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Ultrasound-Guided High-Intensity Focused Ultrasound Could Improve Neuroablation of the Sacroiliac Joint in a Swine Model

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Introduction

The sacroiliac joint (SIJ) can be impacted in up to 22% of individuals with chronic low back pain, and up to 42% of patients who have underwent lumbar fusion surgery (1). Recent systematic reviews have shown that radiofrequency (RF) ablation is a justifiable treatment modality for SIJ pain (2). However, the treatment modality is invasive, can require up to 12 RF probes, and is time-consuming (2,3). High-intensity frequency ultrasound (HIFU) is a less invasive neuroablative procedure that could improve efficiency and decrease the resource-related barriers to patients receiving interventional care for this procedure. Magnetic resonance imaging-guided HIFU (MRgHIFU) has been utilized in the past in swine models and has been recently trialed in humans (3).Ultrasound-guided HIFU (USgHIFU) may be a more practical and efficient technique for treatment of SIJ-related pain.

Materials and Methods

This was a prospective new technology prototype safety and efficacy study in a swine sacroiliitis model, approved by the Memorial Sloan Kettering Institutional Animal Care & Use Committee (Protocol #21-12-009). Two pigs were intubated, placed under general anesthesia, and made prone. The dorsum back was shaved from mid-back to lower rump, and the skin was sterilized with chlorhexidine solution. Sonication was performed using a proprietary HIFU prototype mounted on a linear transducer probe connected to a portable ultrasound laptop. Study targets included bilateral sacral S1, S2, and S3 lateral branches visualized lateral to the foramina in the sagittal plane. After the case, the pig was monitored over 72 hours for gait abnormalities and signs of pain. This was followed by lumbosacral necropsy with gross specimen inspection, as well as specimen sectioning for pathology and histology.

Results/Case Report

Post anesthetic monitoring for 72 hours showed no signs of gait abnormalities or perceived pain in the swine models. 18 primary sonication targets (9 per side) were targeted between the super articulating process of the sacrum and S3 for each pig, totaling 36 overall primary target lesions. Additionally, there were 36 secondary targets (18 lumbar and 18 thoracic). For the lumbar targets, L1-L6 medial branches were lesioned, and inferior bilateral thoracic medial branches were targeted. Of the primary sacral spine targets, histologic specimen review suggested successful lesioning of 21/36 sites (58%) (Figure 1). Of the successful ablation zones, 11/21 (52%) included nerve lesions,

20/21(95%) included muscle lesions, 18/21 (86%) included periosteum lesions, and 20/21 (95%) included bony lesions. There were 10/36 (28%) targets that included an ablation site in the spinal canal. In total, 7/36 (19%) included injury to epidural adipose tissue only, and 3/36 (8.3%) included an ablation of nerve roots in the spinal canal.

Discussion

Traditional treatment modalities for SI joint point, such as RF, can be invasive, resource-consuming, and uncomfortable for patients. In this swine model, we show that a non-invasive and more efficient modality, such as USgHIFU, could potentially be utilized to target these sacral nerves—decreasing cost, time for procedures, resources, and patient discomfort. Future larger scale studies need to be conducted as operators became more experienced with the procedural components in order to ensure safety of the technology given the spinal canal ablation zones identified, and to assess for improved outcomes for those with refractory pain.

References

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Disclosures

No

Tables / Images