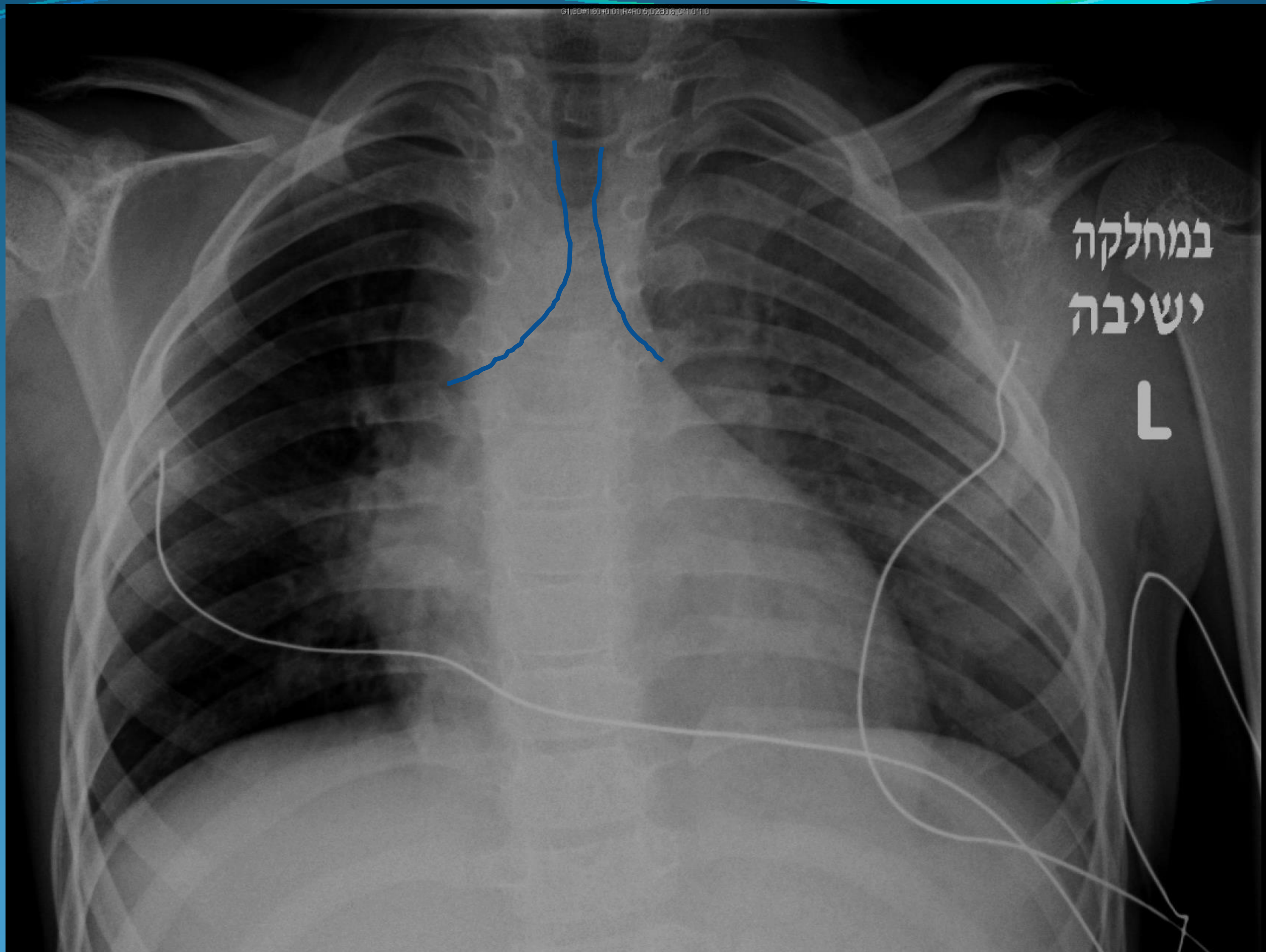
CTA Vs MRA
להדמיית כלי הדם בבית החזה בילדים

ד״ר שלי שירן
דימות ילדים

Tel Aviv Sourasky
Medical Center


במחלקה
ישיבה
L


CTA
MRA

MRA

CTA

Non Ionizing Radiation

Ionizing Radiation

Table I. - Radiation Dose Comparison			
Diagnostic Procedure	**Typical Effective Dose (mSv)[1]**	**Number of Chest X rays (PA film) for Equivalent Effective Dose[2]**	**Time Period for Equivalent Effective Dose from Natural Background Radiation[3]**
Chest x ray (PA film)	0.02	1	2.4 days
CT chest	2.0 (<6.0)	100	243 days
Tc-99m radionuclide bone scan	<6.2	310	753 days
FDG-PET	15	765	1871 days

