



CT-guided sacroiliac percutaneous screw placement in unstable posterior pelvic ring injuries: Accuracy of screw position, injury reduction and complications in 71 patients with 136 screws

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ABSTRACT

Background: Sacroiliac-percutaneous-screw-placement (SPSP) for unstable-posterior-pelvic-ring-injuries (UPPRI) might be associated with severe neurovascular complications because of screw-mal-position. The aim of the present study was to analyse the effectivity of computer-tomography-guided (CTG)-SPSP including accuracy of screw-placement, quality of injury-reduction and documentation of perioperative-complications. Additionally, procedure-dependent radiation-dose and outcome should be analysed.

Methods: A consecutive cohort of 71 patients with UPPRI was operated by CTG-SPSP at a single trauma level 1 hospital. 136 sacroiliac screws were inserted to S1 and S2. Postoperatively, by the use of a computerised-radiologic-work-station all screws were visualised three-dimensionally. Their distances_{min} to the sacral-borders in anterior-posterior and cranio-caudal direction as well as to the neuroforamen S1/S2 were determined. After CTG-SPSP, injury-dislocation in anterior-posterior and cranio-caudal direction was quantified. Local and general complications were documented during the 30-day-period. In 55 patients (77.5%) a follow-up-investigation (29.1 ± 19.1 months) was performed. **Results:** 132 screws (97.1%) were placed completely intraosseous, 3 screws (2.2%) perforated up to 1.0 mm ($n_{(S1)} =$ one screw; $n_{(S2)} =$ two screws), and one screw (0.7%) extended 2.2 mm into the S2-neuroforamen without contact to neural structures. Postoperative dislocation_{anterior-posterior} was 1.3 ± 0.9 mm and dislocation_{cranio-caudal} 1.5 ± 0.9 mm. No procedure-associated-complication was observed. Operation time showed a significant “learning curve” during the six-year study period (initially: 88.6 ± 60.3 min; finally: 44.3 ± 24.6 min). Perioperative effective-radiation-dose for patients_{male} was 5.9 ± 3.1 mSv and for patients_{female} 8.7 ± 4.5 mSv. All injuries healed and 33 patients (46.5%) had metal removal after $11.0 (\pm 4.9)$ months. Only two (5.0%) out of 40 patients complained persistent UPPRI-related pain so they were not able to restart work.

Conclusions: The CTG-SPSP is a safe procedure for UPPRI-stabilisation especially in S1 but also in S2. Injury reduction was excellent and no procedure associated complications were observed.

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Background

UPPRI should be stabilised to avoid dislocation, chronic pain and consecutive immobilisation [1]. In the past, the open technique with direct visualisation of the injury and implant was applied [2]. Since this method was associated with a high risk of neurovascular complications the minimal-invasive, sacroiliac percutaneous screw placement (SPSP) was introduced by Matta

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and Saucedo [3]. Nevertheless, the control of screw placement and injury-reduction might be insufficient using conventional-biplanar-fluoroscopy (CBF), especially in case of intestinal gases, obese patients and sacral dysmorphisms [4,5]. Therefore operative techniques using 2D- and 3D-Computer-Assisted-Surgery (CAS) were developed, but also these techniques might be associated with neurovascular complications and the consecutive need for re-screw-placement [6,7].

The technique used in our Trauma Centre Level I utilises computed-tomography (CT) for intraoperative real-time visualisation of percutaneous screw-placement, first described in a basic technique 1987 by Ebraheim [8]. However, data regarding modern fluoroscopic CT-guided sacroiliac percutaneous screw placement (CTG-SPSP) are limited [8–14]. To our knowledge, a precise determination of screw placement in relation to the sacral bone including the neuroforamen is not available. Therefore the aim of this study was to analyse the accuracy of CTG-SPSP. Additionally, co-parameters like quality of injury reduction, risk of local/general complications, procedure-dependent dose of radiation, and longterm outcome were determined.

Materials and methods

Patients

A consecutive cohort of 71 UPPRI-patients at our Trauma Centre Level I was operated by CTG-SPSP. Their medical records including radiologic data were retrospectively analysed. The cohort included 29 male (40.8%) and 42 female (59.2%) patients with an average age of 51.4 ± 22.3 years (min. 16, max. 91).

Injuries

56 patients (78.9%) had a high energy trauma like motor-vehicle-accident (43.7%), fall from height (19.7%), sports (11.3%) and others (4.2%). 14 patients (19.7%) sustained a simple fall and one patient (1.4%) suffered from a pathological-sacral-fracture because of a renal-cell-carcinoma-metastasis. 48 patients (67.6%) had an isolated sacrum fracture, 14 patients (19.7%) a dislocation of sacro-iliac-joint and 9 patients (12.7%) had a mono- or bilateral injury of both structures. According to the classification of Tile and Pennal 39 patients (54.9%) suffered a type-B and 32 (45.1%) a type-C injury [15]. 40 sacral-fractures (70.2%) were located in the ala-region (Denis-type-I), 15 (26.3%) in the transforaminal-area (Denis-type-II) and 2 (3.5%) in the central-part (Denis-type-III) [16].

Preoperative UPPRI-dislocation

24 patients (33.8%) with severely dislocated pelvic injuries (≥ 20 mm) had to be operated in the primary phase of care to reduce pelvic bleeding and to achieve an UPPRI-reduction below the 20 mm-level suggested by Ebraheim [8]. They were fixed with symphysis plate or external pelvic fixator before CTG-SPSP.

Operation technique

The CTG-SPSP-procedure was performed in the department of radiology. The patient was positioned laterally on the CT-table with the injured side directed upwards. None of the patients received a specific peri-interventional reduction-manoevre since in case of (1) minor UPPRI-dislocation <20 mm: the lateral



Fig. 1. Figures show the four preoperative steps for CT-guided sacroiliac percutaneous screw placement (CTG-SPSP): (a) The patient is fixed on the uninjured side in a vacuum mattress on the CT-table under endotracheal anaesthesia. The preoperative CT-scan (Siemens Somatom[®] Sensation 16 or Somatom[®] Definition AS, Erlangen, Germany) was done to control the injury-reposition and to perform the 3D-screw planning. (b) The operating field is disinfected under standard aseptic conditions. (c) The adhesive part of the sterile vertical transparency coverage sheet is placed directly on top of the operating field. (d) The sterile coverage sheet is spread over the whole CT-table and the front of the CT-gantry. This allows the perioperative movement of the patient on the CT-table into and out of the CT-gantry in order to control the transiliosacral screw placement process perioperatively.

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