Rwanda Medical Journal RMJ

FIRST ANATOMY CONGRESS PROCEEDINGS: FULL PAPER Open Access

Scaphoid Arterial supply: A Review

Authors: O. Kubwimana[1,3,*]; J. P. Rugambwa[1,3]; I. Kwizera[1]; A. M. Buteera[2]; J. Gashegu[3]

Affiliations: *[1]Department of Surgery, University of Rwanda; [2]Department of Orthopedic Surgery, Rwanda Military Hospital; [3]Department of Human Anatomy, University of Rwanda*

ABSTRACT

Scaphoid, the boat-shaped carpal bone, is largely covered by articular cartilage. It has a much more complex arterial supply than previously reported, moreover, this arterial pattern has been hypothesized to lead to avascular necrosis after fractures
Scaphoid blood supply has long been documented as scarce; it arises from the radial artery giving palmar and dorsal branches. There is high-grade evidence reporting two main arteries entering from the distal half of the scaphoid and middle to lower-grade evidence reporting several arteries scattered over the entire scaphoid and anastomosis of the radial artery with intercarpal arteries. Dorsal arteries are slightly larger in diameter and many more than volar ones. The scaphoid shape is associated with variations in arterial supply patterns. Scaphoid surgery preserving vascular supply is the gold standard. Scaphoid blood supply is not as poor as previously documented, as current evidence supports even proximal pole vascularization. We recommend surgery to preserve the blood supply and foster research in this area.

Keywords: Arteries, Hand, Scaphoid, Avascular Necrosis

INTRODUCTION

The scaphoid is a carpal bone deriving its name from the Greek word “scaphos” meaning boat-shaped. It is part of the proximal row of carpal bones and the most important among other carpal bones. It has four anatomical regions, notably the proximal pole, the waist, the tubercle, and the distal pole [1]. The scaphoid has an inconsistent shape with a lot of variation across different literature [2,3]. The adult scaphoid has a surface of around 14 cm^2 [3].
Its arterial pattern poses challenges in cases of fractures, as it is supplied in a retrograde fashion; therefore a more proximal fracture leads to avascular necrosis of the fragment [1]. Nevertheless, the cause of scaphoid avascular necrosis needs further robust research, given a lot of controversy across currently available literature, which seems to be multifactorial in origin [4]. It remains the most commonly fractured carpal bone, accounting for 70% of all carpal fractures. Scaphoid fractures rank second when the upper extremity is considered as a whole [1]. 75-80 % of the scaphoid surface is covered by the articular cartilage. This hinders the union of fractures upon occurrence [1,2]. The scaphoid articular surface of the radius is separated from that of the trapezium and trapezoid with a dorsal ridge which is an important landmark for nutrient arteries entering

***Corresponding author:** Dr. Olivier KUBWIMANA, Email: oliviee3@gmail.com; **Potential Conflicts of Interest (CoI):** All authors: no potential conflicts of interest disclosed; **Funding:** This study was conducted as a part of the first anatomy annual congress in Rwanda, October 13-15, 2022 sponsored by the MoH, UR, UGHE, AUCA-ASOME, Operation Smile, CHUK and MMI; **Academic Integrity.** All authors confirm that they have made substantial academic contributions to this manuscript as defined by the ICMJE; **Originality:** All authors: this manuscript is original has not been published elsewhere; **Review:** This manuscript was peer-reviewed by two reviewers of the S-CAR committee

Received: 27th November 2022; **Accepted:** 18th February 2023.
 Publisher: Rwanda Biomedical Centre (RBC)/Rwanda Health Communication Center, P. O. Box 4586, Kigali. ISSN: 2079-097X (print); 2410-8626 (online)
Citation for this article: O. Kubwimana; J. P. Rugambwa; I. Kwizera et al. Scaphoid Arterial supply: A Review. Rwanda Medical Journal, Vol. 80, no. 1, p. 87-90, 2023. https://dx.doi.org/10.4314/rmj.v80i1.12

the bone [5]. It is biomechanically the cornerstone amongst other carpal bones and this explains the end-stage disease of arthritic changes [1].To the best of our knowledge, there is a paucity of data delineating the arterial pattern of scaphoid supply hence conducting this review.

SOURCE AND MICRO-PATTERN OF SCAPHOID BLOOD SUPPLY

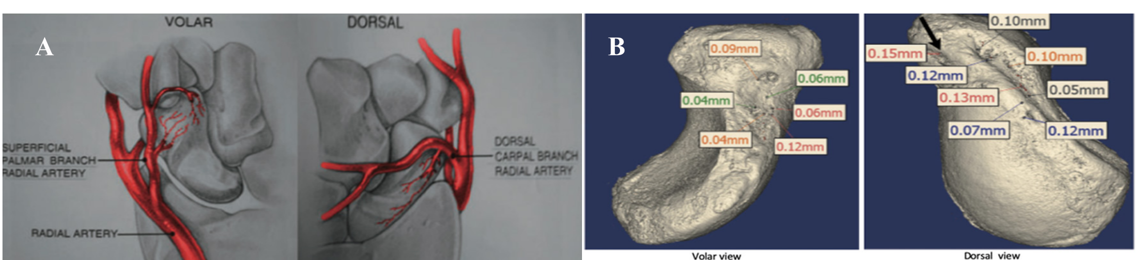
Scaphoid gets their arterial blood supply mainly from the radial artery, which can enter directly or may enter by the superficial palmar arch. There is some tenuous arterial supply through the scapholunate ligament [1]. The dorsal arterial branch arising from the radial artery enters the scaphoid through the dorsal ridge. Hence it supplies the waist and proximal pole of the scaphoid, and it is known to supply 80% of the entire scaphoid [5,6] (Figure 1A). Oehmke et al., with their microscopic analysis of scaphoid arterial supply, also found the scaphoid was mainly covered by articular cartilage. However, this cartilage was special in that it was well supplied by small vessels very close to the articular surface. This contradicts the theory of non-union induced by poor blood supply following scaphoid fractures [3].

