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Diagnostic medical radiation exposure and risk of childhood leukaemia: results from an Italian population-based case-control study

Tommaso Filippini[1], Elisa Arcolin[1], Carlotta Malagoli[1], Silvia Cilloni[1], Federica Violi[1], Lucia Borsari[1], Marco Vinceti[1,2]

Introduction

In utero exposure to low-dose radiation delivered from medical x-rays is a risk factor for childhood leukaemia, although the magnitude of the risk has substantially dropped with the implementation of radiation protection standards. On the converse, the findings for postnatal exposure to low-dose medical radiation and the risk of childhood leukaemia are still inconsistent (Krille et al, 2015; Mercuri et al, 2013; Pearce et al, 2012). In a population-based case-control study carried out in a Northern Italian province we explored the relationship between post-natal exposures to medical radiation and childhood leukaemia risk.

Methods

We identified the 51 childhood leukaemia cases diagnosed from 2004 to 2013 in the Modena province (700.000 inhabitants) through the Italian National Childhood Cancer Register. For each case, we randomly selected four population controls matched by age, sex and calendar year. For each study subject who had accessed the Radiology services of the two major hospitals in the province, we retrieved detailed information about any medical procedure involving ionizing radiations from birth up to six months prior to the onset of the disease. We collected information about child age, type, total number, body region and reason of the radiological examination. After considering for each procedure the age-specific maximum irradiation dose allowed by the National Diagnostic Imaging guidelines, we estimated for each study participant the total effective dose (mSv) and the red bone marrow-specific dose (mGy) experienced from birth.

Table 1. Odds ratios (OR) and 95% confidence intervals (95% CI) of CL associated with exposure to ionizing radiation resulting from having at least one diagnostic investigation, (CT, conventional RX or nuclear medicine), from birth up to at the date of diagnosis or only in the first 5 years of life.

At least one examination from birth to diagnosis

	Cases/ Controls[1]	Cases/ Controls	OR (95%CI)
All leukaemia			
All examinations	31/135	19/65	1.38 (0.66-2.92)
RX only	31/135	18/60	1.51 (0.70-3.23)
CT and RX	49/195	1/5	1.00 (0.11-8.95)
ALL			
All examinations	23/100	15/48	1.35 (0.58-3.13)
RX only	23/100	14/44	1.47 (0.62-3.51)
CT and RX	37/144	1/4	1.00 (0.11-8.95)

At least one examination in the yearliest (<5 years) life

	Cases/ Controls[1]	Cases/ Controls	OR (95%CI)
All leukaemia			
All examinations	39/161	11/39	1.17 (0.55-2.49)
RX only	39/158	10/37	1.10 (0.50-2.42)
CT and RX	49/198	1/2	2.00 (0.18-22.10)
ALL			
All examinations	27/120	11/28	1.82 (0.80-4.15)
RX only	27/118	10/26	1.70 (0.72-4.03)
CT and RX	37/146	1/2	2.00 (0.18-22.10)

[1]Reference category

Dr. Tommaso Filippini, Department of Biomedical, Metabolic and Neural Sciences, Section of Public Health - University of Modena and Reggio Emilia, Via Campi, 287 – 41125 Modena. *tommaso.fiilippini@unimore.it*

Results

Using a conditional logistic regression model we found an increased risk of developing childhood leukaemia (Table 1), especially in children aged 5 or more (Table 2), in association with experiencing one or more diagnostic ionizing radiation tests (OR=1.68, 95% CI 0.66–4.29). The risk of childhood leukaemia and particularly of acute lymphoblastic leukaemia (ALL) increased in children who received one or more x-ray test in the first 5 years of life (OR = 1.42, 95% CI 1.07-1.91). Risk of childhood leukaemia by increasing total effective dose and red bone marrow-specific dose increased in the highest (>0.035 mSv and >0.0125 mGy) exposure category compared to the lowest one (0 mSv/mGy), with a OR of 1.81 (0.74–4.45) and 2.05 (0.82–5.11), respectively.

Table 2. Odds ratios (OR) and 95% confidence intervals (95% CI) of CL associated with exposure to ionizing radiation resulting from having performed at least one diagnostic test (CT, conventional RX or nuclear medicine), in children with leukemia diagnosed before or after five years.

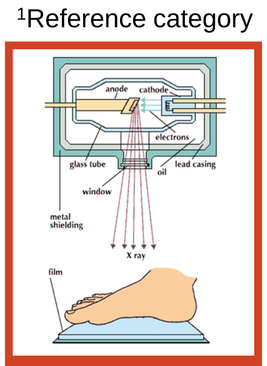
Children aged <5 at diagnosis

	Cases/ Controls[1]	Cases/ Controls	OR (95%CI)
All leukaemia			
All examinations	20/78	3/13	0.86 (0.22-3.33)
RX only	20/78	3/11	1.01 (0.25-4.01)
CT and RX	23/89	0/2	-
ALL			
All examinations	14/56	3/11	1.04 (0.25-4.25)
RX only	14/56	3/9	1.27 (0.30-5.39)
CT and RX	17/65	0/2	-

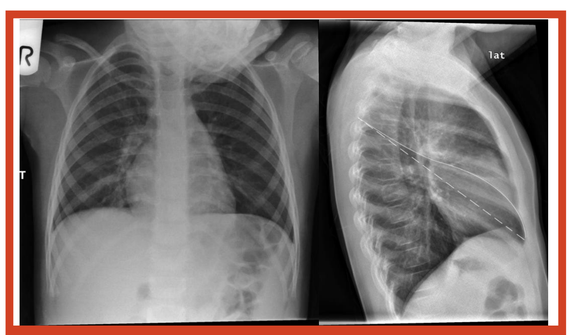
Children aged ≥5 at diagnosis

	Cases/ Controls[1]	Cases/ Controls	OR (95%CI)
All leukaemia	11/57	16/52	1.68 (0.66-4.29)
All examinations	11/57	15/49	1.74 (0.67-4.50)
RX only	26/106	1/2	2.00 (0.18-22.05)
CT and RX	11/57	16/52	1.68 (0.66-4.29)
ALL			
All examinations	9/44	12/37	1.47 (0.51-4.24)
RX only	9/44	11/35	1.49 (0.51-4.41)
CT and RX	20/79	1/2	2.00 (0.18-22.05)

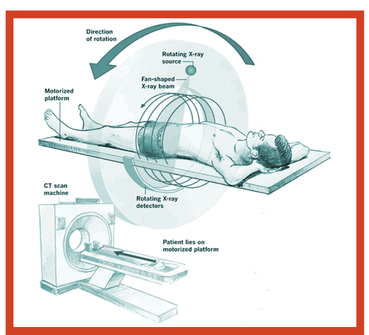
[1]Reference category



X-Ray



Normal paediatric chest x-Rays



Computed Tomography (CT)

Conclusions

Despite the limited stability of the risk estimates and the risk of unmeasured confounding, our study suggest an association between early exposure to post-natal medical radiation and childhood leukaemia risk.

References

Mercuri *et al*, (2013) Evid Based Med 18: 158 – 9
Pearce *et al*, (2012) Lancet 380: 499 – 505
Krille *et al*, (2015) Radiat Environ Biophys 54: 1 – 12

Affiliations: [1]Environmental, Genetic and Nutritional Epidemiology Research Center (CREAGEN), Department of Biomedical, Metabolic and Neural Sciences, University of Modena and Reggio Emilia, Modena, Italy; [2]Department of Epidemiology, Boston University School of Public Health, Boston, USA.