

Development of a new pinless 2D-navigated technique for implant removal of screws in the SI-joint

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Introduction: For stabilization of the posterior pelvic ring implantation of sacroiliacal (SI) screws is a widely accepted method. In our clinic the surgery is performed minimally-invasive using 2D or 3D navigation. Since the screws tend to loosen after some months of full weight bearing, we favor an implant removal after consolidation of the fracture / instability. When applying the standard technique, the patient is placed on a carbon table and the orientation of the c-arm has to be changed from inlet to outlet view multiple times. It is not possible to see both views at the same time. Several X-rays have to be taken in order to find the cannulated screw. This leads to a high radiation dose and a long duration of the surgery. Navigation would reduce radiation and safe time, but the side effects of pin fixation (pain, infection) would not justify this approach for implant removal. We followed the hypothesis that a new pinless 2D- navigation method can reduce radiation and OR-time. First practical tests were performed.

Materials & Methods: A Digital Reference Base (DRB) was fixed in the center of an anatomically formed rectangular plate and pointing upwards between the proximal inner legs. The plate was introduced below the pelvis and fixed to the upper legs using two straps in order to achieve maximum stability. The tests were performed on a plastic pelvis with metal coating in which a cannulated SI-Screw has been placed prior to the tests. In order to get as realistic conditions as possible and block direct sight, the pelvis was wrapped in foam with artificial skin as the outer layer. For navigation a second generation Orbic Arcades 3D-image intensifier with integrated navigation was used in 2D mode [BrainLab / Siemens, Germany]. The C-arm was equipped with a 2D-calibration plate in order to get more precise images. Three X-rays of the SI-joint were taken (inlet, outlet and lateral) and sent to the 2D trauma navigation software. Then the c-arm was completely removed from the OR table. A pre calibrated drillguide (3.2 mm) was referenced and skin incision was done in line of the screw. The drillguide was advanced through the tissue while watching the virtual path on the navigation screen until it was exactly at the beginning of the cannulated screw. Then a K-wire was placed into the screw through the drill guide which was removed after secure placement. The screw was pulled out with a cannulated screwdriver. Before the next navigation the artificial skin was renewed. The above described experiment was repeated 50 times. As parameters the entire time for implant removal, time for navigation, time for acquiring X-rays as well as radiation (dose area product) and radiation time were documented. The parameters were statistically compared with the ones during a navigation free surgery.

Results: In all cases the new reference method provided enough precision for identification of the screw heads. The median total time for implant removal (start of the navigation process until complete removal of the screw) was 6.79 [Q_L 4.64; Q_U 6.47] min. It took a median of 2.83 [Q_L 2.21; Q_U 4.42] min. for acquiring the three referenced X-rays. Median radiation time was 2.00 [Q_L 1.25; Q_U 4.00] sec. Median dose area product (radiation) was 1.97 [Q_L 1.44; Q_U 3.48] cGycm². In contrast for the last 5 years median incision to closure time for conventional SI-screw removal in our clinic was 31.00 [Q_L 19.00; Q_U 46.00] min and median radiation time was 3.12 [Q_L 1.44; Q_U 4.80] seconds.

Conclusion: Common navigation with traumatic pin fixation would not be justifiable for implant removal. This pilot study shows that with the help of this new pinless referencing method total OR time and applied radiation can be considerably reduced without the known risks of pin fixation. A mayor aspect is the simultaneous display of the c-arm inlet and outlet view which results in fast

identification of the screw. Only one skin incision and one direct path through the surrounding soft tissue / muscle is needed which reduces local trauma and leads to a faster recovery of the patient.