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Initial Single Surgeon Evaluation Comparing A Prospective, Multicenter Initial Evaluation of the C-Arm Fluoroscopy with the Cirq Robotic Assistance Device for Instrumentation of the Thoracolumbar Spine

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INTRODUCTION

Spinal robotic surgery is being adopted in the United States with greater frequency even outside tertiary care academic centers at the community level. Coordination of robotic surgical navigation with intraoperative computerized tomography (iCT) has improved the positional accuracy of pedicle screw placement reduced operating room staff exposure to ionizing radiation and may reduce It can offers surgeons increased confidence of pedicle screw placement, resistance to physician musculoskeletal fatigue that could occur with multilevel constructs , and decreased radiation exposure 1. There are currently eight robotic systems approved in the United States by the FDA for spine surgery at the time this manuscript was written including: four iterations of Mazor (Mazor Robotics Inc, Caesarea, Israel), two of the ROSA (Zimmer Biomet, Warsaw, Indiana), ExcelsiusGPS (Globus Medical Inc, Audubon, Pennsylvania), and the Brainlab Cirq (Munich, Germany). The Cirq received FDA clearance in September 2019 however literature regarding its use still remains limited 2-4 in comparison with other available systems. We seek to highlight our experience with the Cirq during instrumentation of the thoracolumbar spine. To our knowledge, this is the first single-center study to compare the use of the CIRQ® Robotic Alignment to standard C-arm fluoroscopy-guided pedicle screw placement during instrumentation of the thoracolumbar spine.

RESULT

A total of 66 screws were placed during the study period. 40% were placed using the Cirq. Two thirds of the diagnoses were for trauma remaining for degenerative pathologies. Average age was 46 years old (24 to 74) in the C-Arm group and 63 years old (51 to 71) in the robotic group (p=0.13). There was no difference in actual procedural time (p=0.11), however total OR time was longer in the robotic group by 123 minutes (p=0.04). There were no misplaced pedicle screws in either group. There were no intraoperative complications such as spinal fluid leak in either group. There was a statistically significant increase in hospital readmissions with the Cirq cohort (p=0.04). Reasons for readmission included urinary retention, severe pain or wound drainage. There were no hospital readmissions or unexpected return to the operating room in the C-arm fluoroscopy cohort. There was one return to the operating room in the Cirq cohort which we discuss in the vignette below and contrast with a similar case in the C arm cohort.

ILLUSTRATIVE CASE

A 72-year-old male with history of ankylosing spondylitis who presented to the emergency department complaining of severe back pain after a ground level fall. On physical exam he moved all extremities, normal reflexes, and intact sensation to light touch throughout. He underwent CT that showed an acute three column fracture through T9 (Figure 1). MRI did not demonstrate any acute epidural hematoma. He underwent posterior instrumentation and posteriolateral arthrodesis from T6 to T12 utilizing the Brainlab Cirq (Figure 1). Post operatively he was mobilized and discharged four days. He returned on post-operative day seventeen with wound drainage. He underwent an MRI which demonstrated a complex fluid collection suspicious for suprafascial wound abscess. He underwent culture, washout, and placement of wound vacuum system. Instrumentation was left in place as the abscess was above the fascia and the recent arthrodesis had not fused yet. His culture returned positive for MRSA and the patient was placed on intravenous antibiotics for 6 weeks. At follow up at 12 weeks he had normalization of his white count and inflammatory markers. His wound had healed.

DISCUSSION

To date, there are very few studies reporting results of Cirq Robotic arm in spine instrumentation. One case report of a patient with type II odontoid fracture underwent a C1-C2 posterior percutaneous fixation using Cirq Robotic Assistance coupled to the AIRO intraoperative computed tomography (iCT)-scan and BrainLab navigation system had an uncomplicated postoperative course3. Four screws were placed, with all of them rated as acceptable (100%).

Another case series reported seven patients undergoing posterior percutaneous pedicle fixation using Cirq robotic assistance coupled to intraoperative computed tomography scan and Brainlab navigation system. 28 screws were placed within cervical and upper thoracic pedicles, 85.7% were rated as acceptable and 14.3% as poor, according to the Neo and Heary classification. The radiation dose received by the patient was 9.1 mSv.2 and postoperative results were excellent6. We offer a contrasting study demonstrating longer time under anesthesia with use of the Cirq, potentially contributing to poor postoperative outcome.

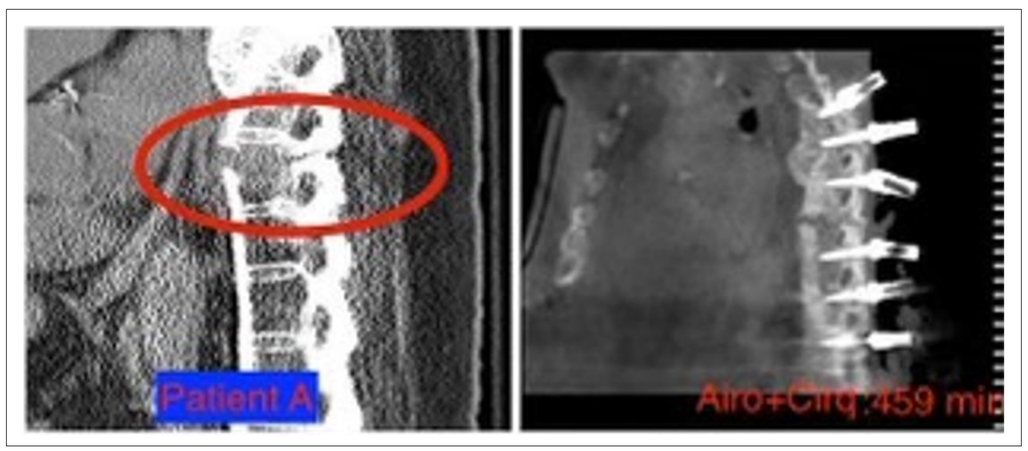

Figure 1:Sagittal noncontrast CT of the thoracic spine optimized for bone windows demonstrated a three-column fracture at T9 level in patient case. Right view shows a sagittal intraoperative CT of the thoracic spine demonstrating instrumentation above and below the chance fracture.

We also saw a corresponding increase in hospital readmission which was statistically significant. The reasons for readmission in our series included uncontrolled pain, post-operative urinary retention, and wound drainage. This finding appears to lend credibility to our hypothesis that increased readmissions resulted from effect of prolonged anesthesia time rather than directly from surgery. Patient A in the above vignette demonstrates surgical site infection (SSI), which remains a problematic complication in the modern era of advanced operative techniques and improved perioperative care. An institutional study by Deng et. Al with 2252 patients over 4-year span undergoing thoracolumbar spine surgery found that older age, ASA classification > II and longer operative times were associated with increased incidence of SSI, with the most common causative organisms being methicillin-sensitive Staphylococcus aureus and methicillin-resistant S. aureus. Other predictors of increased odds of SSI include Coronary artery disease, diabetes mellitis and male sex.

In contrast with that of the larger floor-mounted robotic platforms designed to maximize rigidity of the end effector of the robotic arm, the Cirq robotic assistance has a lighter design and a bedside mount. From a technical standpoint, the bed mounted feature limits the range achieved by the working arc of the Cirq. The arm must be mounted to an ideal position prior to incision where it can sufficiently reach the planned levels of surgery. As such if the device is placed too caudal it may not be able to reach the cranial most level without repositioning.

CONCLUSIONS

Thoracolumbar screws inserted using C-Arm fluoroscopy utilize less total operating room time with similar accuracy compared with the Cirq robotic assistance device. Further studies are warranted.

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