

CQ11 Are postmortem CT and MRI useful for determining cause of death?

Grades of recommendations:

C2* for evaluating the condition

C2 for determining the cause of death

*** C1 if appropriate minimally invasive autopsy including MRI is performed**

Postmortem CT and MRI are promising diagnostic tools to determine the cause of death. With a minimally invasive autopsy they may enable a better diagnostic accuracy than a conventional autopsy. Especially in fetuses and infants, appropriate minimally invasive autopsies including MRI are able to achieve very high diagnostic accuracies for the cause of death.

Explanation-----

Backgrounds

Because autopsy rates are declining worldwide, various non-invasive and minimally invasive autopsy methods are now being developed: postmortem CT, postmortem MRI, and minimally invasive autopsies suggest a concise method to determine the cause of death using only minimally invasive methods such as a blood test, postmortem radiography such as CT and MRI, and image-guided biopsy without performing a conventional autopsy or partial biopsy [1].

Diagnostic accuracy of minimally invasive and conventional autopsies (systematic review)

There is a systematic review article discussing the diagnostic accuracy of non-invasive or minimally invasive autopsies, comparing these to conventional autopsies for deaths suspected as natural in adults. That review includes 13 original prospective validation studies using postmortem CT and MRI [2]. However, the methods and patient groups of the studies were very heterogeneous, and a meta-analysis was not performed. As a conclusion, combining the CT and MR based autopsies was found to be superior among the non-invasive methods (agreement in the cause of death: 70 %), further, minimally invasive methods were superior to non-invasive methods. The highest rate of determination for establishing the cause of death (90.9 %) was achieved in recent studies combining CT, CT-angiography, and biopsies.

Correctness and detection rates in postmortem CT of fetuses and children

A study using postmortem microfocus CT (postmortem micro-CT)** has been reported for the correct diagnosis rate of postmortem CT in fetuses [3]. In the report, the correct diagnosis rate for structural abnormalities in 20 cases at 11 to 21 weeks from gestation was 93.8% for sensitivity and 100% for specificity [3]. In addition, there was agreement for 700 of 718 (97.5%) individual body

organ indices that were assessed on postmortem micro-CT and autopsy [3]. Postmortem micro CT resulted in a better detection rate than autopsies in early pregnancy (earlier than 14 weeks from gestation) [3].

A study on the accuracy of detection sensitivity with postmortem CT in children has also been reported, and the findings established by postmortem CT and autopsies have been analyzed in 26 cases with children aged 0 to 12 years [4]. Of the 486 findings presented in the 26 cases, 79% were identified by autopsies and 65% by postmortem CT. In particular, regarding specific detection sensitivity, parenchymal and luminal organs (81% by autopsy vs 54% by postmortem CT), soft tissue (88% vs 67%), blood vessels (92% vs 58%), bones (61% vs 94%)). However, one essential finding per case was missed by autopsy and 1.8 per case by PMCT with no significant difference. In children, an autopsy alone is not the surest method for estimating the cause of death, and it is considered that autopsies should be used in combination with postmortem images, and postmortem CT is indispensable especially for determining death due to trauma.

**A device that rotates a sample between a micro focus X-ray generator and an X-ray detector and reconstructs the three-dimensional structure inside the sample based on the observed data. Also the fine structure inside can be visualized in this manner.

Diagnostic accuracy of postmortem MRI for fetuses, children, and adults (meta-analysis)

There is a meta-analysis discussing diagnostic accuracy of less invasive autopsies by postmortem MR images, in fetuses, children, and adults [5]. Data from 9 studies were included (totals of: 146 fetuses, 11 children, and 24 adults). In accurately identifying the final cause of death or the most clinically significant abnormality, postmortem MR images resulted in a sensitivity and specificity of 69% and 95% in fetuses, and 28% and 64% in children and adults, respectively; however, the published data is limited to very limited, heterogenous, and poorly designed studies. Insufficient data is available on the acceptability and economic evaluation of postmortem MR images. Well designed, large, prospective studies are required to evaluate the accuracy of postmortem CT and MR image findings, before it can be considered for clinical use [5].

Recent prospective cohort study on the diagnostic accuracy of postmortem CT and MRI in adults (recent prospective cohort study)

After the above mentioned meta-analysis was published, a relatively large and robust prospective cohort study validating postmortem images in the diagnosis of adult deaths was published [6]. The study included 182 unselected cases subjected to study by postmortem CT, postmortem MRI, and conventional autopsies. The major differences in the rates of the cause of death identified by radiology and autopsy was 32% for CT, 43% for MRI, and 30% for the consensus findings of the radiology reports; 10% lower for CT than for MRI. Diagnostic radiologists indicated that an autopsy was not needed in 34% of cases for CT reports, 42% of cases for MRI reports, and 48% of cases for consensus

reports. Of these cases, the major rate of differences compared with autopsies was 16%, 21%, and 16%, respectively. The error rate when confidently radiologists provided a cause of death determinations was similar to that for clinical death certificates and could therefore be acceptable for medicolegal purposes. The most common errors in identification of the cause of death by images were ischemic heart disease, pulmonary embolism, pneumonia, and intra-abdominal lesions. It should be noted that commonly occurring causes of sudden death are frequently missed on CT and MRI, and unless these weaknesses are addressed, systematic errors in mortality statistics would result if imaging were to replace conventional autopsies [6].

