Background:
Conventional spine navigation relies on the use of invasive reference arrays, tracked by an external infrared camera. Inadvertent tracker movement may reduce accuracy. Skin trackers have a flat profile, require no additional incisions, and surround the outside of the surgical field, providing surgeons less obstruction while maintaining accuracy. Soft tissues are mobile; therefore, skin fiducials-based tracking has been reported to have registration errors up to 3 cm. Often navigation and imaging are separate solutions and a registration step is needed to connect the two. This can be a potential source of error. Purpose of the study: A prospective, multi-center clinical study was designed using non-invasive skin markers for motion tracking and video camera based optical navigation cameras integrated into the flat detector of a robotic C-arm, with intraoperative 2D/3D imaging capabilities. The aim of the study was to determine the accuracy of percutaneous pedicle screw fixation in the thoracic and lumbar spine when using such a novel system. In addition, other parameters like time to insert a screw in optimum position and staff and radiation dose were measured. Materials and
Methods:
Adult patients with traumatic, degenerative and neoplastic pathologies, needing percutaneous pedicle screw fixation were included. 211 pedicle screws (126 in lumbar, 69 in thoracic and 16 in sacral regions) were inserted in 39 patients between levels T2 and S1. A disposable Jamshidi needle with on shaft optical markers was guided to the desired location in the vertebral body using Augmented Reality. Screw position was rated on an intra-operatively obtained 3D verification scan by 3 independent reviewers, as per the Gertzbein grading. Operator dose was measured using personal dosimeters worn over the lead apron at the chest level, while the patient dose was recorded in mGy-cm2 and then converted into effective doses.
Results:
Overall, 98.1% screws had accurate placement (92.9% grade 0 (no breach), 5.2% grade 1 (<2 mm breach). There were 4 breaches (1.9% grade 2 (2-4 mm breach) and no grade 3 (>4 mm breach). Six screws (2.7%) were intraoperatively revised. Median time per screw was 6 minutes and 25 sec (± 3.3 min). The radiation dose received by the patient was 11.94 mSv and this included the dose required for planning and verification scans as well as for fluoroscopy during cage placements, decompressions, biopsies and cement augmentations. The staff radiation dose was on an average 40.3μSv. Conclusions: Skin marker tracking based augmented reality optical navigation allows for highly accurate pedicle screw placements in a percutaneous setting, without compromising on efficiency and radiation dose. This study could form the basis for future studies that do a head-to-head comparison of this technology with traditional infra-red camera-based systems that rely on bone anchored reference arrays.