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The venous anatomy of the scaphoid

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INTRODUCTION

Fractures of the carpal scaphoid are common and the complications of delayed union and nonunion are well recognised. The uncertain potential for healing demonstrated by scaphoid fractures is thought to be related to a peculiarity of the vascular anatomy. Obletz & Halbstein (1938) studied the vascular foramina visible on dried specimens of the human scaphoid and proposed a widely accepted concept of a predominantly distally based blood supply entering through the dorsal ridge. However, this concept has not been entirely supported by the results of more recent studies carried out by investigators who used a vascular casting technique to demonstrate the arterial supply to the scaphoid (Taleisnik & Kelly, 1966; Gelberman & Menon, 1980). We consider that the vascular anatomy of the scaphoid and its possible relationship to fracture healing merit further investigation and in particular we are aware of no published accounts of the venous drainage of this bone. The aim of this study was to demonstrate the venous anatomy of the human carpal scaphoid.

MATERIALS AND METHODS

The study material was obtained from cadavers which were undergoing routine hospital postmortem examination. Those with tumours which may have metastasised to bone were excluded. In each case a 5 mm transverse incision was made over the radial artery approximately 8 cm proximal to the wrist joint. The incision was deepened to divide the radial artery and its associated veins. With the wrist hyperextended a steel trocar and cannula (outside diameter 1·5 mm) was then introduced percutaneously into the palmar aspect of the wrist and advanced dorsally and distally until it entered the proximal pole of the scaphoid and was felt to be solidly located within the bone. The trocar was removed and a small quantity of saline was introduced using a 20 ml syringe. If the saline flowed and there was no gross swelling of the wrist joint capsule, this was taken to indicate that the cannula was in an intraosseous location and the preparation continued. If this initial attempt at bone puncture failed and fluid entered the joint capsule, further attempts at cannulation were always unsuccessful as the fluid leaked freely through the area of damage caused by that first attempt at bone puncture. In each of the technically satisfactory preparations, saline injected into the proximal pole of the scaphoid flowed freely into the venae comitantes of the radial artery. In these cases the saline was then replaced with a mixture of Neoprene 572 (DuPont) and India ink, and approximately 20 ml of the solution was infused through the cannula.

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A circumferential skin incision was then made at the level of the initial exposure of the radial artery. The skin was reflected distally to the midpoint of the metacarpals and the area of tissue thus exposed was removed as a block. At this point a 15-gauge cannula was introduced into the cut proximal end of the radial artery and a mixture of Neoprene latex 572 and red ochre was infused. The block preparation was then placed in a deep-freeze (−10 °C) overnight in order to cure the Neoprene latex.

When the Neoprene had cured, the frozen tissue block was placed in a bath of undiluted household bleach. As the soft tissues were digested the exposed pattern of the cast vessels was recorded photographically with the preparation immersed in clean water. When this chemical digestion was complete, only the bones and vascular cast remained. The scaphoid was removed, then subsequently cleared using the modified Spalteholz technique (Panagis, Gelberman, Taleisnik & Baumgartner, 1983) to allow visualisation of the latex vascular cast within the bone. These cleared specimens were stored in oil of wintergreen and the intraosseous vascular pattern was recorded, both graphically and photographically. Photographs were taken using transmitted light between crossed polarising filters. All drawings were made using Micrografix Designer 2.0 on a Research Machines PC286.

RESULTS

Satisfactory casts were obtained in 10 specimens; in one of these it was clear that the point of bone puncture was the waist and not the proximal pole of the scaphoid and so 9 specimens were available for study.

Representative results are illustrated in Figure 1. Figure 1*a* shows the commonest appearance of the intraosseous cast seen in the cleared bone. At the proximal pole of the scaphoid can be seen the wide track of the entry point of the trocar. The cast also demonstrates a thick leash of vessels lying along the dorsal ridge laterally and distally. The extraosseous course of these vessels can be seen in Figure 1*b*, in which it can be seen that they drain via multiple channels directly into the venae comitantes of the radial artery. In this specimen and the majority of the others these were the only draining vessels that were filled.