Emergency Radiology
September 2007, Volume 14, Issue 4, pp 227-232

Increasing utilization of computed tomography in the pediatric emergency department, 2000–2006

Joshua Broder, Lynn Ansley Fordham, David M. Warshauer

» Look Inside » Get Access

Abstract

The objective of this study is to characterize changes in computed tomography (CT) utilization in the pediatric emergency department (ED) over a 6-year period. CT scans ordered on pediatric (ages 0 to 17 years) ED patients from July 2000 to July 2006 were analyzed in five groups: head, cervical spine, chest, abdomen, and miscellaneous. Pediatric ED patient volume and triage acuity scores were determined. There were 6,073 CT scans performed on 4,138 pediatric patients in the ED during the study period. During this same period, 78,932 pediatric patients were evaluated in the ED. From 2000 to 2006, pediatric ED patient volume increased by 2%, while triage acuity remained stable. During this same period, head CT increased by 23%, cervical spine CT by 366%, chest CT by 435%, abdominal CT by 49%, and miscellaneous CT by 96%. Increases in CT utilization were most pronounced in adolescents ages 13 to 17 years. Increases in CT utilization in this age group met or exceeded increases seen in the adult population. In children less than 13 years of age, increases were sub
increased
increase
risks of C
CT diagn
certainty.
deserves

Rising Use of CT in Child Visits to the Emergency Department in the United States, 1995–2008

Expand

David B. Larson, MD, MBA, Lara W. Johnson, MD, MHS, Beverly M. Schnell, PhD, Marilyn J. Goske, MD, Shelia R. Salisbury, PhD and Howard P. Forman, MD, MBA

From the Department of Radiology (D.B.L., M.J.G.) and Division of Biostatistics and Epidemiology (B.M.S., S.R.S.), Cincinnati Children's Hospital Medical Center, 3333 Burnet Ave, MLC 5031, Cincinnati, OH 45229; Robert Wood Johnson Foundation Clinical Scholars Program (L.W.J.) and Department of Diagnostic Radiology (H.P.F.), Yale University School of Medicine, New Haven, Conn.

Address correspondence to
D.B.L. (e-mail: david.larson@cchmc.org).

Author contributions: Guarantor of integrity of entire study, D.B.L.; study concepts/study design or data acquisition or data analysis/interpretation, all authors; manuscript drafting or manuscript revision for important intellectual content, all authors; manuscript final version approval, all authors; literature research, D.B.L., L.W.J., M.J.G.; statistical analysis, D.B.L., L.W.J., B.M.S., S.R.S.; and manuscript editing, all authors