The volar branch, which is also a branch of the radial artery, is known to enter via the distal pole and supply up to 20% of the scaphoid; moreover, there is not enough intra-scaphoid anastomosis between the two arteries [2,6]. The dorsal blood supply enters from the ridge; 70% arises directly from the radial artery, 23 % arises from the intercarpal artery, and 7% arises on both sides [5]. The ulnar artery has no contribution to the scaphoid blood supply. However, the anterior and posterior interosseous arteries anastomose with the radial artery before entering the bone in one-third of cases [5].

There is current controversy when arterial supply to the scaphoid is considered since some report more than three arteries entering the scaphoid on different sites [7]. Zirun et al., through their cadaveric-based study, identified that there is no single arterial trunk entrance in the proximal half of the scaphoid and typically no small arterial branch entrance in the proximal 40% of the scaphoid. This arterial pattern explains the cause of avascular necrosis in settings of scaphoid waist fractures [7]. Scaphoid blood supply is an area with a lot of variations and controversies; in this regard, Oehmke et al. reported this arterial supply to be richer than previously documented. They reported around eight medium and small vessels entering the scaphoid from dorsal to volar, and moreover, the proximal pole was found to be supplied as well, in contrast to the consistency of previous literature.

The Palmar carpal artery, superficial palmar artery, radial rami branches, 1st dorsal metacarpal artery on the palmar surface, and styloid, dorsal scaphoid, dorsal carpal, and radial rami arteries on the dorsal surface are all branches of the radial artery [3]. Xiao et al. in their study reported dorsal arteries entering the dorsal ridge to have a slightly larger number and diameter than volar arteries, where dorsal arteries were in the range of 0.05-0.13 mm while volar were in the range of 0.04-0.12 mm. This evidence strengthens furthermore the existing evidence of the main arterial supply entering the scaphoid dorsally in the dorsal ridge, as per Figure 1B [7].

The scaphoid shape has long been reported to be variable, but its relation with the pattern of blood supply was not known. It was reported by Morsy et al. in 2019 that this correlation does exist. They found mainly two types of scaphoid shapes: smaller and larger in waist diameter. The latter has enough intra-scaphoid anastomosis and a richer arterial



With permission from Ge Xiong in their study "Xiao Z, Xiong G, Zhang W. New findings about the intrascaphoid arterial system. J Hand Surg Eur Vol. 2018;43(10)"

Figure 1: The dorsal arterial branch arising from the radial artery (A) and Scaphoid bone (B)

supply than the former. Morsy et al. also found in a few specimens the anastomosis of proximal and distal arterial networks [8].

CLINICAL SIGNIFICANCE OF SCAPHOID BLOOD SUPPLY PATTERN

Scaphoid avascular necrosis is a real clinical challenge, and it has been previously reported to be secondary to trauma. A proximal fracture is the likely cause of avascular necrosis (AVN). Scaphoid avascular necrosis ranks second after the neck of femur fracture in occurrence [5]. Proximal pole fractures are associated with AVN in 100% of cases [5,6,9]. Scaphoid avascular osteonecrosis has also been reported to be caused by venous infarction, autoimmunity, or merely as idiopathic [6].

The scaphoid could be approached volarly or dorsally as indicated. However, the volar approach was documented by Gelberman et al. to violate the tenuous arterial supply of the proximal pole, thus causing a likelihood of avascular necrosis [5]. Intrascaphoid proximal pole arterial supply was identified as running in an eccentric pattern. Therefore in settings of scaphoid fractures inserting a headless screw in a central position may help to preserve the blood supply [7]. Upon consideration of bone grafting in settings of scaphoid fractures, a volar approach should be considered to preserve the dorsal ridge blood supply enhancing graft osteointegration [3]. Botte et al., in their cadaveric study, were interested in looking at the impact of Herbert screw fixation on the preservation of scaphoid vascularity; this may reflect settings of fracture fixation in live subjects. When comparing palmar, volar, and combined approaches, the volar approach was more efficient when the preservation of vascularity was taken into consideration. Nevertheless, both approaches could lead to optimal results when meticulous dissection is considered [10].

CONCLUSION

Scaphoid blood supply is very complex and an essential topic for practicing orthopedic, hand, and plastic surgeons. The arterial blood supply has long been documented as retrograde and susceptible to being cut by traumatic injury. Mainly the blood supply arises from the radial artery giving palmar and dorsal branches entering the scaphoid in the distal half. Moreover, there is inconsistent evidence of other sources, such as the tenuous arterial supply through the scapholunate ligament and eight small arteries entering the scaphoid volar and dorsally. Dorsal blood supply enters from the ridge and arises from the radial and intercarpal arteries. Moreover, dorsal arteries are many in number and slightly larger in diameter than volar arteries. The scaphoid shape is documented to affect the pattern of arterial supply. Intra-scaphoid anastomosis and ulnar artery supply are not supported by evidence. Current surgical practice attributes scaphoid avascular necrosis to the pattern of blood supply, and 100% of proximal pole fractures lead to avascular necrosis

We recommend the use of the volar approach in settings of Scaphoid surgery when grafting is indicated and to place the headless screw centrally, as well as to enhance research in this area.

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