Image based guided treatment of metatarsal V-fractures

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Background: In orthopaedic surgery, as in many other surgical fields, there is a clear tendency towards the use of minimally invasive procedures. Computer assisted systems and advanced imaging devices are being developed in the hope of assisting the surgeon in achieving these procedures. These techniques are increasingly being implemented almost routinely for procedures such as spine and pelvis surgery. However, for fracture treatment and for applications involving small bones, such as hand and foot surgery, these systems are hardly ever used. Computer assisted imaging systems are rarely used for fracture treatment and foot surgery. We introduce a new system for image based guidance in traumatology.

Methods: We included 20 patients with a fracture of the fifth metatarsal. They were randomized on admission into two groups. Ten patients in the metatarsal group were operated conventionally and ten were operated with the assistance of a new image guidance system. This system is based on 2D-fluoro images which are acquired with a conventional c-arm and are transferred to the system workstation. After detecting marked tools, it can be used to display trajectories for K-wire guidance in the c-arm shot.

Results: The average duration of surgery (time from incision to suture) in the image-based group was 12.7 minutes ± 5.5 (min. 6, max. 23), in the conventional group it was 17 minutes ± 6.5 (min. 7, max. 28) (p=0.086). The average duration of radiation was 18 seconds ± 8.5 (min. 6, max 36) in the image-based group vs. 32.4 seconds ± 19.4 (min. 12, max. 66) in the conventional group (p=0.057). An average of 4.7 C-arm shots ± 2 (min 2, max 9) were necessary in the image-based group to position the K-wire. For the conventional group, 8.2 shots ± 2.3 (min 4, max 12) were used (p=0.0073). It took 1.6 trials ± 0.7 (min.1, max. 3) to position the K-wire for the image-based procedures, in the conventional group 2.7 trials ± 0.9 (min. 1, max 4) were necessary (p=0.0084). There were no malfunctions or adverse events in any of the image-based navigational cases. No screws needed to be replaced in the image-based group. In the conventional group, two screws were replaced intraoperatively because they were too short in the control c-arm shot, and the screw threads did not bridge the fracture gap completely, leading to insufficient compression.

Conclusion: In this pilot study with only a small sample size, the image-based guidance system could be integrated into the existing surgical workflow and was used for applications where existing navigation systems are not commonly used. The technology gives the surgeon additional information and can reduce the number of trials for perfect implant positioning. The reference-free design enables them to readily visualize various indications in foot surgery and other trauma related procedures, especially when K-wires can be used. The reduced number of trials increases the safety of the surgical procedure and spares intact
bone substance which is essential for the footing of implants in small bones and fragment fixation. Whether these factors contribute to a reduction in complications or revision rate must be confirmed in larger prospective studies.