Safe-Zones for Surgical Intervention in the Lunate: a Micro-CT Study

NA van Alphen MD\(^1\), AT Laungani MD\(^1\), A Vercnocke PhD\(^2\), M Saint-Cyr MD\(^1\), N Lachman PhD\(^3\), EL Ritman PhD\(^2\), SL Moran MD\(^1\)

\(^1\)Department of Plastic Surgery, \(^2\)Department of Physiology & Biomedical Engineering, \(^3\)Department of Anatomy

Mayo Clinic, Rochester, MN

**Background**

The etiology of Kienböck's disease is extensively debated and for the majority remains unknown. Both traumatic and non-traumatic causes for avascular necrosis of the lunate are described in literature. The lunate is the second most frequently injured bone in the carpus and the only carpal bone generally undergoing total avascular necrosis. We have designed an anatomical study with use of microtomodensitometry for the assessment of intrasosseous vascularity and its potentially identify "safe-zones" for surgical interventions in the lunate.

**Aim**

The primary scope of the study is to assess the intrasosseous vascularity of the lunate with microtomodensitometry (micro-CT).

**Hypothesis**

Our hypothesis is for the high frequency of avascular necrosis of the lunate, traumatic and non-traumatic, is due to poor vascular architecture of the intrasosseous blood vessels.

**Methods**

Fourteen fresh cadaver wrists were obtained from the Department of Anatomy at Mayo Clinic, Rochester, MN. None of the extremities had any known previous trauma or disease. Both the ulna and radial artery were cannulated with a 20-gauge catheter (BD Key™, Becton, Dickinson and Co., Franklin Lakes, New Jersey). The arteries were flushed with heparinized saline and formalin, and then injected with a lead-based contrast agent (Microfil MV™, Flow Tech, Carver, MA, USA) under a physiologic pressure of 140 mmHg monitored by a pressure monitor (Protoc System, Inc., Beaverton, Oregon). After the polymer was set for 24 hours, the lunate bone was transected(Figure 1) and scanned.

Lunate specimens were scanned at 23-μm voxel resolution using a bench-top micro-CT scanner as described in more detail in this paper by Jorgensen et al. The microcomputed tomography scanner generates three-dimensional images consisting of up to a million cubic voxels, each 5-25 μm on a side. Tomographic reconstruction algorithms applied to these recorded images, are used to generate 3D images of the specimens. The intrasosseous vascularity was assessed and incorporated into a 3D rendering.

**Results**

Fourteen lunate specimens were scanned using micro-CT (Figure 2) and incorporated into a 3D rendering (Figure 3). In average age of the cadaver was 79.5 years. The specimens were almost evenly distributed between left (n=8) and right (n=6) wrists. Eleven specimens had consistent blood supply entering the bone from dorsal and volar. One specimen had no volar nutrient vessels; two specimens had no dorsal nutrient vessel.

The connecting pattern between volar and dorsal intrasosseous blood vessels could consistently be classified following the A, B, C and D-pattern as described by Gelberman et al. Average number and diameter of nutrient vessels entering the lunate was 2.7±1.3 (volar) and 1.3±0.7 (dorsal). Total average diameter of nutrient vessels entering the lunate was 1.14±0.2 μm (volar) and 0.90±0.1 (dorsal).

All scans were stacked, mirrored and resized to fill one average lunate sample scan (Figure 4). Two save zones for surgical intervention were identified. These zones include the two zones with the lowest density of nutrient vessels.

**Discussion & Conclusion**

The intrasosseous vascular system of the lunate has been extensively studied and described by others. We have used a novel technique to assess the blood supply with Microfil injection and analysis with micro-CT.

In a current unpublished study, safe-zones for surgical interventions in the lunate bone are identified, which will help minimizing iatrogenic avascular necrosis of the lunate bone by respecting the intrasosseous blood supply of the lunate bone, and changing our surgical approach accordingly.

**References**


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