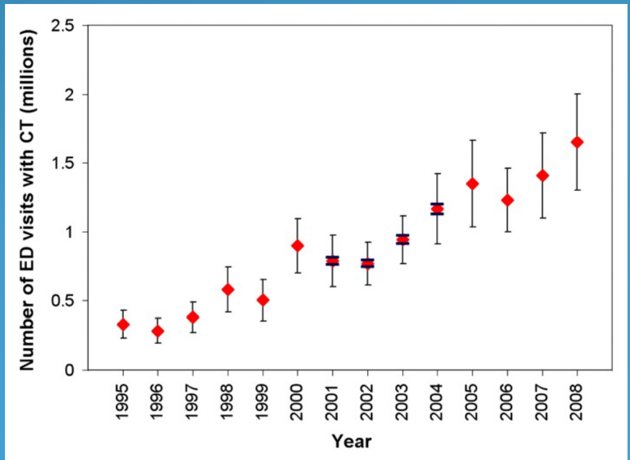
Abstract

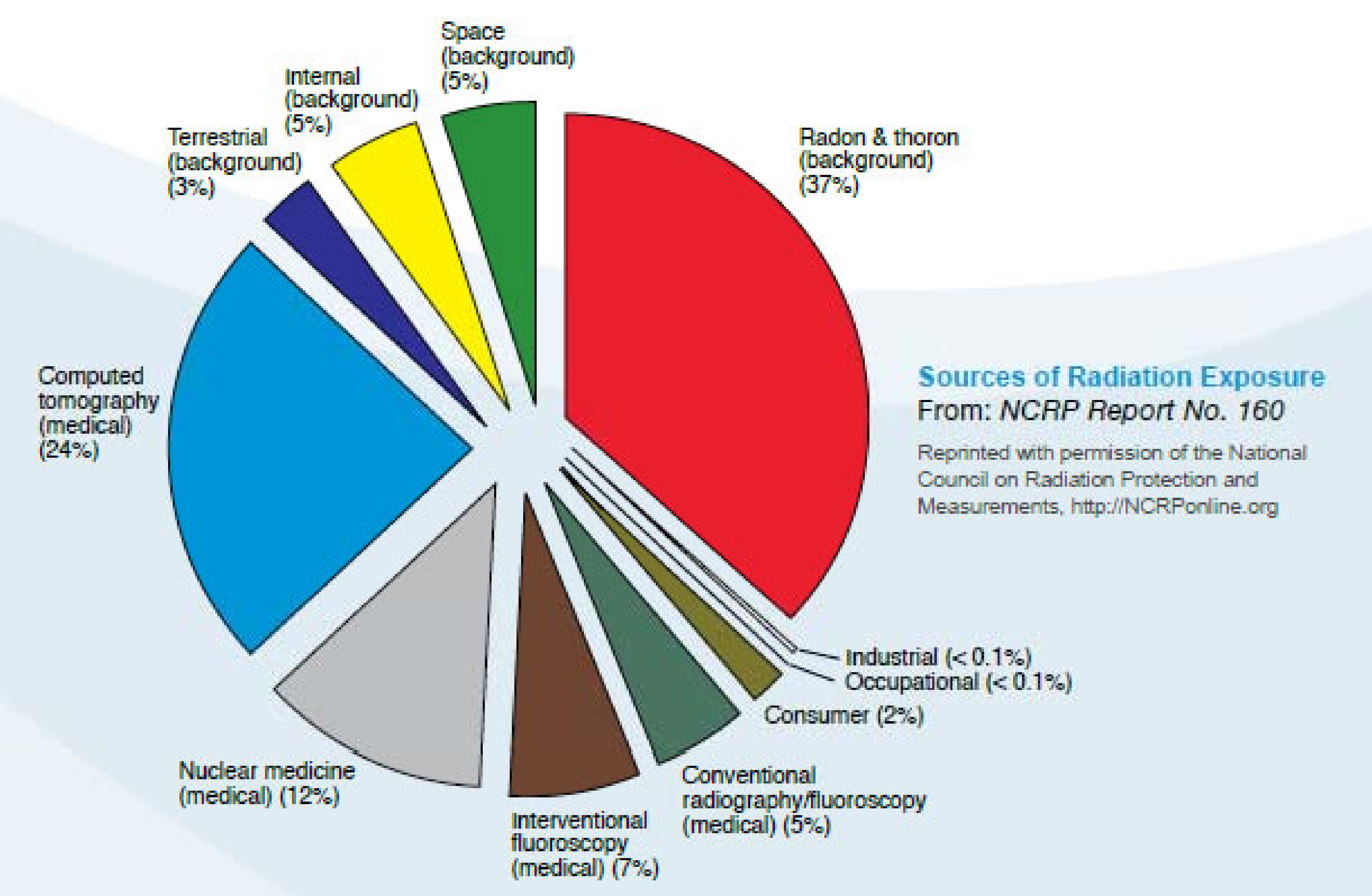
Results: From 1995 to 2008, the number of pediatric ED visits that included CT examination increased from 0.33 to 1.65 million, a fivefold increase, with a compound annual growth rate of 13.2%. The percentage of

with a compound annual growth rate of 12.8%. The number of visits associated with CT at pediatric-focused and non-pediatric-focused EDs increased from 14 895 and 316 133, respectively, in 1995 to 212 716 and 1 438 413, respectively, in 2008. By the end of the study period, top chief complaints among those undergoing CT included head injury, abdominal pain, and headache.