Figures 1*c* and 1*d* show 2 atypical specimens; in these a variation in the extraosseous venous drainage was observed. Although their intraosseous vascular pattern was similar to that observed in the other specimens, instead of all the extraosseous vessels draining in a radial direction, vessels were observed leaving the ulnar end of the dorsal ridge of the bone to enter a small midline dorsal vein. This was in continuity with venae comitantes of the radial artery.

DISCUSSION

Demonstration of venous anatomy using a casting technique can be attempted by introducing the casting material retrogradely via a vein, anterogradely through an artery or anterogradely by interrupting the circulation at some midpoint. If the casting material is introduced retrogradely via a vein then its distribution may be influenced unpredictably by venous valves. Furthermore, the draining veins of structures other than the one under investigation may also be filled by this technique and so complicate the identification of the relevant veins.

Similarly, anterograde filling of the venous network via the arterial supply is also subject to this limitation and in addition there is the uncertainty about a viscous fluid

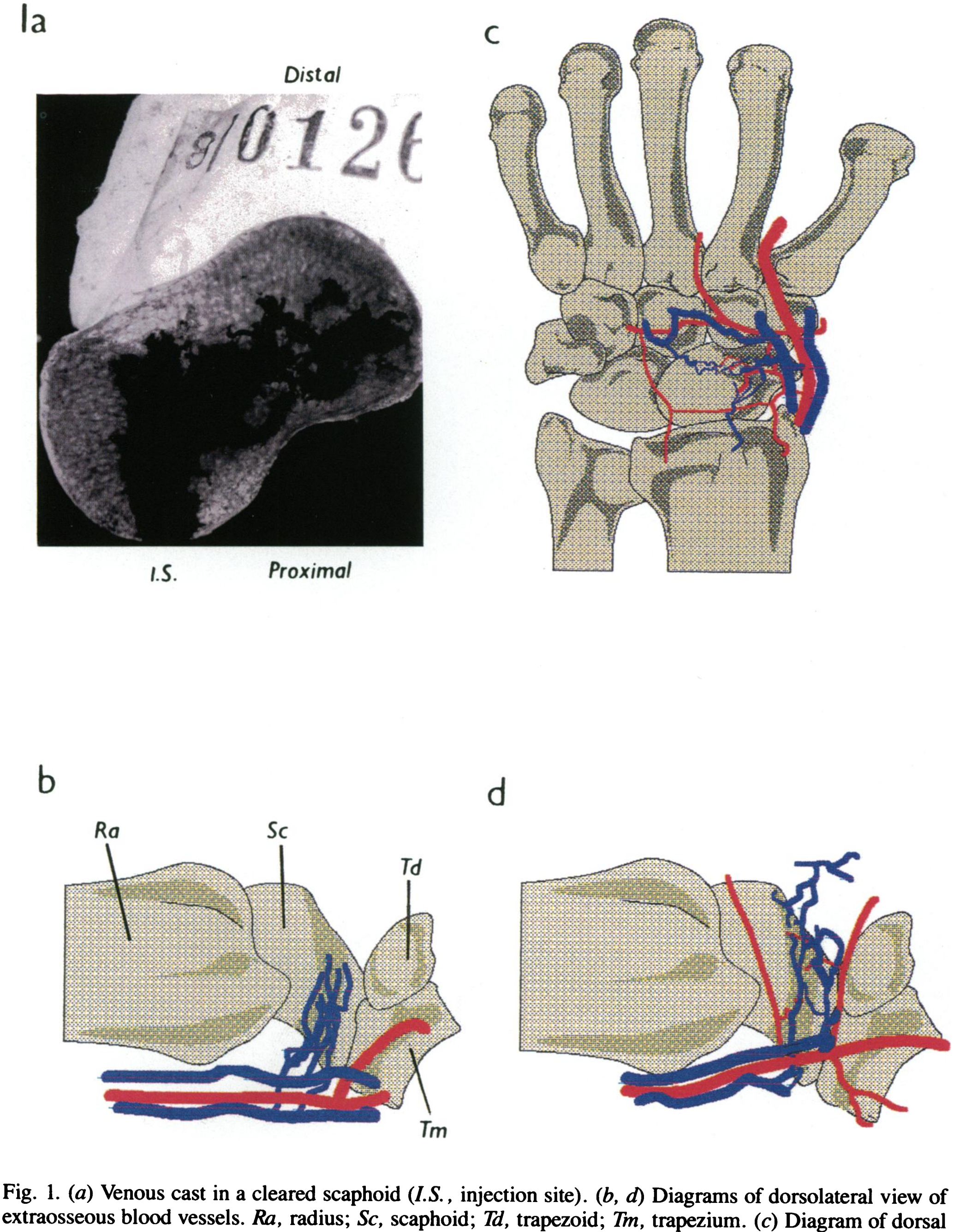

Fig. 1. (*a*) Venous cast in a cleared scaphoid (*I.S.*, injection site). (*b, d*) Diagrams of dorsolateral view of extraosseous blood vessels. *Ra*, radius; *Sc*, scaphoid; *Td*, trapezoid; *Tm*, trapezium. (*c*) Diagram of dorsal view of extraosseous vascular cast.

passing through a capillary bed. Even if a satisfactory cast is produced, one faces the difficulty of distinguishing between arteries and veins.

Direct puncture of a bone is known to provide ready access to the venous circulation (Harrison & Gossman, 1955): indeed this route has been used to administer intravenous infusions and whole blood in the past (Tocantis & O'Neill, 1941). In common with the other injection techniques, it is not possible to state with certainty that the veins demonstrated by this method would necessarily drain the bone under normal physiological conditions. Nevertheless, this method is well suited for studying a region of a bone of particular interest. In our studies of the scaphoid, therefore, we chose to introduce the casting material through the proximal pole of the bone.

