Mallet fracture is an avulsion fracture of the distal phalanx that is often caused by traumatic forced flexion of the distal interphalangeal joint. In most cases, the dorsal fragment involves a small portion of the joint and conservative (nonsurgical) treatment provides satisfactory results. However, surgical treatment is often required when the injury involves more than one-third of the base of the distal phalanx or when it includes volar subluxation.

Multiple operative techniques have been described in the management of mallet fracture. Open surgery with accurate reduction was previously recommended to avoid degenerative arthritis and loss of motion. Several open reduction and internal fixation techniques have been described, including the use of K-wire fixation, a hook plate, a miniscrew, a pullout suture, and a tension band wire. However, direct fixation of a fragment sometimes causes fragment comminution.

To overcome this problem, the authors developed a method of bone fragment fixation without direct fragment penetration in bony mallet finger. This technique is called the “fish hook” technique. This report describes this technique and presents the results and assessments with this approach.

Materials and Methods

Between March 2010 and February 2014, 26 patients with mallet finger fractures who underwent surgery using the fish hook technique between 2010 and 2014. The fractures were classified according to the method of Wehbe and Schneider. The fracture fragment was fixed with a fish hook technique in all patients. The K-wire was removed after 6 weeks, when bone union was achieved. Clinical parameters, including range of motion and extensor lag, were assessed at the distal interphalangeal joint according to Crawford's criteria. The mean follow-up period was 12.8 months. Mean extensor lag was 3°, and mean range of flexion of the distal interphalangeal joint was 76°. All patients achieved bone union after 6 weeks. According to Crawford's criteria, there were 20 excellent results, 5 good results, and 1 fair result. No complications, including skin necrosis, pin loosening, and nail deformity, occurred. The fish hook technique is an effective treatment option for bony mallet finger and provides good clinical and radiologic results. [Orthopedics. 2016; 39(5):295-298.]
Features underwent surgical treatment with the fish hook technique at the study hospital. Patients who were included had an injury involving more than one-third of the base of the distal phalanx. Of the 26 patients, 10 were women and 16 were men. Mean patient age was 34.5 years (range, 20-48 years). The following digits were affected: index finger (n=4), middle finger (n=4), ring finger (n=8), and little finger (n=10). Of the injuries, 18 occurred while playing sports and 8 occurred in traffic accidents. Average time from injury to surgery was 3.9 days.

A preoperative lateral radiograph of the finger was used to identify palmar subluxation of the distal phalanx, fragment displacement, and fragment size. Fractures were classified by the Wehbe and Schneider classification (Table 1), which is based on analysis of lateral radiographs. Serial lateral and anteroposterior radiographs were obtained immediately after surgery and 2 weeks, 4 weeks, 6 weeks, 3 months, and 6 months postoperatively. Clinical parameters, including range of motion and extensor lag, were assessed at the distal interphalangeal joint according to Crawford’s criteria (Table 2).

### Surgical Technique

A magnifying fluoroscope was used during surgery. Anesthesia was administered with a digital block. A rubber finger tourniquet was applied. The first 1.2-mm K-wire was driven from the tip of the distal phalanx to the point at which it meets the distal interphalangeal joint (Figure 1A). At this point, the second 1.2-mm K-wire was inserted distal to the fracture site. The K-wire was then bent into the shape of a fish hook. The length of the hooked K-wire tip was cut so that it could catch the avulsed dorsal fragment (Figure 1B). A 2-mm skin incision was made on the dorsum of the finger. Once proper reduction was confirmed with fluoroscopy, this wire was pulled toward the palmar side to catch the avulsed dorsal fragment. Then the first K-wire is driven through the distal interphalangeal joint (C).

### Postoperative Management

Postoperative splint protection was not provided, and active motion of the proximal interphalangeal and metacarpophalangeal joints was allowed. All of the K-wires were removed after 6 weeks under a digital block performed in the office. Full active and passive distal interphalangeal joint exercises were then initiated.

