

## Advancing Pediatric Distal Forearm Fracture Diagnosis: Analyzing Ultrasound Secondary Indicators

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### DESCRIPTION

There is increasing interest in the use of Point-of-Care Ultrasound (POCUS) for diagnosing pediatric distal forearm fractures, a common reason for Emergency Department (ED) visits in children. Emergency clinicians are becoming more adopt with POCUS, which is now a key component of emergency medicine training [1]. As ultrasound devices become more affordable, portable and accessible, they offer significant advantages, particularly in settings with limited or no access to traditional radiographic imaging. Recent studies have demonstrated that ultrasound is not only accurate but also quick and well-tolerated in diagnosing distal forearm fractures in children and adolescents. Patients diagnosed *via* POCUS tend to have similar or better recovery outcomes compared to those diagnosed with radiographs [2]. The use of POCUS for these injuries is necessary in ensuring that important fractures, such as incomplete, complete or physical fractures, are not missed, as these may present a risk for instability or growth disturbances.

Previous study has primarily focused on using standard ultrasound views of the radius and ulna to identify direct signs of fractures, such as cortical breaks or deformities, which remain the gold standard for diagnosis [3]. However, ultrasound has a distinct advantage over radiographs in its ability to visualize soft tissue changes, which may reveal secondary signs of a fracture. These secondary indicators can complement primary findings and potentially improve the diagnostic capability of ultrasound. Several secondary signs of distal forearm fractures, such as periosteal hematoma or fracture angulation, have been reported, but their diagnostic value remains underexplored. On completing secondary sign, the Pronator Quadratus Hematoma (PQH), may help distinguish between cortical fractures and buckle fractures. Another potential indicator is the "Fracture-to-Physics Distance" (FPD) rule, which could assist in differentiating Salter-Harris type II fractures from other types.

### Study overview and research environment

This was a prospective diagnostic study embedded within a larger parallel-group randomized controlled trial [4]. The parent study

took place across four emergency departments in South East Queensland, Australia, where children and adolescents with distal forearm injuries were randomly assigned to receive either ultrasound or X-ray as their initial imaging modality [5]. Ethical approval for the study was obtained from the children's Health Queensland Human Research Ethics Committee (HREC).

### Participant recruitment and eligibility criteria

Participants were recruited between September 2020 and November 2021. To be eligible, children aged 5 to 15 years had to present to the emergency department with an isolated, acute distal forearm injury, showing no clinical deformity and requiring imaging to investigate a potential fracture. Enrollment was conducted on a consecutive basis, with trained clinicians screening patients for eligibility during their shifts [6]. Only those who were assigned to undergo initial ultrasound imaging in the parent trial were included in the current diagnostic study.

### Data acquisition and ultrasound procedure

Each participant was scanned by a trained practitioner, following a predefined protocol that included the evaluation of secondary signs of fractures. The ultrasound results and diagnoses were recorded in the final image. If a cortical breach fracture or secondary signs were detected, participants received X-rays for confirmation and were referred for follow-up in an orthopedic clinic. Those diagnosed with either a "buckle" fracture or no fracture were treated and discharged without the need for further X-ray imaging.

The POCUS scans were performed by nurse practitioners, physiotherapists or emergency physicians, all of whom had completed a training program consisting of a 2h course (including lectures, phantom models and proctored scans), a logbook documenting 20 scans and assessments (including a quiz on image interpretation and a summative observed scan) overseen by a pediatric emergency physician with specialized expertise in distal forearm ultrasound. A modified 6-view approach was used, capturing images of the distal radius and ulna from the dorsal, lateral and volar perspectives [7,8].

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## Expert panel consensus diagnosis

At the conclusion of the study, a panel of experts reviewed all participant data to establish a final diagnosis, which served as the reference standard for each injury. The expert panel was composed of a pediatric radiologist, a pediatric orthopedic surgeon and a pediatric emergency medicine physician. These panel members were independent of the study's clinical and imaging processes. Each participant's injury was classified by the panel as either "no fracture," "buckle fracture," or "other fracture," based on the most clinically significant injury [9,10]. The "other fracture" category included any fractures with a cortical breach or fractures at other sites, such as the scaphoid.

## CONCLUSION

Ultrasound secondary signs demonstrated strong diagnostic value for pediatric distal forearm fractures. Specifically, a negative PQH sign or a ProQuest Dissertations and Theses database (PQDT) measurement under 1.8 mm were reliable indicators for ruling out cortical breach fractures. In contrast, the observation of "visible angulation" or "periosteal hematoma" was strongly associated with fractures involving a cortical breach. A cortical breach within 1 cm of the growth plate strongly indicated a Salter-Harris type II fracture, supporting the "POCUS 1 cm rule." Furthermore, any displacement of the physics was a key indicator of a displaced Salter-Harris type II fracture.

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