Chest Wall Injury Summit 2023

Oral Presentation Abstract Submission

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Title of Presentation The True-Blue Technique: Enhanced Chondral Assessment of the Chest Wall

Background

Costal cartilage injuries have a prevalence as high as 42% in patients with blunt chest wall trauma. Current gold standard diagnostic modalities are still limited in their ability to identify and diagnose these injuries despite growing interest in this pathology. Computed tomography (CT) and magnetic resonance imaging (MRI) have been shown to be the most sensitive with potential benefits of dynamic ultrasound.

Although superior to standard radiographs, these modalities may still prove difficult to discern as the costal cartilage is oftentimes not captured appropriately. 3D reconstructions are made by a process called "segmentation" that utilizes Hounsfield units (HU) to identify chest wall structures based on their signal intensity. Cortical bone registers at greater than 1000 HU and trabecular bone ranges from 300-800 HU. Costal cartilage is relatively uniform in terms of density at 70-120 HU. Typical reconstructive techniques isolate the HU ranges corresponding to bone, excluding lower values resulting in the costal margin not being captured in final reconstructions. The purpose of this technique is to better identify costal cartilage injuries through manual segmentation and a custom density-based coloring process to optimize 3D CT scans.

Methods

3D chest wall reconstructions were assembled by trained orthopaedic research fellows using Vitrea Advance Visualization Platform software (Cannon Medical, Minnetonka, MN). High quality CTs are essential for this technique with ideal slice thickness of 2 mm or less. The musculoskeletal viewer in this application creates a raw 3D model of the scanned area with extraneous soft tissues included. A bone selector tool is utilized to automatically segment the bony portion of the chest wall. The costal

cartilage is then manually segmented and added to the model to ensure no loss of definition.
The model is colored on a scale from purple to red according to HU signal intensity using a custom coloring preset we call True-Blue. This preset tints the pixels in the 70-120 HU range corresponding to the costal cartilage as a range of blues. As HU intensity amplifies the color spectrum becomes warmer such that anything above 250 HU is red. As such bone and calcifications appear red. The True-Blue model is saved in Vitrea and can be saved in PACS for clinical use.

Results

Limitations do exist, as the process of manually segmenting and isolating cartilage can be time consuming, even with training. Although the concept of using radiodensities to isolate different structures is not exclusive to this software, it may take time to optimize a similar process in other software. For the future, we hope to utilize this technique to correlate certain anatomical morphology or defects with pathology and clinical findings.

Conclusion

Although CT and MRI have been reported in literature to be the most sensitive imaging modalities for diagnosis of costal cartilage injuries, there are still significant limitations. Through our novel technique of radiodensity based coloring, we can better isolate the costal cartilage, thus allowing pathology at the costal margin to be easily visualized. Therefore, diagnosticians can make more definitive diagnoses as well as provide improved images when showing patients or colleagues.