### Table 1

**Wehbe and Schneider Classification of Mallet Fractures**

<table>
<thead>
<tr>
<th>Type</th>
<th>Definition</th>
<th>Subtype</th>
<th>Articular Surface</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>No distal interphalangeal joint subluxation</td>
<td>A</td>
<td>Less than one-third</td>
</tr>
<tr>
<td>II</td>
<td>Distal interphalangeal joint subluxation</td>
<td>B</td>
<td>One-third to two-thirds</td>
</tr>
<tr>
<td>III</td>
<td>Epiphyseal and physeal injuries</td>
<td>C</td>
<td>Greater than two-thirds</td>
</tr>
</tbody>
</table>

### Table 2

**Crawford Classification**

<table>
<thead>
<tr>
<th>Classification</th>
<th>Extension Loss</th>
<th>Flexion</th>
<th>Pain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>None</td>
<td>Full</td>
<td>None</td>
</tr>
<tr>
<td>Good</td>
<td>0°-10°</td>
<td>Full</td>
<td>None</td>
</tr>
<tr>
<td>Fair</td>
<td>10°-25°</td>
<td>Any loss</td>
<td>None</td>
</tr>
<tr>
<td>Poor</td>
<td>&gt;25°</td>
<td>Any loss</td>
<td>Persistent</td>
</tr>
</tbody>
</table>
RESULTS

The average percentage of articular surface involvement was 42%. There were 4 type IB, 3 type IC, 10 type IIB, and 9 type IIC fractures. Mean follow-up was 12.8 months.

In all patients, radiographic union was documented within 6 weeks of surgery (Figure 2). The average final active range of flexion of the distal interphalangeal joint was 76° (range, 60° to 90°), and extensor lag was 3°. Proximal interphalangeal joint motion was within normal limits, without hyperextension. According to Crawford’s criteria, 20 of 26 patients had excellent results, 5 had good results, and 1 had a fair result. No complications, including pin site infection, nail deformity, and skin necrosis, occurred.

DISCUSSION

The goal of mallet fracture treatment is to restore the continuity and possibly the function of the damaged tendon. To prevent secondary arthritis or joint stiffness, the fragment must be reduced anatomically and must be maintained.12 Nonsurgical treatment of mallet finger may result in secondary degenerative arthritis, loss of movement, and poor cosmetic outcomes. Therefore, surgical reduction of the articular surface and stable fixation are recommended.1,5,9 Multiple operative techniques have been described in the management of mallet fracture. Both open and closed fixation techniques are used. Open fixation is technically challenging because of the small fracture fragments and difficulty visualizing the articular surface of the distal interphalangeal joint.5 To address this limitation, both volar approaches (through the lateral collateral ligament) and dorsal approaches (through the extensor tendon) have been suggested. However, these approaches cause soft tissue scarring that may result in joint stiffness.6,9 In addition, complications of open surgery may occur, including early avascular necrosis, nail growth deformities, soft tissue scarring, infection, implant failure, and subsequent joint stiffness.13

To reduce the complications associated with open fixation, closed percutaneous fixation was developed.14,15 Ishiguro et al16 proposed a method of closed reduction with an extension block and fixation of the distal interphalangeal joint with K-wires. This technique not only is easier than open surgery but also reduces the possibility of fragment comminution. Potential disadvantages of this closed approach include articular cartilage damage leading to secondary osteoarthritis and flexion contracture. In addition, this method is not possible when the fragment is rotated. Badia and Riano17 reported a simple K-wire fixation technique in which the dorsal fragment is penetrated with a bent K-wire shaped like an umbrella handle and transarticular fixation is performed with another K-wire. Unfortunately, this technique introduces a high risk of dorsal fragment comminution because of direct penetration of the fragment.8 Teoh and Lee7 reported a method in which the hook plate is used to catch the dorsal fragment directly without passing it through; however, this technique needs a relatively large transverse incision that can cause skin problems or nail bed injury.

The fish hook technique described in this article involves percutaneous indirect fixation of mallet finger and distal interphalangeal joint transfixion. This technique reduces the complications associated with open surgery and avoids the risk of breaking the fracture fragment. Even if the fragment is small, this technique is associated with fewer technical difficulties than direction fixation. The K-wire is not exposed, which theoretically also reduces the risk of infection. In addition, dorsal incisions are made as far as possible from the nail. No nail deformities were reported with this technique. This study is limited by its small sample size and the indirect comparison of surgical methods. A disad-
vantage of this technique is the need for an additional procedure to remove the K-wires; however, this procedure can be done on an outpatient basis. It is important to recognize that nail deformities and marginal skin necrosis are possible complications of this method, although these did not occur in this study. Further research is needed to support the study findings.

**Conclusion**

This study presents the clinical and radiographic results of 26 patients who were treated successfully with the fish hook technique. This technique is an effective treatment option for bony mallet finger.

**References**