Polymer Cable/Grip-Plate System with Locking Screws for Stable Fixation to Promote Healing of Trochanteric Osteotomies or Fractures in Revision Total Hip Arthroplasty

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ABSTRACT

Multiple methods have been proposed to establish stable fixation to promote healing of trochanteric osteotomies or fractures in revision total hip arthroplasty (revTHA), from wiring techniques through cable-plate systems with or without supplemental locking screws. The purpose of this study is to report the clinical results of a single cable-plate system with locked screw fixation in revTHA. Between 2009 and 2012, 27 grip-plates (Supercable® System, Kinamed Inc., Camarillo, CA) were used in 26 patients in 27

revTHA procedures. Utilization was 12 1-hole (50 mm) grip-plates, 10 2-hole (135 mm) grip-plates, four 4-hole (190 mm) grip-plates, and one 6-hole (245 mm) grip-plate. There were 14 women and 12 men. Age averaged 63.2 years and BMI averaged 29.4 kg/m2. At average 2.5 year follow-up, grip-plate fixation was considered successful in 22 hips (81%) with five failures. Three failures consisted of 50 mm/short grip-plates used in one trochanteric slide, and two intraoperative trochanteric fractures during revTHA. The two additional failures were related to pre-revision trochanteric avulsion from bony necrosis of the proximal femur. An additional three grip-plates were removed electively for soft-tissue irritation and pain but with successful fixation and bony healing. Thus 70% of hips were free of reoperation related to the grip-plate. All other hips had successful fixation and the grip-plate was not symptomatic. In this study, the cable-grip system and isoelastic Supercables provided reliable fixation for adequate healing of difficult ETO and trochanteric fractures with an 81% rate of mechanical success with radiographic and clinical healing observed.

INTRODUCTION

Establishing stable fixation to allow healing of trochanteric osteotomies or fractures in revision total hip arthroplasty (revTHA) can be difficult. Multiple methods have been proposed beginning with wiring techniques and advancing through cable-plate systems with or without supplemental locking screws.[1-4] Recent investigations using in-vitro experimental designs have demonstrated that cable-grip fixation is significantly more stable than wire-based fixation.[1,2]

Clinical results demonstrate that newer generations of cable plates appear to function better than early-generation systems.[3] Furthermore, the addition of locking screws to trochanteric fixation has also been suggested to provide successful fixation in early reports.[4] While it would appear that cable-grip technology with supplemental locked screw fixation provides rigid and reliable fixation, several authors agree that more clinical outcome studies are needed to validate this technique.[2,4] The purpose of this study is to report on the clinical results of using a single cable-plate system with locked screw fixation in revTHA.

MATERIALS AND METHODS

Between 2009 and 2012, 27 grip-plates (Supercable® System, Kinamed Inc., Camarillo, CA) were used in 26 patients in 27 revTHA procedures. Utilization consisted of 12 1-hole (50 mm) grip-plates, 10 2-hole (135 mm) grip-plates, four 4-hole (190 mm) grip-plates, and one 6-hole (245 mm) grip-plate. There were 14 women and 12 men. The average age at the time of revTHA was 63.2 years (range 44.5-89.0; SD 10.5), the average weight was 186 pounds (86–290; SD 56), and average height 67 inches (59–74; SD 3.9). The procedure was performed on the left hip in 14 cases.

Radiographic evaluation and clinical exam using the Harris hip score[5] (pain 0–44 possible; total 0–100 possible) and the lower extremity activity scale[6] (1–18 possible) were performed preoperatively, at six weeks and annually postoperatively. Preoperatively, the indications for revTHA and the reason for use of the trochanteric grip-plate were recorded. Failure of the cable-grip plate was documented and an attempt to identify the etiology was undertaken.

