

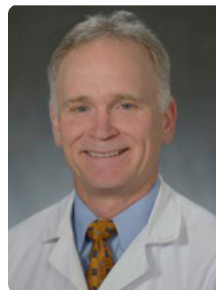
Clinical utility of digital tomosynthesis in the diagnosis and management of radius and scaphoid fractures

VolumeRAD™ case study

Introduction

The University of Pennsylvania Perelman School of Medicine conducted a single center prospective trial of patients who presented with suspected or confirmed wrist fracture and in whom conventional X-rays were insufficient to diagnose or manage their injury. These are all cases where additional imaging – either CT or MRI – would typically be required.

Of the 400 patients screened over the 20-month study period, 70 met the inclusion criteria and were enrolled. Mean age of the participants was 46 years with approximately 60% being female.



Cases submitted by:
David J Bozentka, MD,
Professor, Chief of Hand Surgery
David R Steinberg, MD,
Professor, Director of Hand
Fellowship

Department of Orthopaedic
Surgery, University of
Pennsylvania, Perelman School
of Medicine, Philadelphia, PA

With their consent, each study participant also underwent digital tomosynthesis imaging of the wrist, which was then evaluated and compared to the findings of either the CT or MRI exam. The CT or MRI exam was considered the diagnostic truth based on the radiologist's interpretation.

Case 1: Occult wrist fracture

History — A 58-year-old, right-hand dominant male presented with left wrist pain after a motor vehicle accident. Both X-ray and CT were performed in the emergency department. Patient was seen in our office four days later with persistent tenderness, pain and swelling in both his distal radius and snuffbox. The initial X-ray was read as no acute fracture (Figure 1A). The CT demonstrated a non-displaced fracture through the radial styloid and an irregular appearance of the distal scaphoid (Figure 1B). The latter was not addressed in the initial radiologist's report. Patient was referred for a follow-up digital tomosynthesis exam.

VolumeRAD imaging — VolumeRAD digital tomosynthesis clearly delineated the non-displaced fracture of the radial styloid. The lateral tomosynthesis images also depicted a non-displaced fracture through the scaphoid, which correlates with the clinical exam of tenderness in both of these areas (Figure 1C).

Case 1:



Figure 1A. X-rays of wrist, day of injury.



Figure 1B. CT scans of wrist, day of injury.



Figure 1C. Digital tomosynthesis of wrist, 4 days post-injury.

Case 2: Rule-out scaphoid fracture

History — A 57-year-old right-hand dominant female fell on her wrist, experiencing mild swelling and tenderness in the volar-radial of the wrist. An X-ray was ordered to evaluate whether the patient suffered a scaphoid fracture and determine the source of the radius pain. The X-rays showed lucency in the mid-scaphoid and a small area just off the scaphoid wrist was concerning (arrow, Figure 2A). Patient was referred for both MRI and digital tomosynthesis and treated with a splint to immobilize the wrist.

VolumeRAD imaging — The digital tomosynthesis showed no evidence of a fracture eight days post-injury. In clinical practice, this information could have negated the need for an MRI. However, since this patient was enrolled in the study, an MRI was obtained 21 days post-injury demonstrating no edema and no evidence of a fracture, confirming the results of the digital tomosynthesis exam.

Case 2:

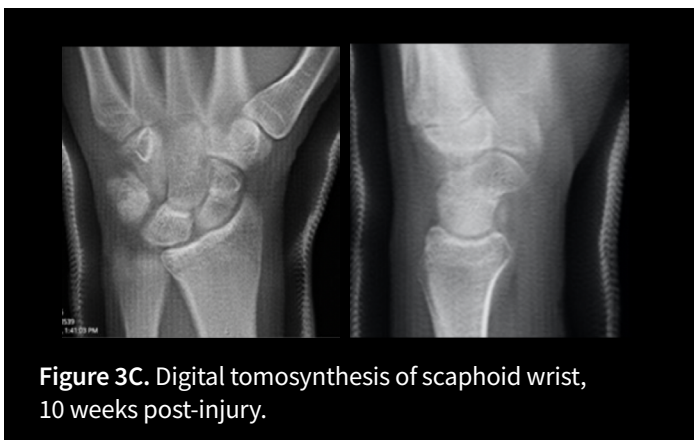


Case 3: Scaphoid fracture healing

History — A 21-year-old right-hand dominant male sustained a scaphoid fracture, confirmed by X-ray, and underwent 2.5 months of closed immobilization for a non-displaced fracture. Upon removal of the cast, patient had minimal tenderness on the clinical exam. In the initial X-rays one week after injury, there was cortical irregularity over the volar aspect consistent with this type of injury. Follow-up X-rays indicated increased sclerosis across the scaphoid wrist on both views, making it difficult to assess the degree of healing. In cases of uncertainty regarding the degree of healing, a CT study is typically ordered. The patient was enrolled in our study and a digital tomosynthesis exam was also ordered.

VolumeRAD imaging — Digital tomosynthesis demonstrated a trabecular bridging across the fracture site, providing the clinical confidence that the scaphoid fracture was healing. One week later the CT exam confirmed the VolumeRad imaging – the increase sclerosis at the fracture site with the trabecular bridging was consistent with healing. Patient was transitioned to a splint with a standard motion protocol. This case demonstrates the value of office-based tomosynthesis imaging versus waiting for a CT exam to be scheduled and read.

