

# The Cup of Diogenes: a fixed anatomical landmark for carpal tunnel surgery

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## Abstract

**Purpose** Carpal tunnel syndrome is a common entrapment neuropathy. When conservative management fails to relieve symptoms, carpal tunnel surgery is indicated. The surgical exposure for this procedure is commonly based on variable anatomic landmarks. The purpose of this study was to describe a fixed, easily referenced anatomical landmark for the distal extension of the transverse carpal ligament, the “Cup of Diogenes.”

**Materials and Methods** Topographical landmarks including Kaplan cardinal line, palmaris tendon, and distal palmer crease were marked on six fresh frozen cadaveric wrist and hand specimens. The apex of the Cup of Diogenes is determined to be the confluence of the thenar and hypothenar musculature of the palm. Wrists were dissected and the distance between these landmarks and the superficial palmar arch, median nerve, transverse carpal ligament, and ulnar nerve were measured.

**Results** In all specimens, the ulnar nerve was ulnar to this the apex of the Cup of Diogenes, while the median nerve was radial. The apex was proximal in all specimens to the superficial palmar arch. The apex marked the distal extent of the transverse carpal ligament in all specimens.

**Discussion** Based on our results, we feel the apex of the Cup of Diogenes is a consistent, fixed anatomical marker for the distal extent of the transverse carpal ligament, marking a safe zone in the palm for surgical planning of incisions.

**Level of Evidence** Level V - Therapeutic

**Keywords** Carpal tunnel · Carpal tunnel release · Kaplan cardinal line

## Introduction

Carpal tunnel syndrome (CTS) is the most common entrapment neuropathy, affecting roughly 3.8 % of the general population [3, 8, 15]. After a failure of conservative management for CTS, surgical release of the transverse carpal ligament is associated with 90 % of patients reporting improvement of their symptoms [13].

The surgical technique of carpal tunnel release (CTR), whether open or endoscopic, requires understanding of the topographical landmarks to minimize and potentially avoid complications. To this end, different topographical landmarks have been proposed, most notably, Kaplan cardinal line [2, 10, 19]. This line is described from the apex of the interdigital fold between the thumb and index finger toward the ulnar side of the hand; running parallel with the middle crease of the hand [10]. Kaplan cardinal line has been associated as a landmark for the motor branch of the median nerve, superficial and deep palmar arch, and distal extent of the transverse carpal ligament [5] and has been used as a topographical landmark since its introduction in 1953.

Although it is commonly used, the drawbacks with using the Kaplan cardinal line are that it is based on a moving reference point and is dependent on the position of the patient’s thumb metacarpal. Particularly in patients with first

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carpometacarpal joint arthritis, the line can be displaced, potentially putting neurovascular structures at risk [7]. The purpose of this paper was to describe an easily visualized and fixed anatomical landmark for the carpal tunnel surgery, the confluence of the thenar and hypothenar muscles, or the “Cup of Diogenes.”

## Methods

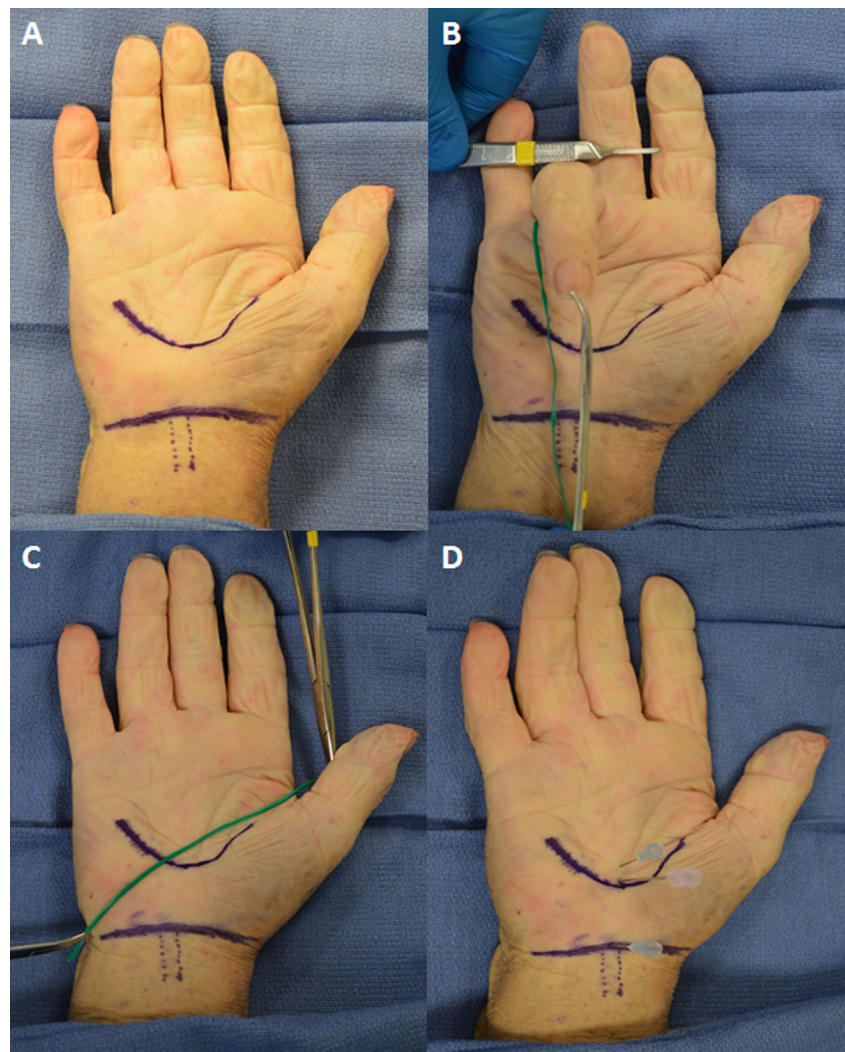
Following permission from our Biospecimen Review Committee, six fresh frozen cadaver hands with wrists were obtained and the Cup of Diogenes, palmaris tendon (when present), and distal palmar creases were marked using surface landmarks on the skin (Fig. 1). Kaplan cardinal line and the ulnar boarder of the ring finger were then traced with a wire. Hypodermic needles were then used to mark the location of the apex of the Cup of Diogenes, as well as the intersections of the ulnar boarder of the ring finger, the distal palmar crease, and

