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Thoracic Spine Surgery: Minimally Invasive Pre-operative CT-guided Gold Fiducials for Easy Level Localization under Local Anesthesia

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Introduction

Thoracic spine surgery, while less common compared to cervical or lumbar interventions, poses distinct challenges due to the complex anatomy of the thoracic region. The spinal cord is less forgiving to errors, the vertebrae are smaller, and access to the thoracic region is more complicated due to the surrounding ribcage and vital organs. Accurate localization of the appropriate spinal level is crucial for successful outcomes in thoracic spine surgery, and mislocalization can lead to surgical complications, unnecessary trauma, or even neurological damage. Traditional methods of localization often rely on intraoperative fluoroscopy, which can be imprecise, time-consuming, and expose both the patient and surgical team to radiation. Recent advancements in image-guided surgery, specifically the use of CT-guided gold fiducial markers, have revolutionized the approach to thoracic spine surgery. These small, gold markers are placed percutaneously in the pre-operative setting under local anesthesia, providing a reliable and visible reference for accurate localization of the spinal level during surgery. The use of gold fiducials allows for a minimally invasive approach, reducing the risk of complications, shortening operative times, and improving overall surgical precision. This article explores the use of CT-guided gold fiducials in thoracic spine surgery, including the technical aspects of their placement, advantages, and potential challenges [1,2].

Description

The thoracic spine, consisting of 12 vertebrae (T1-T12), forms the midsection of the spinal column. Unlike the cervical and lumbar regions, the thoracic vertebrae are attached to the ribcage, providing structural stability but making surgical access more complex. The thoracic spinal cord is also more vulnerable to damage due to the narrower spinal canal in this region. As a result, precise localization of the affected vertebral level is critical for avoiding inadvertent damage to the spinal cord or adjacent structures. Thoracic spine surgery is often performed to address various conditions, including degenerative disc disease, herniated discs, spinal tumors, fractures, and scoliosis. The surgeon must accurately identify the correct vertebral level before proceeding with the surgical intervention. Traditional methods of localization rely on intraoperative imaging techniques, such as fluoroscopy, which are prone to inaccuracies, particularly in the thoracic region where the vertebrae appear similar and are less distinguishable. Gold fiducials are small, radiopaque markers that are typically cylindrical or spherical in shape and are made of biocompatible materials, such as pure gold or gold alloys. These markers can be implanted into soft tissues or bones under image guidance (CT or fluoroscopy), where they remain visible on radiographic images, serving as reliable reference points during surgical procedures. In thoracic spine surgery, gold fiducials are placed percutaneously in the pre-operative phase, often under local anesthesia, to ensure accurate spinal level localization during the subsequent surgical intervention [3-5].

Conclusion

CT-guided gold fiducial markers represent a significant advancement in thoracic spine surgery, offering a minimally invasive, precise, and reliable method for spinal level localization. By improving surgical accuracy, reducing radiation exposure, and enhancing overall efficiency, fiducials have the potential to improve patient outcomes and reduce the risk of complications in complex thoracic spine procedures. As the technology continues to evolve, gold fiducial markers may become a standard tool in the armamentarium of spine surgeons, particularly in cases where accurate localization is critical to the success of the surgery. CT-guided gold fiducials have been successfully used in various thoracic spine surgeries, including those involving spinal tumors, fractures, and degenerative conditions. In patients with spinal metastases, for example, fiducial markers can be used to delineate the boundaries of the tumor and guide the surgeon in removing the affected tissue while sparing healthy structures. In one case study, a 55-year-old female patient with a thoracic vertebral fracture due to osteoporosis underwent surgery for spinal stabilization. Pre-operative placement of gold fiducials allowed the surgical team to quickly and accurately identify the fractured vertebra, resulting in a shorter operative time and reduced post-operative pain. Another case involved a patient with a thoracic disc herniation compressing the spinal cord. Fiducial markers were placed at the target vertebra, facilitating a minimally invasive decompression surgery. The patient recovered quickly, with no complications, and reported significant improvement in symptoms.

Acknowledgement

None.

Conflict of Interest

None.

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