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Longitudinal computed tomography of the scaphoid: a new technique

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Abstract. Computed tomography is increasingly utilized for the evaluation of scaphoid fracture, nonunion, and deformity. We have developed a new technique of positioning patients while performing longitudinal computed tomography of the scaphoid. With the wrist positioned in radial deviation and neutral flexion, greater patient comfort is provided and immobilization of the wrist is not required. A reproducible image can be obtained with attention to the alignment of the scanning plane to the longitudinal axis of the scaphoid on the scout image, and verified with the "target sign". High resolution images, which clearly demonstrate the abnormalities of the scaphoid, can be produced even if the patient has a cast on the wrist or if there is hardware in situ.

Key words: Carpal bones – Fracture – fracture healing – Fracture, ununited – Image processing, computer-assisted – Diagnostic imaging, imaging techniques

Imaging of the scaphoid is well known to be difficult with plain radiography [1–3]. Computed tomography (CT) is increasingly utilized as the definitive investigation [2, 4–8]. Imaging along the longitudinal axis is most suited for the evaluation of scaphoid fractures and healing [4–6, 8]. Various techniques for CT imaging along the longitudinal scaphoid axis have been described [1, 5, 7], most of which require the wrist to be positioned in ulnar deviation, or which require the use of an immobilization device. Many patients with scaphoid fractures find this position uncomfortable and move during scanning despite attempts at immobilization. We describe a new method by which the longitudinal axis of the scaphoid can be obtained reproducibly with increased patient comfort. We have used this technique successfully to image the scaphoid in over 100 patients.

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Method

A General Electric 9800 CT scanner (Milwaukee, Wisconsin) is used. The patient lies prone on the CT table with the affected arm above his or her head with the wrist in radial deviation and neutral flexion (Fig. 1A). The scanning plane is orientated along the thumb metacarpal (Fig. 1B), as this approximates the longitudinal axis of the scaphoid when the wrist is in radial deviation. A posteroanterior scout image is obtained and the wrist repositioned as necessary to ensure that the scanning plane corresponds to the scaphoid longitudinal axis (Fig. 1C). Images are then acquired at 120 kVp and 200 mAs as contiguos 1.5-mm slices. Wrist immobilization devices are not required.

Image reproducibility is aided by attention to the orientation of the capitoscaphoid joint. The head of the capitate is seen to indent the scaphoid on the scout image. When equal portions of the proximal and distal poles of the scaphoid are visualized on either side of the capitate, the scanning plane is in the same plane as the longitudinal axis of the scaphoid. On the CT image the head of the capitate is seen as a disc in the centre of the proximal and distal portions of the scaphoid. This "target sign" (Fig. 2) provides objective criteria for the radiologist and surgeon by which the CT image can be assessed for reproducibility.

Discussion

Plain radiography, while forming the mainstay of scaphoid imaging, is less than optimal for the evaluation of scaphoid fracture, union and deformity [1–3]. Plain tomography improves imaging but is time-consuming and does not provide the resolution of CT. CT is being increasingly utilized to image the scaphoid and is the modality of choice for the evaluation of scaphoid fracture, nonunion, deformity and cysts (Fig. 3). Because quality images can be obtained through a plaster of Paris cast (Fig. 4), there is no need to remove the cast prior to scanning. Also, fracture union can be confirmed with hardware in situ (Fig. 5).

Various techniques have been described for CT imaging of the scaphoid [2, 4–8], most of which require the patient to maintain the wrist in ulnar deviation or which necessitate the use of immobilization devices [1, 2, 5]. Positioning the wrist in ulnar deviation has three major

