Perioperative Change in Bone Quality following Posterior Cervical Fusion and its Effects on Postoperative Outcomes

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INTRODUCTION:
Preoperative computed tomography (CT) vertebral Hounsfield Units (HUs), a validated assessment of regional bone mineral density, has been previously associated with adverse outcomes after cervical and lumbar fusion including pseudoarthrosis, screw loosening, subsidence, and overall revision rate. Due to limited availability of postoperative CT images, no existing studies have investigated the preoperative to postoperative change in vertebral HUs after spinal fusion. Within the fusion construct, it is possible that stress shielding and decreased axial loading forces decrease regional bone quality. Whereas, in the terminal instrumented levels and adjacent non-instrumented vertebrae altered junctional loading and increased segmental movement may precipitate reactive bony hypertrophy. The current study investigated the effect of long-segment posterior cervical fusion (PCF) on regional bone quality to determine if HUs (at an individual vertebral level) changed significantly in the postoperative versus preoperative setting and if postoperative vertebral HUs varied significantly relative to construct location. Secondarily, the effect of preoperative to postoperative change in HUs on radiographic outcomes and fusion status after PCF was assessed.
METHODS: All adult patients who underwent C2-T2 PCF for myelopathy or myeloradiculopathy at a multi-institutional academic center between 2013-2020 were retrospectively identified. According to standard institutional practice, postoperative CTs were obtained at six months one year postoperatively for fusion assessment. Patients with traumatic injury, infection, malignancy, a combined anterior / posterior surgical approach, or incomplete medical records or radiographic follow up were excluded. Preoperative and postoperative HUs were assessed on coronal CT images in the mid vertebral body of C2, C6, T2, and T3, outside of the region of hardware or hardware artifact in postoperative CTs. Preoperative and short- and long-term postoperative local and global cervical alignment and postoperative fusion status, distal junctional kyphosis, screw loosening, and revision rate were assessed. Paired univariate analysis compared within patient pre- to postoperative change in HU and variation in HUs by construct location. Pearson's correlation compared postoperative HU and pre- to postoperative change in HU with patient demographics, surgical factors, radiographic measures, and complications.
RESULTS:
A total of 79 patients met the inclusion/exclusion criteria. The average pre- to postoperative change in HUs in the C2, C6, and T2 vertebral bodies were -16.2, -47.1, and 7.8, respectively. The pre- to postoperative reduction in C6 HUs was found to be significant ($p=0.001$). In comparison of postoperative HUs based on fusion construct location, there were significant differences between C2 and T2 (317.8 vs. 247.5, $p<0.001$), C6 and T2 (305.9 vs. 247.5, $p<0.001$), and T2 and T3 (247.5 vs. 224.5, $p<0.001$). Postoperative HUs and pre- to postoperative change in HUs at all measured vertebral bodies was not significantly correlated with patient demographic or surgical factors (all $rho<0.3$). The pre- to postoperative change in HUs at T2 was found to be correlated with the postoperative distal junctional angle ($rho=0.31$). Otherwise, postoperative HUs and pre- to postoperative change in HUs were not correlated with pre- or postoperative radiographic alignment, fusion status, or screw loosening (all $rho<0.3$).
DISCUSSION AND CONCLUSION:
In the middle of the PCF construct, postoperative vertebral HUs were found to decrease significantly from preoperative HU values, likely underscoring the stress shielding effects of long-segment fixation. Furthermore, the positive correlation between PCF lower instrumented vertebrae changes in HUs and postoperative distal junctional angle may reflect vertebral ossification in response to increased angular loading.