SIGN Nailing of Humeral Fractures and Nonunions

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Summary: This article outlines the Russian experience with the Surgical Implant Generation Network tibial nail in treating diaphyseal fractures of the humerus. This solid stainless steel nail has a unique targeting technique for the placement of distal interlocking screws. The surgical technique is reviewed and the results of treatment of 168 acute fractures and nonunions is presented.

Key Words: humeral shaft fractures—intramedullary nailing—SIGN nail—antegrade humeral nailing.

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Fractures of the humerus comprise 1% to 3% of all fractures. The incidence has a bimodal age distribution with peaks in adolescence and the 5th and 6th decades of life.1 Most shaft fractures of the humerus can be treated successfully nonsurgically with the use of splints or humeral orthoses.

Operative treatment of humeral fractures is also predictable with the relative indications being:

- Open fractures
- Multiple trauma
- Unacceptable alignment after closed reduction
- Delayed or nonunion
- Associated vascular injury
- Other ipsilateral upper extremity fracture (“floating elbow”)
- Bilateral upper extremity injury
- Inability to use humeral brace secondary to obesity or large breasts
- Need for early weightbearing
- Pathologic fractures
- Transverse midshaft fractures

Contraindications include active regional or systemic infection, too proximal or distal fractures, and severe osteoporosis. Operative treatment can be by plating, intramedullary nailing with flexible or rigid locking nails, and external fixation.1–3 This article outlines the technical aspects of the use of the Surgical Implant Generation Network (SIGN) interlocking nail in the treatment of diaphyseal humeral fractures and nonunions as well as the review of outcomes in 98 cases.

The SIGN nail is a solid stainless steel nail originally designed to treat tibia fractures. Its use has been expanded to nailing femoral and humeral shaft fractures. The SIGN nail is unique in its ability to be placed and screw interlocks to be performed without intraoperative imaging. Details of its design are included in other articles in this journal.

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FIGURE 1. Patient positioned on table with bump under scapula and additional support under forearm.

TECHNIQUE

Preoperative full-length radiographs should be available to assess the location of the fracture and the integrity of the proximal and distal aspects of the humerus. Measurement of the uninjured humerus from the lateral acromial tip to the lateral epicondyke and subtracting 5 cm gives the approximate length of the nail. Several nail lengths shorter and longer of multiple diameters should be sterilized and available. The injured extremity if possible should be scrubbed with chlorhexidine soap preoperatively. Intravenous broad-spectrum antibiotics such as cephalaxin should...
be given at appropriate doses within 30 minutes of incision. The patient is given a general anesthetic and placed supine on a regular operating table with a bump under the shoulder to stabilize the scapula and elevate the lateral entrance site (Fig. 1). A mayo stand or other support is placed next to the table to support the arm during the procedure. Because fluoroscopy is not being used, the support need not be radiolucent. The entire shoulder from nape of neck to mid chest wall down to the wrist is prepared with the antiseptic of surgeon’s choice. The arm is draped free.

An anterolateral skin incision is made from the tip of the acromion distally extending 6 to 8 cm in length (Fig. 2). The deltoid muscle is split bluntly in line with the muscle fibers. Access to the sub-acromial space is thus obtained and the bicipital groove palpated. A 1 to 2 cm longitudinal incision through the supraspinatus tendon is made 1 finger-breadth posterior to the biceps tendon. The edges of the supraspinatus tendon can be tagged with retention sutures (Fig. 3). A pointed awl is used to open the canal at the junction of the articular surface and the greater tuberosity (Fig. 4).

Reduction is always done in an open fashion with a small incision made laterally at the fracture site (Fig. 5). If the fracture is freely mobile, usually just a finger placed on the shaft at the fracture site can be used to guide the reamers and nail across the fracture. If operative treatment has been delayed or a delayed or nonunion is being treated, then a larger incision with formal exposure and reduction of the fracture may be necessary. The canal is reamed with hand-powered reamers until cortical chatter is felt. A reamer may be left in the canal to maintain reduction while the nail is prepared.

A nail at least 1 mm smaller in diameter of the appropriate length is attached to the insertion device. The target arm is attached and confirmation of alignment of the interlocking guides both proximal and distal is made. The target arm is then removed and the nail introduced into the canal.
proximally (Fig. 6). The nail is passed carefully with small twisting motions and gentle taps of the mallet. The proximal bend in the nail is aimed laterally leaving the interlocking holes in an anterior to posterior alignment. Heavy striking of the nail may lead to comminution of the fracture or incarceration of the nail in the canal. The nail is guided by palpation across the fracture site and driven at least 1 cm below the level of the proximal articular cartilage to prevent subacromial impingement. Counter pressure is placed on the olecranon as the nail is being passed to prevent distraction of the fracture.

The distal interlock is performed first by reattaching the target arm and making a small incision beneath the guide bluntly dissecting down to bone (Fig. 7). One screw is placed in the most proximal slot with the standard SIGN technique if there is at least 10 cm from the slot to the fracture site. Two screws are placed if the fracture is less than 10 cm to the slot (Fig. 8). If the fracture is not apposed as assessed by finger palpation, the nail is backslapped with the appropriate device or gentle thrusts against the olecranon will compress the fracture. Care must be taken to assure the nail remains below the condylar surface to prevent impingement. The proximal target arm is then used to place 2 proximal interlocking screws (Fig. 9).

The supraspinatus tenotomy is repaired with nonabsorbable suture and the deltoid and skin closed in a routine fashion. Wounds are dressed and a sling applied.

Postoperative care allows early active motion of the elbow and wrist but active and aggressive passive motion at the shoulder is restricted for 4 weeks. A sling is encouraged during that time. Follow-up evaluation including radiographs is done at routine intervals. Nails are not routinely removed unless they are causing impingement or pain.

**RESULTS**

A total of 168 nailings for acute fractures and nonunions have been performed to date. Ninety-eight have follow-up of at least 6 months. Three iatrogenic radial nerve palsies developed and all resolved spontaneously without intervention by 3 months postoperatively. Two cases of proximal impingement were noted early in the series. One patient had exchange nailing performed and the other refused further intervention. There was 1 nonunion of a distal fracture that required bone grafting and exchange nailing. That fracture healed. There were no losses of fixation or alignment at follow-up. There were no broken screws or nails. All fractures eventually healed including the 10 nonunions treated. There were 2 deep infections requiring nail removal and placement of an antibiotic polymethylmethacrylate coated nail with concomitant intravenous antibiotics and delayed exchange nailing. Both infections cleared and both fractures united.
DISCUSSION

Controversy remains as to the most appropriate method for treating humeral shaft fractures. The experience with the SIGN nail in treating humeral shaft fractures confirms the predictable success of intramedullary nailing in treating these fractures. Nailing of humeral shaft fractures allows early mobilization of the upper extremity which is beneficial in multiply injured patients. Complications in this series of patients were few and resolved with standard treatment. Violation of the rotator cuff during nail insertion led to few cases of shoulder stiffness. Alternative entry portals may improve this problem. Few radial nerve palsies were noted and as with other surgeons’ experiences, all palsies resolved spontaneously.

CONCLUSIONS

1. SIGN nail is a predictable and dependable method of treating diaphyseal humeral shaft fractures.
2. This technique has a low complication rate.
3. The SIGN nail is a novel inexpensive interlocking nail with a predictable distal interlocking screw technique performed without fluoroscopy.
4. Most humeral fractures require open reduction when using this technique.
5. No postoperative bracing is needed.

REFERENCES