All procedures were performed by a single surgeon (KRB) using a modified direct lateral approach as described by Frndak et al.[7] In cases where an extended trochanteric osteotomy (ETO) was utilized, the ETO technique described by MacDonald et al. using the direct lateral approach was used.[8] Routinely this osteotomy was reduced and fixed using multiple isoelastic Supercables (Kinamed Inc.) without grip-plate fixation. In cases of iatrogenic fracture of the trochanteric fragment, osteolysis, or periprosthetic fracture, the grip-plate

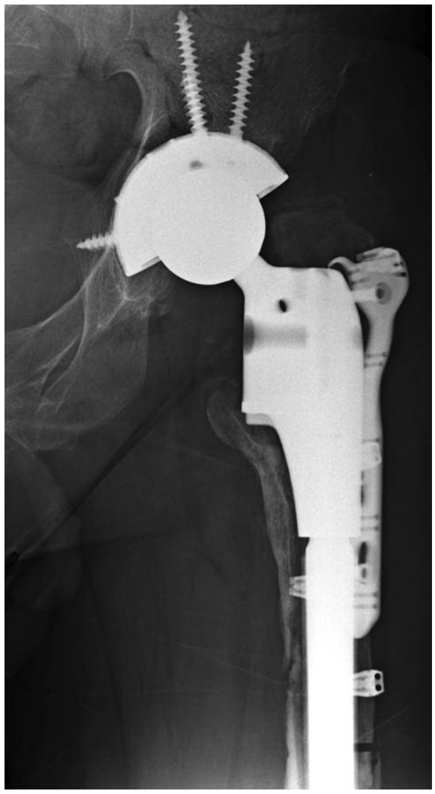

Figure 1. Complex reconstruction using Supercable and grip-plate system. The patient had undergone a two-stage treatment of infection with a 10-inch, bowed, cylindrical stem which failed from aseptic loosening and failure of ingrowth. Subsequent revision was complicated by infection requiring a second two-stage exchange with ETO and massive proximal bone loss. During the reimplantation, multiple fractures of ectatic trochanteric fragment occurred. A 2-hole (135 mm) grip-plate with Supercables and locked screws was used during the final reconstruction. At four years, the trochanteric fixation is healed and solid and the patient has no complaints related to the construct.

was utilized. In cases where the femoral stem was left in-situ and extensile acetabular exposure was needed, a modified transtrochanteric slide as described by Lakstein et al. was used and fixed with a grip-plate.[9]

Following completion of the revTHA, the trochanteric fragment or fragments were reduced into as close to anatomic location as possible. Provisional fixation using large bone holding clamps was used. The appropriate length grip-plate was selected to ensure that the plate spanned the entire osteotomy. The plate was then held in place using bone holding clamps, and isoelastic Supercables were passed through the plate and around the femur. Once the cables were passed, they were sequentially tightened until the construct appeared rigid. At this point any available locking screws were drilled, measured for length, and inserted.

RESULTS

The grip-plate was utilized in four revTHA with ETO complicated by intraoperative fracture, 15 revTHA with trochanteric escape or trochanteric periprosthetic fracture (Vancouver 1 grade), seven trochanteric slide osteotomies, and one failed trochanteric slide.[10] At average 2.5 year follow-up (range, 0.1-5.1), grip-plate fixation was considered successful in 22 hips (81%) with five failures. Three failures consisted of 50 mm/short grip-plates used in one trochanteric slide, and two-intraoperative trochanteric fractures during revTHA. The two additional failures were related to pre-revision trochanteric avulsion from bony necrosis of the proximal femur. An additional three grip-plates were removed electively for soft-tissue irritation and pain but with successful fixation and bony healing. Thus 70% of hips were free of reoperation related to the grip-plate. All other revTHA had successful fixation and the grip-plate was not symptomatic. At final follow-up HHS pain component improved from 17 to 35, HHS total score improved from 47 to 71, and LEAS improved from 7.3 to 9.3, with nine equating to "I am up and about at will in the house and can go out and walk as much as I like with no restrictions—weather permitting" (all $P<0.005$).

