Skull radiography for Pediatric Skull Fracture Diagnosis

Skull fractures can be identified on plain radiograph, Computerized Tomography. (CT), ultrasound, and magnetic resonance imaging (MRI).

Radiologic imaging is crucial in the diagnosis of skull fracture, but there is some doubt as to whether different imaging modalities can accurately identify fractures present on a human skull. While studies have been performed to evaluate the efficacy of radiologic imaging at other anatomical locations, there have been no systematic studies comparing various CT techniques, including high-resolution imaging with and without 3D reconstructions to conventional radiologic imaging in children, Mulroy et al. investigated which imaging modalities: high-resolution CT scan with 3D projections, clinical-resolution CT scans or X-rays, best showed fracture occurrence in a pediatric human cadaver skull by having an expert pediatric radiologist examine radiologic images from fractured skulls. The skulls used were taken from pediatric cadavers ranging in age from 5 months to 16 years. We evaluated the sensitivity and specificity for the imaging modalities using dissection findings as to the gold standard. They found that high-resolution CT scans with 3D projections and conventional CT provided the most accurate fracture diagnosis (single-fracture sensitivity of 71%) followed by X-rays (single-fracture sensitivity of 63%). Linear fractures outside the region of the sutures were more identifiable than diastatic fractures, though the incidence of false positives was greater for linear fractures. In the two cases where multiple fractures were present on the same anatomical skull location, the radiologist was less likely to identify the presence of additional fractures than a single fracture. Overall, the high-resolution and clinical-resolution CT scans had similar accuracy for detecting skull fractures while the use of the X-ray was both less accurate and had a lower specificity [1].

In a few cases, a well, asymptomatic child with a localized head injury that is suspicious for a fracture may be a candidate for a skull x-ray instead of CT. The risks associated with a CT scan in a child also should be considered. The younger the child, the greater the risk of malignancy later in life as a result of exposure to ionizing radiation. There also are associated risks with the sedation or anesthesia that may be required to perform a CT on a child [2] [3].

2D+3D CT in combination showed increased sensitivity in the diagnosis of linear skull fractures in all children and increased specificity in children less than 2 years of age. In children less than 2 years of age, added confidence in the interpretation of fractures by distinguishing them from sutures may have a significant implication in the setting of nonaccidental trauma. Furthermore, 3D CT is available at no added cost, scan time, or radiation exposure, providing trainees and clinicians with limited experience an additional valuable tool for routine imaging of pediatric head trauma [4].

A retrospective multi-center study consisted of a development dataset acquired from two hospitals (n = 149 and 264) and an external test set (n = 95) from a third hospital. Datasets included children with head trauma who underwent both skull radiography and cranial computed tomography (CT). The development dataset was split into training, tuning, and internal test sets in a ratio of 7:1:2. The reference standard for skull fracture was cranial CT. Two radiology residents, a pediatric radiologist, and two emergency physicians participated in a two-session observer study on an external test set with and without AI assistance. We obtained the area under the receiver operating characteristic curve (AUROC), sensitivity, and specificity along with their 95% confidence intervals (CIs).

The AI model showed an AUROC of 0.922 (95% CI, 0.842-0.969) in the internal test set and 0.870 (95% CI, 0.785-0.930) in the external test set. The model had a sensitivity of 81.1% (95% CI, 64.8%-92.0%) and specificity of 91.3% (95% CI, 79.2%-97.6%) for the internal test set and 78.9% (95% CI, 54.4%-93.9%) and 88.2% (95% CI, 78.7%-94.4%), respectively, for the external test set. With the model's assistance, significant AUROC improvement was observed in radiology residents (pooled results) and emergency physicians (pooled results) with the difference from reading without AI assistance of 0.094 (95% CI, 0.020-0.168; p = 0.012) and 0.069 (95% CI, 0.002-0.136; p = 0.043), respectively, but not in the pediatric radiologist with the difference of 0.008 (95% CI, -0.074-0.090; p = 0.850).

A deep learning-based AI model improved the performance of inexperienced radiologists and emergency physicians in diagnosing pediatric skull fractures on plain radiographs [5].

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