Conclusion: Use of CT in children who visit the ED has increased substantially and occurs primarily at non-pediatric-focused facilities. This underscores the need for special attention to this vulnerable population to ensure that imaging is appropriately ordered, performed, and

vulnerable: vu




Space (background) (5%)
Internal (background) (5%)
Terrestrial (background) (3%)
Radon & thoron (background) (37%)
Computed tomography (medical) (24%)
Industrial (< 0.1%)
Occupational (< 0.1%)
Consumer (2%)
Nuclear medicine (medical) (12%)
Conventional radiography/fluoroscopy (medical) (5%)
Interventional fluoroscopy (medical) (7%)
Sources of Radiation Exposure
From: NCRP Report No. 160
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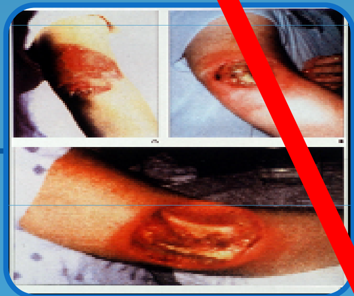
קרינה

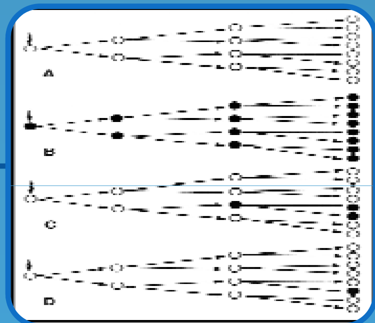
אפקט דטרמיניסטי

- תלוי במינון
- קיים ערך סף
- קטרקט, אובדן שיער, כוויות



אפקט סטוקסטי

- השפעה על ה-DNA בתא
- אין ערך סף ידוע
- הופעה של גידול סרטני, הופעה של מוטציות בצאצאים



- Pierce and Preston (2000)
- 50,000 survivors (1988-1994)
- Risk of cancer at low dose
  - 50-150 mSv
- Excess cancer *deaths*

Table 7. Thyroid cancer after childhood radiotherapy

Study	Mean dose (Gy)	ERR/Gy
Enlarged thymus	1.4	9.1 (3.6–29)
Michael Reese tonsils	0.6	2.5 (0.6–26)
Israeli *tinea capitis*	0.1	32 (14–57)
Childhood cancer	12	1.1 (0.4–29)
A-bomb survivors (< 15 years)	0.3	4.7 (1.7–16)

Table 3. Breast cancer mortality and diagnostic X-rays for scoliosis (*ERR* excess relative risk; from [4])

4,822 Exposed; 644 nonexposed
Mean age at exposure, 10.6 years
Mean dose, 0.11 Gy
70 Observed cancers; 35.7 expected
ERR at 1 Sv = 5.4 (95% CI = 1.2–14)
Results similar to A-bomb survivors

