The use of contrast enhanced ultrasound (CEUS) in the identification of paediatric blunt abdominal trauma.

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Introduction

- Major trauma injuries are the most common cause of morbidity and mortality in children over the age of one year (Centers for Disease Control 2001).
- The taking of accurate histories and physical examinations in injured children is limited; therefore the identification of intra-abdominal injuries may be difficult.
- In most severe paediatric trauma cases the gold standard method of diagnostic imaging is currently computed tomography (CT). However due to children having different physiology, trauma patterns and radio-sensitivity, compared to adults, this raises questions concerning whether CT is still the best practice.
- Ultrasound (US) imaging in Paediatrics has been used routinely for decades, predominantly due to its advantages over other imaging modalities such at CT.
- In addition to being non-invasive and cost effective, US does not use harmful ionising radiation and often removes the need for sedation that is frequently required for magnetic resonance imaging (MRI).
- It has been noted that continuing advancements in US, including the use of contrast enhanced US (CEUS) may eventually lead to a change in national guidance with regard to paediatric blunt trauma imaging. CEUS does not involve the use of ionising radiation; it is portable, widely available and easily performed. It may also be repeated without great concern.

Aim

The primary aim of this review is to determine whether CEUS can be used as an alternative to CT, as diagnostic imaging, in the evaluation of blunt trauma injuries in haemodynamically stable paediatric patients.

Method

Data Sources and Study Selection

- The Cochrane Library, AHMED, CINAHL, MEDLINE, EMBASE, Science Direct, SIGLE, HSRProj and the national Research Register were searched in January 2018.

Inclusion Criteria

- All relevant studies from 2001 onwards which investigated the use of CEUS in the paediatric population, in relation to blunt abdominal trauma evaluation, were systematically reviewed.

Study Quality

- The included studies were assessed for methodological quality using the specifically modified QUADAS-2 tool, which can assess the external and internal validity using a single checklist.(Whiting et al. 2011).
- Two reviewers with experience in US and research were involved in the quality assessment of the studies.

Data Analysis

- Once the data was extracted from the included studies, it was synthesised and summarised in order for it to be critically analysed.
- Due to the small number of studies, study heterogeneity and the fact that not all of the original raw study data was available, it was not possible to conduct a formal meta-analysis and hence a systematic review was conducted.

Included Studies

Study Number	Study
1	Menichini et al. (2015) Accuracy of contrast-enhanced ultrasound (CEUS) in the identification and characterization of traumatic solid organ lesions in children: a retrospective comparison with baseline US and CE-MDCT. La Radiologia Medica, 120(11): p 989-1001.
2	Valentino et al. (2008) Blunt abdominal trauma: diagnostic performance of contrast-enhanced US in children--initial experience. Radiology, 246(3): p 903-909.
3	Durkin et al. (2016) Post-traumatic liver and splenic pseudoaneurysms in children: Diagnosis, management, and follow-up screening using contrast enhanced ultrasound (CEUS). Journal of Paediatric Surgery, 51(2): p 289-292.
4	Armstrong et al. (2018) Contrast enhanced ultrasound for the evaluation of blunt pediatric abdominal trauma. Journal of Pediatric Surgery, 53(3): p 548-552.
5	Miele et al. (2003) Role of Contrast Enhanced Ultrasound (CEUS) in the evaluation of localized low-energy abdominal trauma in a pediatric population: our initial experience. EPOS, Scientific Exhibit- Conference. European Society of Radiology, C-0873.

Principle Findings

Following an extensive search of all available literature regarding this topic, five studies were identified that fit the review criteria. All studies to came to the following main conclusions;

- CEUS is a highly accurate imaging modality for the identification of abdominal trauma in the paediatric population.
- CEUS has a high negative predictor value for abdominal trauma in the paediatric population.
- In CEUS traumatic solid organ injuries present as hypoechoic lesions, compared to the adjacent normal parenchyma reflectivity.
- CEUS has the potential to demonstrate active parenchymal bleeding.
- CEUS is not suitable for the imaging of the renal collecting system.

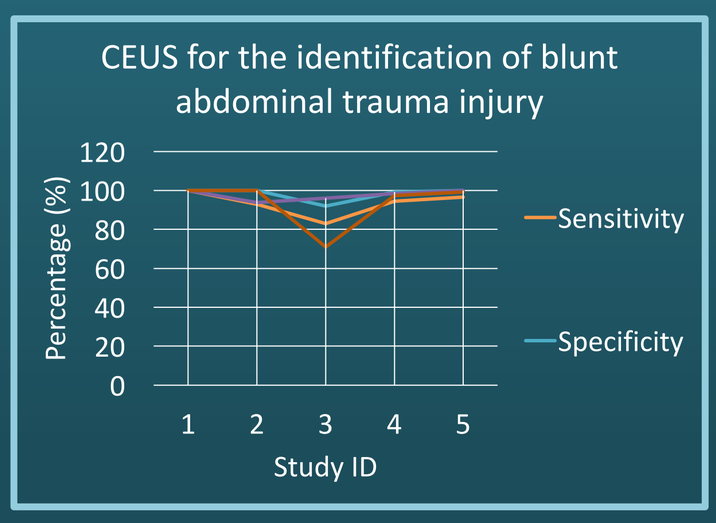

Figure 1: Statistics regarding the use of CEUS in the identification of blunt abdominal trauma injury in the paediatric population.

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Poster Number 42

Image 1: CEUS image of the liver depicting a markedly hypoechoic area with extravasation of microbubbles within the haematoma (arrows).

Image 2: Contrast enhanced CT of same lesion (arrow).

(Valentino et al. 2008)

Limitations

- As CEUS is a relatively new technique, which is not currently licenced for the use abdominal trauma imaging in the paediatric population, it is only used off-label. Consequently, CEUS is not routinely used in clinical practice, resulting in a lack of randomised controlled trials or large scale studies involving its use.
- All included studies involved a relatively small sample size, the largest only included 73 patients. This subsequently reduces the validity of the results. Additionally, due to the small sample sizes, none of the reviews included a sample population which was fully representative of the general population.

Conclusion

- CEUS has many benefits including the lack of ionising radiation and portability, however it has not been readily implemented into paediatric evaluation due to its off-label status. Even though the interest in CEUS by clinicians is increasing, its routine use in paediatrics is hindered by legislation.
- The results from this review suggest that CEUS has the potential to be an alternative imaging modality to CT for the identification of blunt abdominal trauma in the paediatric population with excellent negative predictive value and a good positive predictive value.
- However, there is still a lack of large scale studies on the use of CEUS in children and some disagreement regarding the reliability of results.
- Further research is required before changes to the current patient pathway are put in place and recommended by the Royal College of Radiologists. Until this occurs CEUS should be used as an additional tool to compliment US in initial imaging and follow up, but not to replace CT in the imaging of blunt abdominal trauma in paediatric patients.
- This review has highlighted that there are some instances where CEUS is not reliable. In cases of active bleeding and urinoma CEUS may be misleading. Additionally, situations may arise where an injury is located in a position difficult to view with US or the patient's body habitus may affect the ability of CEUS to identify a traumatic abdominal injury. Alternative imaging modalities are essential for such situations.

References

Centers for Disease Control. Deaths, leading causes for 2001. National Vital Statistics Report, 2004.

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Valentino, M. Serra, C. Pavlica, P. Labate, A. Lima, M. Baroncini, S. Barozzi, L. (2008) Blunt abdominal trauma: diagnostic performance of contrast-enhanced US in children--initial experience. Radiology, 246(3): p 903-909.