Initial clinical experiences using a new image based guidance system for K-wire insertion in scaphoid bone fractures

Schöll H¹, Mentzel M¹, Gülke J¹, Gebhard F¹, Kraus M²

¹Department of Trauma, Hand and Reconstructive Surgery, Ulm University, Ulm, Germany
²Institute of Research in Rehabilitation Medicine, Ulm University, Ulm, Germany

hendrik_s@gmx.de

Purpose: The internal fixation of scaphoid bone fractures remains technically difficult due to the size of the bone and its three-dimensional shape.

It is the most commonly fractured carpal bone and accounts for approximately 60 % of all carpal fractures. Early rigid fixation has been shown to support good functional outcome. There are various methods for internal fixation of scaphoid bone fractures. One successful, common method is the screw fixation, which was described by Herbert in 1984. Several technical difficulties and complications were identified. In terms of stability of the fracture, biomechanical studies have shown a superior result with central screw placement in the scaphoid in comparison with an eccentric position, which can lead to delayed or non-union. Therefore, a central screw placement is recommended. Image-based navigation, originally developed to improve intraoperative visualization and guidance, as mainly used for dorsal spinal fusion procedures with pedicle screws, could be helpful for this cases.

However, the main limitation of reference-based navigation systems is their dependence on fixed markers. Modern navigation systems use 3D capable image intensifiers to acquire images for navigation right in the operating room. All objects of interest have to be equipped with rigid markers to allow live tracking using the system’s camera. Movements of the non-marked areas (or fracture fragments) are not registered by the system.

In the treatment of small bone fractures, such as the scaphoid bone, conventional navigation is therefore limited by this dependence on fixed reference arrays. We introduced a new technique based on reference markers in surgical instruments. If visible on a standard fluoroscopic image, static trajectories are overlaid in this image to guide implant insertions. Fixed markers are not required.

In former experimental studies 20 artificial hand specimens were randomized into two groups and blinded with polyurethane foam: 10 were treated conventionally and 10 were image guided. For trajectory guidance a reduction of duration of surgery, radiation exposure and perforation rate compared to the conventional technique could be found. Accuracy was not improved by the new technique.

The purpose of this study was to identify the possible advantages of the new guidance technique in a clinical setting.

Methods: In this prospective, non-randomized case series we tested the feasibility of the system into the accommodated surgical workflow. There were no control group. Three cases of scaphoid fractures were included. All of the patients were treated with a cannulated screw following K-wire placement via the percutaneous volar approach described. In addition, length measurements and screw sizes were determined using special features of the system (Fig.1). The performing surgeon and two attending assistant doctors (one assisting the surgical procedure, one handling the guidance system) had to rate the system following each procedure via a user questionnaire. They had to rate the system’s integration in the workflow and its contribution to the success of the surgical procedure in percentages (0 %: totally...
unsuccessful; 100 %: perfect integration and excellent contribution). All of the clinical procedures were performed by the same surgeon.

Results: The surgeons rated the system’s contribution and integration as very good (91 and 94 % of 100 %). No adverse event occurred. An average of 1.3 trials ± 0.6 (1; 2) was required to place the K-wire in the fractured scaphoid bone. The dose-area product was 19 cGycm² ± 3 (16; 22). The mean incision until suture time was 36.7 min ± 5.7 (30; 40).

For clinical cases, the system was integrated and rated as very helpful by users.

Conclusion: The system is simple and can be easily integrated into the surgical workflow. Therefore it should be evaluated further in prospective clinical series.