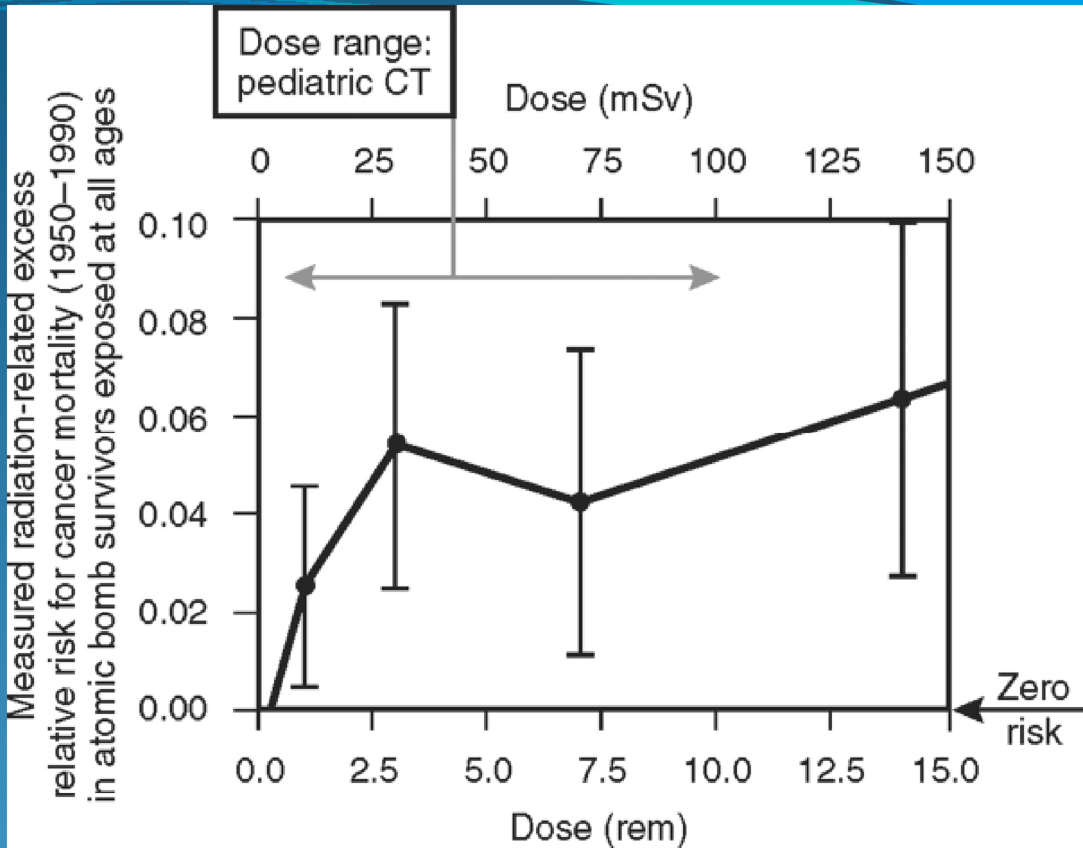
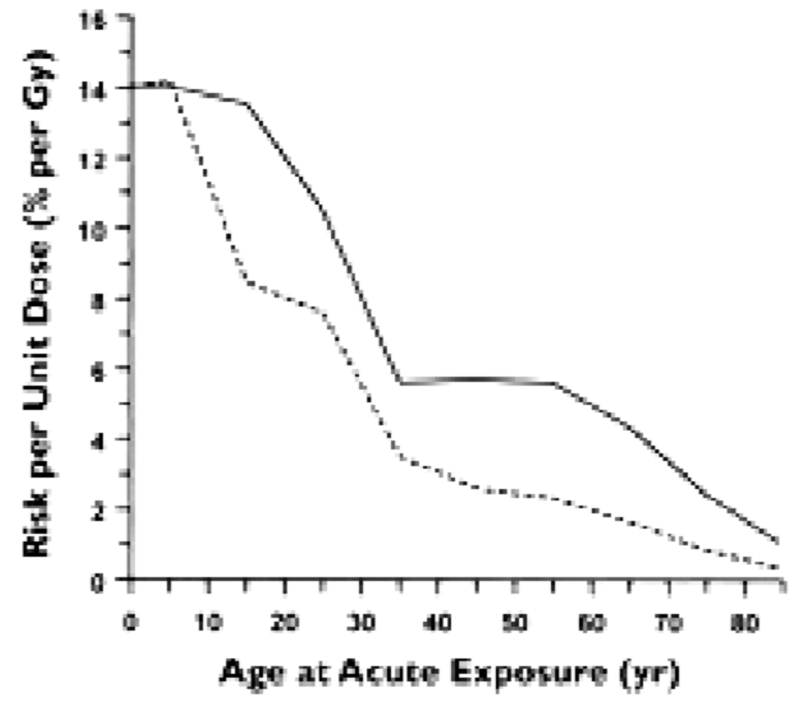


FIGURE 1-4 Relevant dose range for pediatric CT: 6 to 100 mSv (0.006 to 0.1 Sv). "There is direct, statistically significant evidence for risk in the dose range from 0 to 0.1 Sv."

(From Brenner DJ: Estimating cancer risks from pediatric CT: going from the qualitative to the quantitative. Pediatr Radiol 2002;32:228-231.)

“Estimated Risks of Radiation-Induced Fatal Cancer from pediatric CT” / Brenner et al., (AJR:176, Feb 2001)



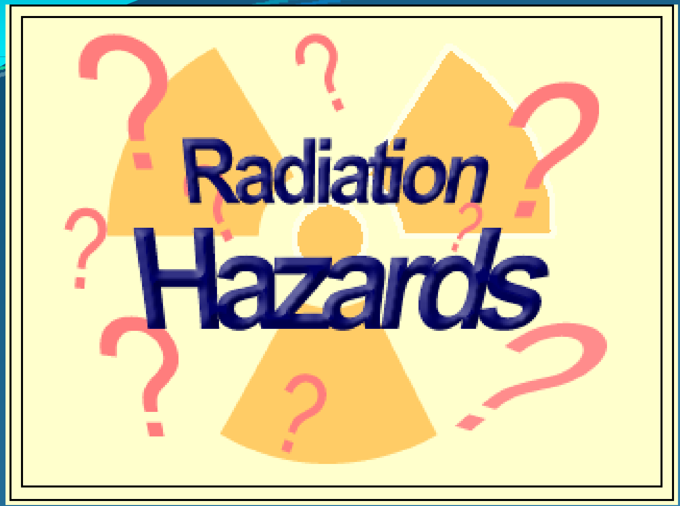
- Pediatric CT will result in significantly increased lifetime radiation risk over adult CT
  - Increased dose per mAS
  - Increased tissue radiosensativity
  - Increased life time risk per unit dose