DISCUSSION

Trochanteric fixation methods have evolved over the past four decades advancing from simple wire fixation, to cable fixation, to supplemental plate fixation and finally isoelastic cable fixation with locked plates. This evolution has come from necessity with more difficult revision scenarios, increasing periprosthetic fractures, and more severe bone loss at the time of revision total hip arthroplasty (revTHA). The current study investigates the use of polymer isoelastic cables and a novel grip-plate system in the most difficult revTHA cases. Overall 77% of constructs were mechanically successful with trochanteric healing clinically and radiographically (Fig. 1).

In-vitro analyses have demonstrated that cable-grip fixation is significantly more rigid than wire fixation methods.[1] While this is important information, the clinical relevance of testing normal cadaveric bone, free from osteolysis or osteoporosis, may not equate to the difficult revTHA situations in which the current authors would utilize the isoelastic cable and grip-plate fixation with locked screws. For most ETO in revTHA, the authors utilize three isoelastic cables without supplemental grip-plate fixation and have seen excellent results (Fig. 2). However, when bone loss compromises the stability of cable-only fixation, when an iatrogenic fracture of the trochanteric fracture occurs, or when there is trochanteric escape or a periprosthetic fracture of the trochanter, the authors use the isoelastic cable system and grip-plate with locking screws (Fig. 3). Clearly, these cases represent the end of the spectrum of difficulty.

It has been shown that elastic cables reduce cable loosening during cyclic

Figure 2. a. Preoperative radiograph of a patient with failed cemented femoral fixation with long cement mantle. b. The patient underwent femoral revision requiring ETO for cement removal. The procedure was without fracture of the trochanteric fragment and thus three cables were used without grip-plate for ETO fixation. A fourth Supercable is seen distal to the osteotomy as prophylaxis against fracture. At five years, complete radiographic and clinical healing of the ETO is seen.

loading or cyclic strain on the trochanteric fragment.[2] The high healing rate and mechanical success rate, given the complexity seen in the current series, may be attributed to this benefit. When combined with locked screws, this multimodal fixation method provides stable fixation.[3] Unlike previous studies, the current cohort is made up of only the most complex cases. Ting et al. reported on their initial series of 29 cases using the Supercable isoelastic system without supplemental grip-plate fixation. They demonstrated a 6.9% failure rate but included relatively straightforward ETO procedures and intraoperative fixation of calcar cracks during primary THA in their series.[11] The compounded complexity of the current series resulted in slightly higher mechanical failure at 13%. The current authors would agree with the conclusions of Ting et al. that Supercable fixation provides adequate early fixation strength to allow for osteotomy or fracture healing. We observed an additional three patients who required removal of the grip-plate for pain and soft-tissue irritation, but all three cases had successful healing that did not require fixation when the plate was removed.

Menard et al. recently published their findings from a biomechanical in vitro study examining the initial loss of tension in various cerclage cable designs.[12] Specifically, they describe cable tension immediately after the cable is applied and the crimp/clamp device is deployed. The authors report significant tension loss with crimping all designs and that removing the tensioner resulted in even more loss of initial tension, a finding that was unexpected and ranged from 18–52% with multifilament cobalt-chromium (Co-Cr) cables and 46% with the non-metallic Supercable. Importantly, the authors concluded that a simple Co-Cr system outperformed more sophisticated locking devices, including the polymer Supercables, due to better ability to prevent tension loss.[12] However, the authors fail to recognize the superiority of isoelastic cables in the clinical in-vivo setting where Co-Cr cables cause resorption and loosen over time, can have significant and deleterious cable debris, and higher non-union rates compared with other fixation options.[13] In addition, the use of metallic cables has been associated with significantly increased polyethylene wear, osteolysis, acetabular loosening, and acetabular revision as compared to monofilament wires.[14] This difference is likely related to third-body metal debris not seen with monofilament wire or polymer Supercable fixation.

Lastly, Menard et al. report their findings in percentage of tension reduction after crimp/clamping and tensioner removal. However, the initial tension of the various devices is not the same. The cable reported to have the best performance and the polymer Supercable had final tensions that were only 8 lbs. different, and again maintenance of that tension over the healing time of an osteotomy is not reported with the metallic cables.