Recent prospective cohort study on diagnostic accuracy of postmortem MRI in fetuses and children (recent prospective cohort study)

A somewhat larger and more robust prospective cohort study validating postmortem MRI in the diagnosis of fetus and child deaths was also published [7]. The study analyzed 400 cases (277 fetuses and 123 children). The cause of death or major pathological lesions identified by minimally invasive autopsy including postmortem MRI was in agreement with conventional autopsies in 89.3% of cases: 94.6% of fetuses up to 24 weeks of gestation, for 95.7% of fetuses later than 24 weeks of gestation, 81.0% of newborns aged up to 1 month, 84.9% for infants older than 1 month and up to 1 year, and 53.6% for children between 1 and 16 years of age. The dedicated diagnostic radiologist or pathologist review of the minimally invasive autopsy showed that in of 41% cases a full autopsy might not have been needed; in these cases, agreement between autopsy and minimally invasive autopsy was 99.4%. The findings by the minimally invasive autopsy has an accuracy similar to that of the conventional autopsy for detection of the cause of death or major pathological abnormality after death in fetuses, newborns, and infants, but was less accurate in older children. If undertaken jointly by pathologists and radiologists, minimally invasive autopsy could be an acceptable alternative to conventional autopsies in selected cases [7].

Column -----

The diagnostic accuracy of the cause of death with postmortem CT generally performed in Japan is estimated at approximately 30 %, which is lower than that mentioned above [8]. It is generally accepted that postmortem CT and MRI are not a substitute for conventional autopsies at the present time.

Literature search formula and literature selection (2019/5/27)

PubMed

#	Search formula	No.
1	((((((((((postmortem) OR post-mortem) OR "post mortem")) AND imaging)) OR (((postmortem) OR post-mortem) OR "post mortem")) AND CT)) OR (((postmortem) OR post-mortem) OR "post mortem")) AND "computed tomography")) OR (((postmortem) OR post-mortem) OR "post mortem")) AND MR)) OR (((postmortem) OR post-mortem) OR "post mortem")) AND "magnetic resonance")) OR (((postmortem) OR post-mortem) OR "post mortem")) AND MDCT)) OR ((MSCT) AND ((postmortem) OR post-mortem) OR "post mortem"))	23,613
2	((autopsy) AND ((correlation) OR (validation)) AND ((magnetic resonance) OR (MR)))	362
3	#1 and #2	358
4	((autopsy) AND ((correlation) OR (validation)) AND ((computed tomography) OR (CT)))	417
5	#1 and #4	406

Ichushi (Medical Journal)

#	Search formula	No.
1	(((死亡時画像/AL) and ((FT=Y) and AB=Y)) or ((死後検査/TH or autopsy/AL) and ((FT=Y) and AB=Y)) or ((死後画像/AL) and ((FT=Y) and AB=Y)))	5,793
2	(MRI/AL)	248,819
3	#1 and #2	630
4	(CT/AL)	1,305,564
5	#1 and #4	2,543

From other than search formula

[5]

References

- [1] Postmortem MRI, CT, and CT-guided Biopsy: Comparison of Diagnostic Performance. Radiology. 2018;289(3):658-67. (Level 4b)
- [2] Blokker BM et al: Non-invasive or minimally invasive autopsy compared to conventional autopsy of suspected natural deaths in adults: a systematic review. Eur Radiol. 2016; 26(4): 1159-79. Level 3)

- [3] Hutchinson JC et al: Postmortem microfocus computed tomography for early gestation fetuses: a validation study against conventional autopsy. *Am J Obstet Gynecol.* 2018; 218(4): 445 e1- e12. (Level 4b)
- [4] Krentz BV et al: Performance of post-mortem CT compared to autopsy in children. *Int J Legal Med.* 2016; 130(4): 1089-99. (Level 4b)
- [5] Thayyil S et al: Diagnostic accuracy of post-mortem magnetic resonance imaging in fetuses, children and adults: a systematic review. *Eur J Radiol.* 2010; 75(1): e142-8. (Level 3)
- [6] Roberts IS et al: Post-mortem imaging as an alternative to autopsy in the diagnosis of adult deaths: a validation study. *Lancet.* 2012; 379(9811): 136-42. (Level 4a)
- [7] Thayyil S et al: Post-mortem MRI versus conventional autopsy in fetuses and children: a prospective validation study. *Lancet.* 2013; 382(9888): 223-33. (Level 4a)
- [8] Takahashi N et al: The effectiveness of postmortem multidetector computed tomography in the detection of fatal findings related to cause of non-traumatic death in the emergency department. *Eur Radiol.* 2012; 22(1): 152-60. (Level 4a)