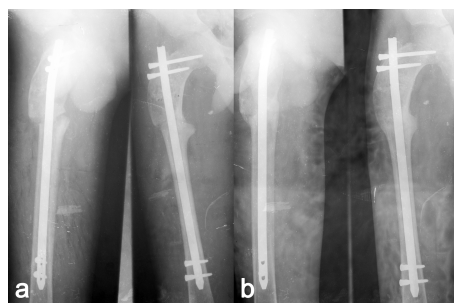


Figure 4: Six week and three month follow-up x-rays a) Partial healing can be seen on the six week follow-up x-ray. Patient tolerated full-weight-bearing without pain. b) Consolidation of fracture three months postoperatively.

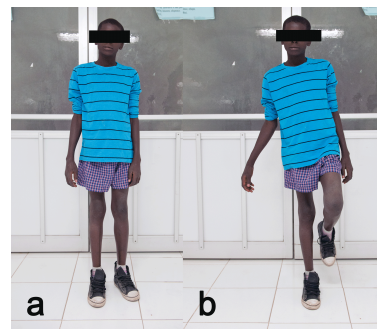


Figure 5: Depiction of clinical image at three month follow-up Patient shows equalized leg length (a) and successfully performed a single leg stance test. (b). Patient is able to walk normally without limping.

Operating times were perhaps longer than usual and could be reduced. However, this was likely due to unfamiliarity working within a low-resource setting, language barriers and cases that required additional debridement and/or repair of open wounds (e.g. applying split thickness skin grafts, etc.). The time/experience-dependent decrease in operating time does, however, highlight the advantage of mid- to long-term volunteers in contrast to those that only volunteer for a few weeks at a time.

The three cases in which the distal interlocking screws missed the distal nail holes occurred early on and is a reflection of the short learning curve required to work with the SIGN-nail system. The rarity at which this happens demonstrates that the tactile-based system and the aiming-device work very well within the SIGN-nail system.

The learning curve should be considered when volunteers are making plans to serve at a low-resource hospital. The six-month presence of the orthopedic-surgeons, as targeted by the Bündner Partnerschaft Hôpital Albert Schweitzer Haiti (BPHASH), seems to be an adequate time period, as it allows a surgeon to adapt to the new setting and unfamiliar systems. This, in turn, enables superior patient care and collaborative teamwork among staff and volunteers. Additionally, it allows for mutual education, as both the resident staff and volunteers have the time to learn from and teach one another. This particular time frame appears to work well, and we recommend this project be continued.

Panti et al. [2] compared outcomes of the solid stainless steel SIGN-nail to treatment with common cannulated interlock intramedullary nails and found no difference. We believe, however, that a solid nail has an advantage, especially for cases with fibrous dysplasia. Therefore, treatment of shepherd's crook deformity with intramedullary nails and with neck cross-pinning is recommended [4-6].

Although the SIGN-nail does not provide oblique proximal interlocking screws, the holes are proximal enough to place a screw through the femoral neck. Fakler et al. [7] after comparing intramedullary nailing to endoprosthetic reconstruction for pathologic fractures of the femoral intertrochanteric and subtrochanteric region did not find a difference due to survival.

The limitations of the current study include the relatively low number of patients and the short follow-up time periods. This reflects, in part, the unfortunate, yet unavoidable reality of having a definitive

time frame in which to follow patients postoperatively as a volunteer surgeon. However, the nature of mid-term volunteers allows for greater control of patients over a longer time period than short-term volunteers, who often struggle with the inability to control patients at all.

In summary, the SIGN-nail system is a tactile system that does not require an image intensifier and appears to be a good solution for treating long bone injuries in developing countries.

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