Case 3:



Case 4: Fracture management

History — A 40-year-old, right-hand-dominant active female fell on her outstretched hand, suffering a distal radius fracture as shown on her initial X-rays (Figure 4A). A key concern in intraarticular injuries is whether displacement occurred, requiring surgery, and determining which surgical approach is best. In this case, the AP X-ray view indicates the intraarticular fracture extends through the scaphoid facet with a depressed appearance. However, on the lateral X-ray view, it is difficult to determine if there is significant depression or the degree of dorsal angulation, which are key factors in deciding surgical management. In this case, an initial CT was also ordered for patient management decision-making. Patient was enrolled in the study.

VolumeRAD imaging — The CT and digital tomosynthesis study were both obtained two days post-injury. The CT shows depression of the articular surface and the sagittal view depicts the dorsal aspect of the lunate facet impacted underneath the dorsal cortical rim. The digital tomosynthesis provided very similar information as the coronal CT: the AP view showed the depression of the scaphoid facet and the sagittal view of the lateral showed how depressed the dorsal articular surface was, appearing beneath the dorsal rim of the cortex. In these types of fractures, it is difficult to use the volar surgical approach and reduce the degree of depression with adequate fixation. In this case, the digital tomosynthesis helped confirm a dorsal fixation was the correct surgical approach. Further, digital tomosynthesis can also be used postoperatively to assess the articular alignment and evaluate the fracture, including healing. Again, this case demonstrates the immediacy of office-based digital tomosynthesis, enabling quicker treatment for the patient.

Case 4:



Case 5: Occult scaphoid fracture

History — A 21-year-old, left-hand-dominant female injured her wrist after falling on an outstretched hand while snowboarding. She had tenderness in both the snuffbox and scaphoid tubercle one-week post injury. Initial radiographs did not demonstrate a fracture. However, snuffbox tenderness is typically a clinical concern. Patient was leaving for college the next day, so a CT or MRI could not be obtained and a digital tomosynthesis was ordered.

VolumeRAD imaging — In the digital tomosynthesis, it is apparent there is a crack in the cortex on the AP view and a subtle line and crack in the dorsal on the lateral view. Based on this data, patient was diagnosed with a non-displaced scaphoid fracture resulting in placing her left wrist/hand into a short arm thumb spica cast. She was further managed at her college with immobilization for five to six weeks with a transition to a splint. This is a case where the availability of office-based digital tomosynthesis provided the information needed for proper patient management.

Case 5:

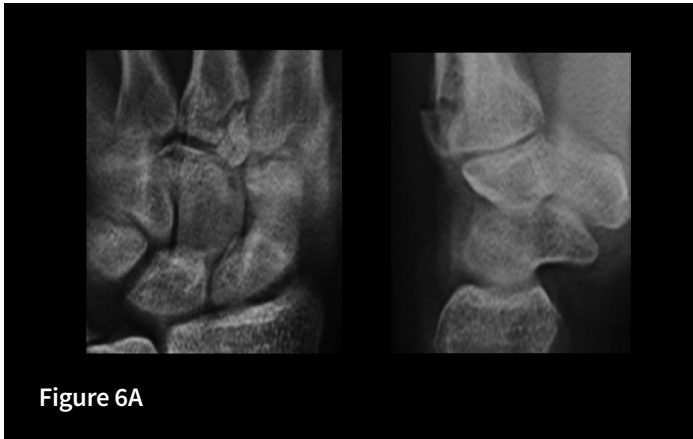


Case 6: Wrist injury

History — A 30-year-old, right-hand-dominant male presented with right dorsal wrist pain one week after a fall. Patient had tenderness directly over the base of the metacarpals. Initial X-rays indicated some abnormality on the lateral view on the dorsal aspect of the metacarpal base at the carpometacarpal (CMC) joint and it was unclear from the X-rays if there was a fracture or a subluxation. On the X-ray AP view, there was an ulnar styloid fracture yet at the base of the third metacarpal there did not appear to be much of a change. On the X-ray lateral view, a dorsal fragment is visible with extent unknown. Patient was sent back for a digital tomosynthesis exam.

VolumeRAD imaging — The digital tomosynthesis confirmed the fracture was just at the base and the radial aspect of the metacarpal. On both the tomosynthesis AP and lateral views at the base of the long finger metacarpal, it was apparent a small quadrant of the bone was fractured and evolved. Most likely, this fragment attached to the extensor carpi radialis brevis. This diagnosis was made in the office rather quickly without having to wait to schedule a CT exam.

Case 6:



Conclusion

These cases demonstrate the clinical value and useful addition of digital tomosynthesis in an orthopedic or musculoskeletal practice for patient management. It is convenient with same-day imaging, which helps the patient avoid the cost and time of multiple imaging appointments, is a lower radiation dose than CT and more cost-effective for both the patient and the healthcare system. Digital tomosynthesis is a useful adjunct to standard X-ray for diagnosing and managing bony injuries around the wrist and the hand.

In some cases, such as assessing healing or alignment, or to assess the articular surface, it may be appropriate to order a digital tomogram rather than conventional X-ray.

VolumeRAD™ digital tomosynthesis

VolumeRAD™ digital tomosynthesis brings 3D imaging to radiography, helping clinicians resolve inconclusive X-rays quickly and cost-effectively with minimal added radiation. The technology helps improve the patient experience by providing additional information that could help make decisions faster. VolumeRAD™ provides multiple images of the anatomy in a single sweep at a low dose, capturing up to 60 ultra-low dose exposures. Similar to CT exams, the acquired data is then reconstructed into a set of tomographic images that can be reviewed sequentially on the console or any standard PACS workstation.

