EDITOR'S CHOICE

Effects of Removal and Reinsertion of Headless Compression Screws

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Purpose This study investigates the loss of compression when 3 commonly used headless compression screws are backed out (reversed), and assesses the ability to re-establish compression with screws of greater diameter.

Methods Two investigators tested 3 screw designs (Acutrak 2, Synthes HCS, Medartis SpeedTip CCS) in 2 diameters and lengths. Each design had 10 test cycles in a polyurethane foam bone model with compression recorded using a washer load cell. A 28-mm screw of the narrower diameter was inserted until 2 mm recessed and then reversed 30°, 60°, 90°, 180°, 270°, 360°, and 720°. After this the screw was removed completely and a 24-mm screw of greater diameter inserted until recessed 2 mm with the compressive force again recorded.

Results All screws showed an immediate, statistically significant loss of compression at 30° of reversing. The Acutrak 2 Micro screw demonstrated not only the greatest mean compressive force, but also the fastest compressive loss. Insertion of the shorter screw of greater diameter was associated with re-establishment of compression to levels comparable with the original screw.

Conclusions This study reaffirms the importance of establishing the correct screw length before insertion due to the immediate loss of compression with reversal of these devices.

Clinical relevance If a headless compression screw penetrates the far joint surface, the screw should be completely removed and replaced with a shorter screw of greater diameter. *(J Hand Surg Am. 2017;■(■):■−■. Copyright © 2017 by the American Society for Surgery of the Hand. All rights reserved.)*

Key words Headless compression screw, loss of compression, reversal.

FRACTURE HEALING IS PROMOTED BY stability and compression at the fracture site.[1] Compression is directly related to screw purchase, which is a product of bone quality and screw design.[2] Herbert and Fisher[3] developed the headless compression screw in 1977 for use in fractures and nonunions of the scaphoid. The screw was designed to be a completely intramedullary implant with a second thread in place of the normal screw head. The threads on the leading and trailing ends were of differing pitches to directly apply compression between the 2 fragments. Their original paper described union rates of 100% in acute fractures and 83% in nonunions, results that have been repeated across multiple studies.[3−5] "Second generation" headless compression screws (SG-HCS) are now available that feature design modifications aimed at improving compressive force, ease of insertion, and product versatility.[6,7] Mechanical studies examining compressive force with SG-HCS have demonstrated results equal or superior to those achieved with the Herbert screw.[7−13] SG-HCS have become the gold

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FIGURE 1: The 3 headless compression screw designs studied (left to right): Acutrak 2 Mini and Micro, Medartis SpeedTip CCS 3.0 and 2.2, and Synthes HCS 3.0 and 2.4.

standard for scaphoid fixation,[6,9] and their use in fractures, osteotomies, and arthrodeses of small- to medium-sized bones and joints has been well documented.[13–17]

Intra-articular protrusion of screws can cause secondary joint injury, and may result in considerable morbidity and the requirement for revision surgery.[6,18–20] This is particularly likely to occur when headless compression screws are used for scaphoid fixation for several reasons. Percutaneous and limited visualization mini-open techniques that rely heavily on fluoroscopy have become common.[6,9,21–23] Obtaining orthogonal fluoroscopic views of the scaphoid is challenging and can lead to uncertainty over whether the measuring guidewire has penetrated the far cortex. Shortening of the scaphoid occurs as the screw closes, and then compresses, the fracture gap. When screw penetration of the far joint surface is detected intraoperatively, it is necessary to withdraw the prominent screw threads from within the joint. Significant loss of compression has been noted with complete removal and then replacement of the same headless compression screw.[24] However, no studies have been performed to assess the loss of compression caused by stepwise backing out of a headless compression screw, or to assess the effects of reinsertion of a shorter screw of greater diameter.

The purpose of this study was to establish at what point "backing out" of headless compression screws results in an important loss of compression; to compare the compression profile of 3 commonly used SG-HCS; and to determine if it is possible to re-establish a comparable degree of compression with insertion of a shorter screw of greater diameter.

MATERIALS AND METHODS

Screws

Three SG-HCS designs were tested using 2 screw sizes: Acutrak 2 Micro and Mini (Acumed, Hillsboro, OR); Synthes HCS 2.4 and 3.0 (DePuy Synthes, Zuchwil, Switzerland); and SpeedTip CCS 2.2 and 3.0 (Medartis, Basel, Switzerland) (Fig. 1, Table 1).

Compared with the original Herbert Bone Screw, all SG-HCS tested feature design modifications. The Acutrak 2 design has a gradually tightening variable pitch, is fully threaded, and is in the shape of a tapered truncated cone. The single-pitch design of the