The arteries were cast in this study primarily to demonstrate that they were indeed separate from the vessels filled by the bone puncture technique and that we were not unwittingly filling arteries retrogradely. The arterial cast also provided a helpful anatomical landmark as the chemical digestion process progressively removed all soft tissues.

The results of the investigation indicate that the venous drainage of the proximal pole of the scaphoid takes place through vessels that leave the bone through the dorsal ridge and then drain into the venae comitantes of the radial artery. We believe that the draining veins may be a factor in determining the outcome of fracture through the waist of the bone. We accept that the location and distribution of the vascular foramina visible along the dorsal ridge of a dried scaphoid would account for the occurrence and incidence of aseptic necrosis of the proximal pole of the scaphoid following fracture through the waist. However, we consider that the assumption made by Obletz & Halbstein (1938) that these foramina correspond to the points of entry of the arterial supply is questionable. Brooks (1971) pointed out that vascular foramina visible on specimens of dried bone are in life usually occupied by veins, occasionally accompanied by an artery.

Our series consistently demonstrated the presence of a leash of vessels confined to the dorsal ridge of the scaphoid. These did not correspond to the division into a dorsal and laterovolar arterial supply of the proximal pole suggested by Taleisnik & Kelly (1966) but rather more with the exclusively dorsal supply of the proximal pole described by Gelberman & Menon (1980).

Whether the venous and arterial anatomy in any individual subject is parallel has not been determined. A fracture through the waist of the scaphoid may leave the proximal fragment without venous drainage. It therefore remains possible that the correlation of the visible vascular foramina with avascular necrosis described by Obletz & Halbstain (1938) is due to the occurrence of a venous infarct.

SUMMARY

The intraosseous injection of coloured latex allows the venous drainage of a particular area of a bone to be studied. The extraosseous anatomy is visualised by chemical digestion of the soft tissues, the intraosseous anatomy by clearing the bone using the Spalteholz technique. When applied to the proximal pole of the scaphoid, this showed the venous drainage to be via the dorsal ridge into the venae comitantes of the radial artery.

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