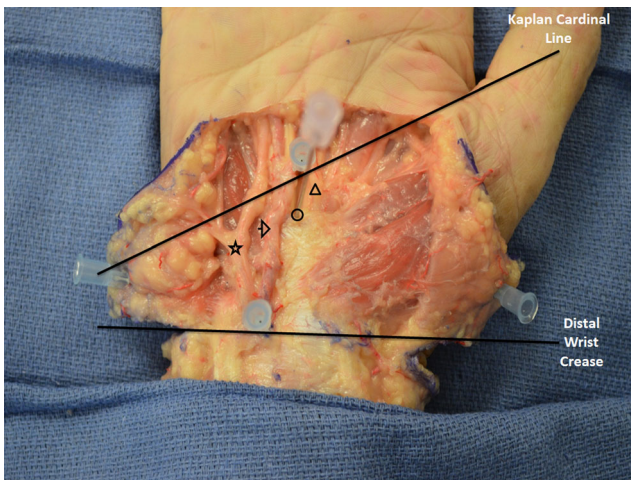
Kaplan cardinal line; common markers for incisional planning for an open carpal tunnel release [20]. A flexible tape measure and dial caliper (General Tools, New York City, New York) were used to measure the distance from the hypodermic needles and various anatomical structures, including the superficial palmar arch (ulnar and radial), distal and proximal transverse carpal ligament, ulnar nerve, and median nerve.

## Results

In all specimens, we were able to identify the superficial palmar arch, transverse carpal ligament, and the ulnar and median nerves (Fig. 2). The apex of the Cup of Diogenes has a mean of 5.3 mm (range 5–6 mm) and 6.8 mm (range 6.5–7) from the ulnar and radial contributions of the superficial palmar arch, respectively (Table 1). Likewise, a mean of 6.7 mm (range 6–8 mm) and 6.2 mm (range 5–7 mm) was identified from the ulnar and median nerves, respectively. The apex of the Cup of

**Fig. 1** Surgical markings of the Cup of Diogenes, distal palmar crease, and palmaris tendon (a). The ulnar boarder of the ring finger (b) and Kaplan cardinal line (c) were diagrammed and marked in relation to the apex of the Cup of Diogenes (d)





**Fig. 2** Anatomical dissection of the palm showing the location of the ulnar nerve (*star*), ulnar artery (*arrow*), and median nerve (*triangle*) in relation to the apex of the Cup of Diogenes (*circle*) as well as Kaplan cardinal line and the distal wrist crease

Diogenes was found to correlate with the distal extent of the transverse carpal ligament, with a mean distance of 1.9 mm (range 1–3) from the distal extent and 20.7 mm (range 18–22 mm) from the proximal extent. In relation to common surgical landmarks, the Cup of Diogenes has a mean of 3.5 mm (range 2–5 mm) from the intersection of Kaplan cardinal line and the ulnar board of the ring finger and a mean of 16 mm (range 11–20 mm) from the intersection of the ulnar board of the ring finger and distal wrist crease.