The five failures in this series (19%) could be classified into two groups. The first were 50 mm/short grip-plates, in which the failure rate was 27%, and appeared to be unable to provide adequate stability during healing. The authors believe that in cases of intraoperative trochanteric fracture during revTHA and trochanteric slide osteotomy, more fixation with locking screws and Supercables placed through the grip-plate, distal to the osteotomy or fracture, is needed for healing, and would recommend their use. The second failure mode was pre-revision trochanteric escape related to proximal femoral necrosis, in which the grip-plate system failed in both (100%) cases. In these cases alternative reconstructive techniques may be warranted.

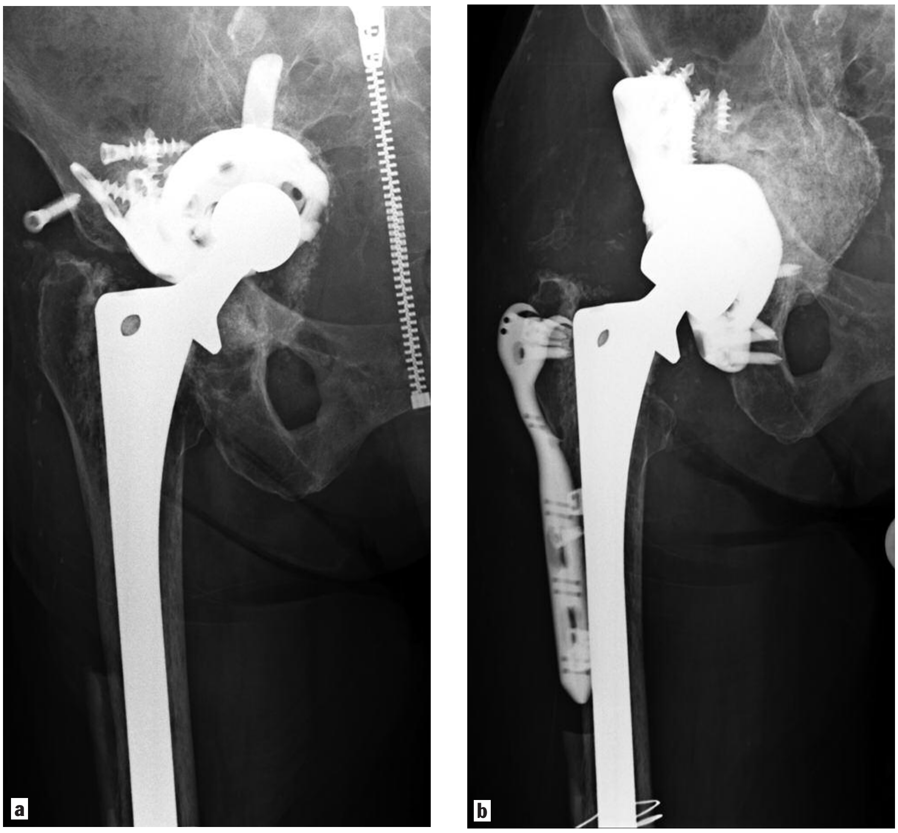

Figure 3. Trochanteric Slide Osteotomy for acetabular exposure. a. Preoperative radiograph of the right hip of an elderly female patient demonstrates complete migration of the acetabular component and femoral head through the acetabular wall, and loosening of acetabular screws and plate. b. A custom acetabular triflange component was designed and required trochanteric slide osteotomy for exposure and insertion. Given the patient's advanced age, osteoporosis, and multiple surgical history, a 2-hole (135 mm) grip-plate with locked screws and Supercables was used. At four years postoperative, stable trochanteric fixation and healing is present.

CONCLUSION

In conclusion, the cable-grip system and isoelastic Supercables provide reliable fixation for adequate healing of difficult ETO and trochanteric fractures with an 81% rate of mechanical success with radiographic and clinical healing observed. The ability of the construct to utilize multi-modal fixation with locked screws appears to aid in its success. STI

AUTHORS' DISCLOSURES

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