3D Navigation Reduces Radiation Exposure and Operative Time in Lumbopelvic Fixations

***Martin Hoffmann, MD**; Thomas Schildhauer, MD*
BG-University Hospital Bergmannsheil, Ruhr Universität Bochum, Bochum, GERMANY

Background/Purpose: Management of unstable sacral fractures has evolved from non-operative treatment to relatively rigid internal fixation. Multidirectional instability of the posterior pelvic ring and lumbopelvic junction may be stabilized by lumbopelvic fixation. This technique decreases the load to the sacrum and sacroiliac (SI) joint and transfers axial loads from the lumbar spine directly onto the ilium, which allows early full weight bearing and therefore reduces prolonged immobilization. One of the keystones for lumbopelvic fixation is the placement of the iliac screws. The iliac screws are directed from the posterior superior iliac spine (PSIS) to the anterior inferior iliac spine (AIIS). The optimal osseous corridor for iliac screw placement requires multiple posteroanterior and lateral views with additional obturator outlet and obturator inlet views. Obtaining the correct views results in increased operating room (OR) times, fluoroscopy times, and radiation exposure of the patients and OR personnel. The purpose of this study was to evaluate if a better intraoperative visualization of bony structures utilizing a 3-dimensional (3D) navigation system can reduce operative time, fluoroscopy time, and radiation exposure.

Methods: From one academic trauma center, 44 consecutive patients were retrospectively identified as having been treated with lumbopelvic fixation between July 2011 and June 2015 (4 years). Of these, 10 patients were excluded because of only a unilateral triangular fixation. 34 patients (61.8% female) met the inclusion criteria. Patients had an average age of 58.9 years (range, 18-87 years). Lumbopelvic implants (USS II, DePuySynthes) were inserted as described by Schildhauer. A passive optoelectronic navigation system (Brainlab) was utilized for navigated iliac screw placement. Surface registration of L4 was performed for the matching procedure. To compare groups, demographics were assessed, and operative time, fluoroscopic time, radiation, and screw malpositioning were delineated.

Results: During the study period, 24 patients underwent bilateral lumbopelvic fixation utilizing conventional fluoroscopic imaging alone and 10 patients underwent the procedure with 3D navigated iliac screw placement. No differences were found between the two groups regarding age (60.3 vs 55.6 years; $P = 0.553$), body mass index (BMI 25.65 vs 25.17 kg/m^2; $P = 0.808$), gender (62.5% vs 60% females; $P = 0.891$), or length of hospital stay (39 vs 26 days; $P = 0.089$). Comparing screw length and diameter, the median was 110 mm and 8 mm, respectively in both groups. Utilization of 3D navigation led to a fluoroscopy time reduction of more than 50% (3.47 vs 8.32 min; $P = 0.004$) resulting in a significantly reduced radiation (4980 vs 2665 $Gy*cm^2$; $P = 0.032$). Operative time was reduced in the navigation group (177 vs 234 min; $P = 0.028$) despite the necessity of additional surface referencing.

Conclusion: Fixation of sacral fractures continues to be challenging due to complex local anatomy. Especially in severe comminuted sacral fractures lumbopelvic fixation provides superior stability and allows immediate weight bearing. For iliac screws, identifying the correct entry point and angle of implantation in all planes requires detailed anatomic

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knowledge and multiple radiographic views. In the current study, 3D navigation helped to reduce operative time and fluoroscopy time resulting in a significant reduction of radiation exposure for the patient and OR personnel.