In all specimens, the ulnar nerve was ulnar to the Cup of Diogenes, while the median nerve was radial. The relationship to the superficial palmar arch was consistent in all specimens, located in a safe zone, just ulnar to the equidistance point between the ulnar and radial contribution of the superficial palmar arch.

## Discussion

Diogenes of Sinope is considered to be one of the founders of the philosophical movements of Cynicism [11]. When seeing a child drinking with his hands, he is famously quoted as throwing away his cup and proclaiming “A child has beaten me in the plainness of living” (Fig. 3) [11]. The “cup” created by this child is in part due to the thenar and hypothenar musculature of the palm, which have shown in this study to be a reliable landmark for the distal extent of the transverse carpal ligament.

The location of the superficial palmar arch is of critical importance during carpal tunnel release, either open or endoscopic. It has been reported that injury to the superficial palmar arch occurs in up to 1.5 % of endoscopic and 3.7 % of limited incision carpal tunnel releases, and is attributed to poor visualization and localization using surface landmarks [1, 4, 6,

**Table 1** Distance (mm) from the apex of the Cup of Diogenes to various anatomical landmarks

Specimens	Superficial arch (ulnar)	Superficial arch (radial)	Proximal transverse carpal ligament	Distal transverse carpal ligament	Ulnar nerve	Median nerve	Kaplan Cardinal line	Ulnar boarder ring finger
1	5.5	6.5	19	1	6.5	7	5	11
2	5	7	21	3	7	5	2	17
3	6	7	24	2.5	8	6	4	20
4	5	6.5	20	1.5	6	7	3.5	17.5
5	5	7	22	2	6	7	3	16
6	5.5	6.5	18	1.5	6.5	5	3.5	14.5
Mean	5.3	6.8	20.7	1.9	6.7	6.2	3.5	16



**Fig. 3** Oil painting by the French artist Nicolas Poussin (1647) depicting Diogenes of Sinope throwing away his cup after seeing a child use their hand as a cup to drink water

21]. Although previous studies have shown that the superficial palmar arch is consistently distal to Kaplan cardinal line, this is dependent on the position of the first metacarpal [7, 14]. First carpometacarpal pathology can change the orientation of the first metacarpal, thus placing the arch potentially in danger of iatrogenic injury [7, 14]. Due to the variability of the location of Kaplan cardinal line in relation to the superficial palmar arch, the authors have suggested the use of the distal wrist crease as a fixed landmark [14, 16]. Likewise, the results of our study show that the apex of the Cup of Diogenes is located proximal to Kaplan cardinal line, which is proposed to be the distal extent of a planned incision [17]. This more proximal location is important because it further reduces the risk of iatrogenic injury to the superficial palmar arch compared to Kaplan cardinal line.

Incision placement for carpal tunnel release is debated. Proponents of extensile approaches site the ability to see all structures within the carpal tunnel is of critical importance; however, it may increase the risk of postoperative pillar pain and scarring [6, 18]. Due to the increased rates of pain and early functional debility, limited incision and endoscopic methods for carpal tunnel release have been advocated [6, 9, 12, 18]. However, these minimally invasive incisions have been shown to have a higher risk of complications related to injury of the superficial palmar arch, ulnar nerve, and wound complications [6]. Anecdotally, the senior author of this study has used the apex of the Cup of Diogenes as the marker for the distal extent of his incision for over 17 years. Through a limited surgical incision, the anatomy of the carpal tunnel is easily visualized, allowing for complete release of the transverse carpal ligament and has no injury to the superficial palmar arch.

This study has several limitations which are similar to those of other cadaveric studies. First, since this is a cadaveric study, it is difficult to completely replicate in vivo conditions. This

study focused on the relationship of the apex of the Cup of Diogenes to the distal extent of the transverse carpal ligament as well as the ulnar and radial contribution of the superficial palmar arch. Likewise, there were only a small number of specimens; even with this limitation, we feel our samples reflect the broad array of patients encountered in a surgical practice.

Based on our results, we feel the apex of the Cup of Diogenes is a consistent, fixed anatomical marker for the distal extent of the transverse carpal ligament. This location also marks a safe zone in the palm for surgical planning of incisions, allowing adequate space for dissection free from potential neurovascular injury. The apex of the Cup of Diogenes can be used for any carpal tunnel release as an easily referenced anatomical landmark to the location of the distal transverse carpal ligament, and can act as a landmark for the distal extent for a planned surgical incision.

**Conflict of Interest** Matthew T. Houdek declares that he has no conflict of interest.

Eric R. Wagner declares that he has no conflict of interest.

Alexander Y. Shin declares that he has no conflict of interest.

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**Statement of Informed Consent** Informed consent was obtained from all individual participants included in the study.

**Statement of Human and Animal Rights** This article does not contain any studies with human or animal subjects. The use of cadaver specimens was approved by our institutions biospecimen review committee.

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