Spatially tracked ultrasound has attracted research into its utility for providing intra-operative guidance for spinal interventions as an alternative to procedures using ionizing radiation. Recent methods produce spinal visualizations, often by registering either a model generated from pre-operative imaging or a statistically generated atlas, to one produced by intra-operative ultrasound. These visualizations aid practitioners in locating the target of their intervention, for example, facet joints for spinal injections. The need for pre-operative CT or MRI imaging compromises the portability and accessibility of such methods compared to ones which require only ultrasound. Furthermore, the variability of spinal anatomy, especially in diseased spines, makes the generation of suitable statistical atlases for registration a challenge. We propose a method for generating spinal visualizations using only ultrasound imaging. The method does not require a statistical atlas but scales and warps a generic spine model patient-wise and vertebra-wise to match the patient’s anatomy. Deep learning is used to predict vertebral scale from the locations of ultrasound-accessible transverse process skeletal landmarks. The scale is used with local geometry to determine the locations of anchor points, used to supplement the natural landmarks in the subsequent registration, warping the generic spine to the patient’s anatomy in a realistic manner. The quality of the registrations are assessed on the basis of their Hausdorff distances to ground-truth CT, and the registration error at landmarks of clinical interest as determined by an expert practitioner. These results are used to compare this method with existing visualization techniques.