Scaphoid Fracture and Proximal Pole Avascular Necrosis Volume: What are The Effects on Bone Healing?

Sophia Jacobi, Samara Moll, Emily B Davidovic Katz, Jonah X Dewing, Janos Barrera, Omri Ayalon, Steven Z Glickel, Jacques Henri Hacquebord

INTRODUCTION:
Avascular necrosis (AVN) of the scaphoid following a fracture is a well-documented phenomenon. While some scaphoid fractures complicated by AVN successfully heal, many fail to do so. The purpose of this study is to better understand factors influencing successful resolution of AVN secondary to scaphoid fracture. We hypothesize that the fracture location, the anatomical distribution of AVN, and the volume of necrotic bone are all associated with the likelihood of fracture healing and the resolution of AVN.

METHODS:
A retrospective review was conducted at a single institution, examining all patients diagnosed with proximal pole scaphoid AVN secondary to fracture on computed tomography (CT) imaging between January 2018 and November 2024. These patients were categorized into two groups based on radiographic outcomes: those with evidence of scaphoid healing and those without. Scaphoid CT scans at time of diagnosis for all patients were uploaded to Syngo Via, a software platform capable of calculating volumetric data from CT slices. Volumetric measurements of the entire scaphoid, the sclerosed proximal pole, and the proximal pole portion of the scaphoid fracture were collected. Univariate analysis was performed to assess the association between the AVN volume and scaphoid healing.

RESULTS:
A total of 32 scaphoids were included in this study. Six (18.8%) scaphoid fractures healed and 5 (15.6%) exhibited resolution of proximal pole AVN. The mean scaphoid volume was 2.37 ± 0.95 cm^3 and the mean volume of the scaphoid fracture segment involving the proximal pole was 0.62 ± 0.31 cm^3. AVN was defined as sclerotic bone within the scaphoid substance. The average necrotic area was 0.35 ± 0.23 cm^3. There were no statistically significant differences between scaphoids that healed and those that did not heal with respect to total scaphoid volume, proximal pole AVN volume, or the volume of the proximal scaphoid fracture segment. Furthermore, the percentage of AVN involvement within the scaphoid and the percentage of the scaphoid in the proximal fracture segment were not associated with differences in healing outcomes.

DISCUSSION AND CONCLUSION:
Areas of AVN in a scaphoid still have capacity for healing. Our study found no significant association between the volume of the scaphoid, the sclerotic portion, or proximal fracture segment and the resolution of AVN or fracture union. Similarly, the percentage of the scaphoid in the proximal fracture segment and the proportion of the scaphoid that is necrotic have no significant relationship with AVN resolution or fracture healing.

Table 1: Logistic Regression Evaluating the Impact of Scaphoid Volumes on Fracture Union and Avascular Necrosis Healing

	Odds Ratio	95% Confidence Interval	P-Value
Fracture Healing			
Scaphoid Volume	1.233	0.485 - 3.132	0.660
Proximal Pole Fracture Volume	5.215	0.210 - 129.565	0.314
Sclerosis Volume	8.526	0.160 - 453.546	0.291
Percent of Scaphoid Fractured	1.017	0.963 - 1.074	0.547
Percent of Scaphoid with Sclerosis	1.045	0.964 - 1.134	0.286
Percent of Fracture Segment with Sclerosis	1.004	0.979 - 1.030	0.734
AVN Healing			
Scaphoid Volume	1.243	0.458 - 3.376	0.669
Proximal Pole Fracture Volume	2.247	0.087 - 58.072	0.626
Sclerosis Volume	5.619	0.083 - 381.225	0.422
Percent of Scaphoid Fractured	1.007	0.948 - 1.070	0.823
Percent of Scaphoid with Sclerosis	1.041	0.955 - 1.134	0.329
Percent of Fracture Segment with Sclerosis	1.009	0.980 - 1.037	0.557

AVN: Avascular Necrosis