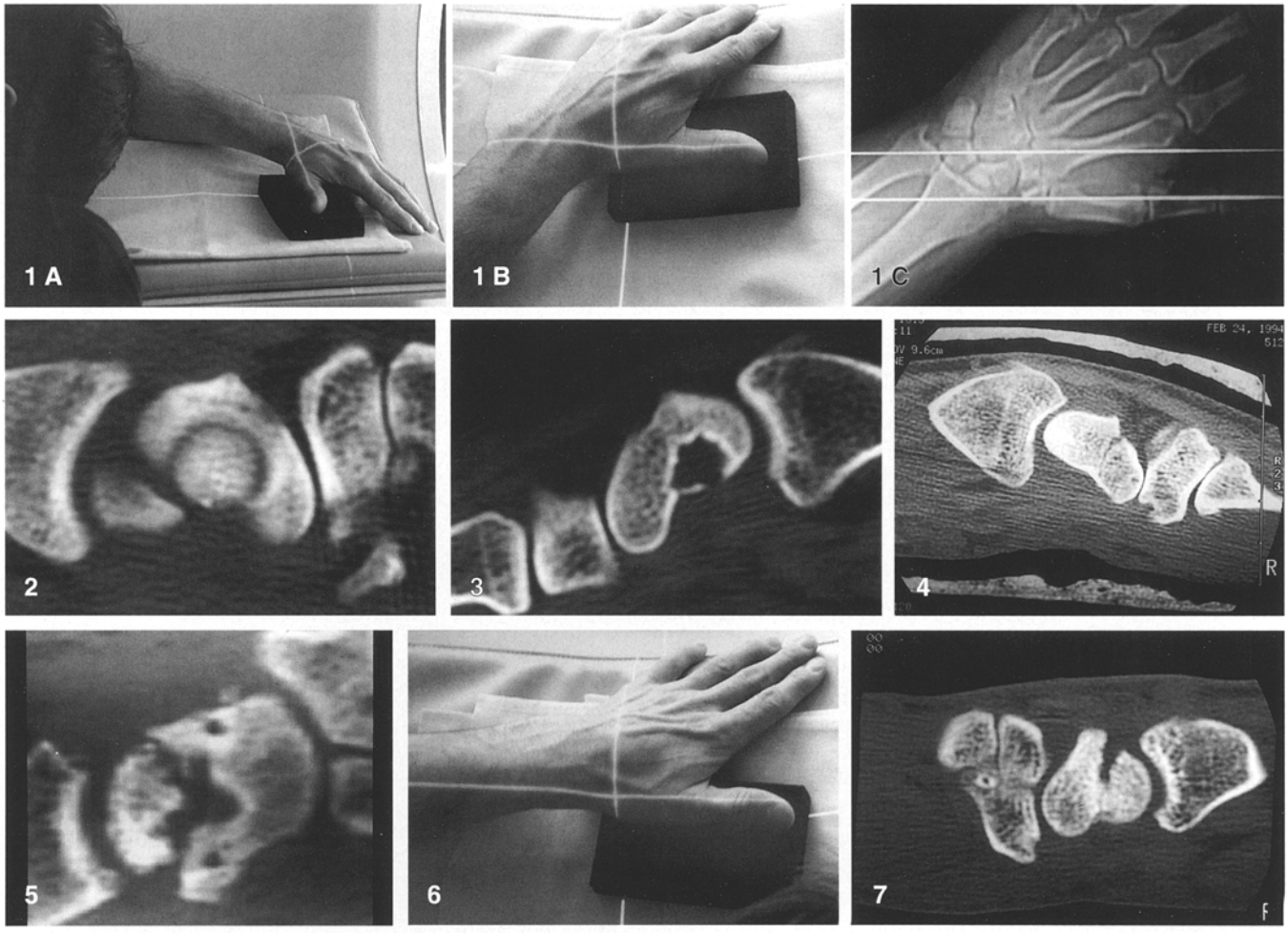

Fig. 1. **A** Patient lies prone in the CT scanner with hand above head. **B** With the wrist held in radial deviation and neutral flexion, the scanning plane is aligned along the first metacarpal, which approximates the longitudinal axis of the scaphoid. **C** The posteroanterior scout image shows the scanning plane along the longitudinal axis of the scaphoid, with the scaphoid indented by the head of the capitate

Fig. 2. The "target sign" is the head of the capitate between the proximal and distal poles of the scaphoid. It is objective evidence that the scan is along the longitudinal axis of the scaphoid, and that a reproducible image is obtained

Fig. 3 CT scan of a cyst within the scaphoid with a cortical fracture

Fig. 4. CT scan of a scaphoid fracture. Note that the wrist is within a plaster of Paris cast

Fig. 5. CT scan of a scaphoid nonunion with a Herbert screw in situ

Fig. 6 With the wrist in ulnar deviation the patient will often have discomfort and the scaphoid image will be distorted by the radius. The scaphoid humpback deformity will also be underestimated

Fig. 7. CT scan of a scaphoid fracture with a humpback deformity

disadvantages. First, patients with scaphoid fractures have discomfort with ulnar deviation and are unable to maintain this position despite attempts at immobilization (Fig. 6). Secondly, with ulnar deviation of the wrist, the longitudinal axis of the scaphoid approximates the longitudinal axis of the radius, which produces deterioration of the scaphoid image due to scattered radiation from the radius. Thirdly, in a displaced fracture of the scaphoid, the distal pole will flex to produce a humpback deformity. Ulnar deviation of the wrist extends the scaphoid and underestimates the humpback deformity. In contrast, radial deviation of the wrist is more comfortable for the patient and this position can therefore be maintained without immobilization. In addition, radial deviation rotates the axis of the scaphoid so that it is oblique to the radius, resulting in less scatter to distort the image. Finally, radial deviation flexes the fractured scaphoid so that the humpback deformity can be truly appreciated (Fig. 7).

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