Table 7
Dose Summary for CT Examinations (at 120 kVp)

Patient Age (y)	Radius (mm)*	Mean Section Dose (mGy)	Milliampere Second Setting	Energy Imparted to the Phantom (mJ)	Effective Dose (mSv)
			Head Examinations		
Newborn	52.5	41.3	300	32.2	6.0
1	71.4	39.2	340	75.2	4.9
5	83.9	38.8	380	120.0	4.0
10	87.3	39.5	400	142.0	2.8
15	91.9	37.8	400	150.0	1.7
Adult	94.3	36.8	400	165.0	1.5
			Abdomen Examinations		
Newborn	57.6	19.7	150	14.4	5.3
1	75.7	16.6	150	32.8	4.2
5	92.9	15.0	160	56.7	3.7
10	108.0	14.4	180	95.6	3.7
15	132.0	12.5	200	158.0	3.6
Adult	143.0	11.2	200	172.0	3.1

* Computed with Equation (4).

Huda et al Radiology 203: 1997 pg 421


Radiation
Hazards


פרסומים על עליה
במספר בדיקות ה-
CT בילדים
השימוש באותם
פרמטרים
בבדיקות
לילדים
ולמבוגרים
ההבנה שרמת
הקרינה שנחשפים
לה בבדיקה חופפת
רמות קרינה שהראו
הגברה בסיכון
למחלת הסרטן

AJR Feb 2001

From the Editor's Notebook

Taking Care of Children: Check Out the Parameters Used for Helical CT

Estimated Risks of Radiation-Induced Fatal Cancer from Pediatric CT

David J. Brenner[1]
Carl D. Elliston[1]
Eric J. Hall[1]
Walter E. Berdon[2]

Helical CT of the Body: Are Settings Adjusted for Pediatric Patients?

Anne Paterson[1]
Donald P. Frush[2]
Lane F. Donnelly[3]

OBJECTIVE. Our objective was to determine whether adjustments related to patient age are made in the scanning parameters that are determinants of radiation dose for helical CT of

Perspective

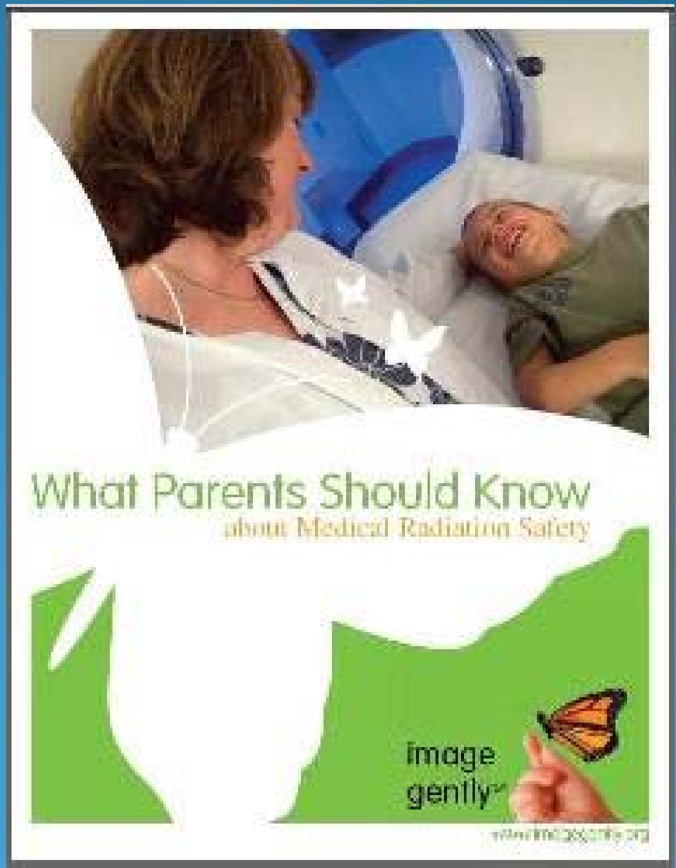
Minimizing Radiation Dose for Pediatric Body Applications of Single-Detector Helical CT: Strategies at a Large Children's Hospital

Lane F. Donnelly[1,2], Kathleen H. Emery[1,2], Alan S. Brody[1,2], Tal Laor[1,2], Victoria M. Gylys-Morin[1,2], Christopher G. Anton[1,2], Stephen R. Thomas[2], Donald P. Frush[3]

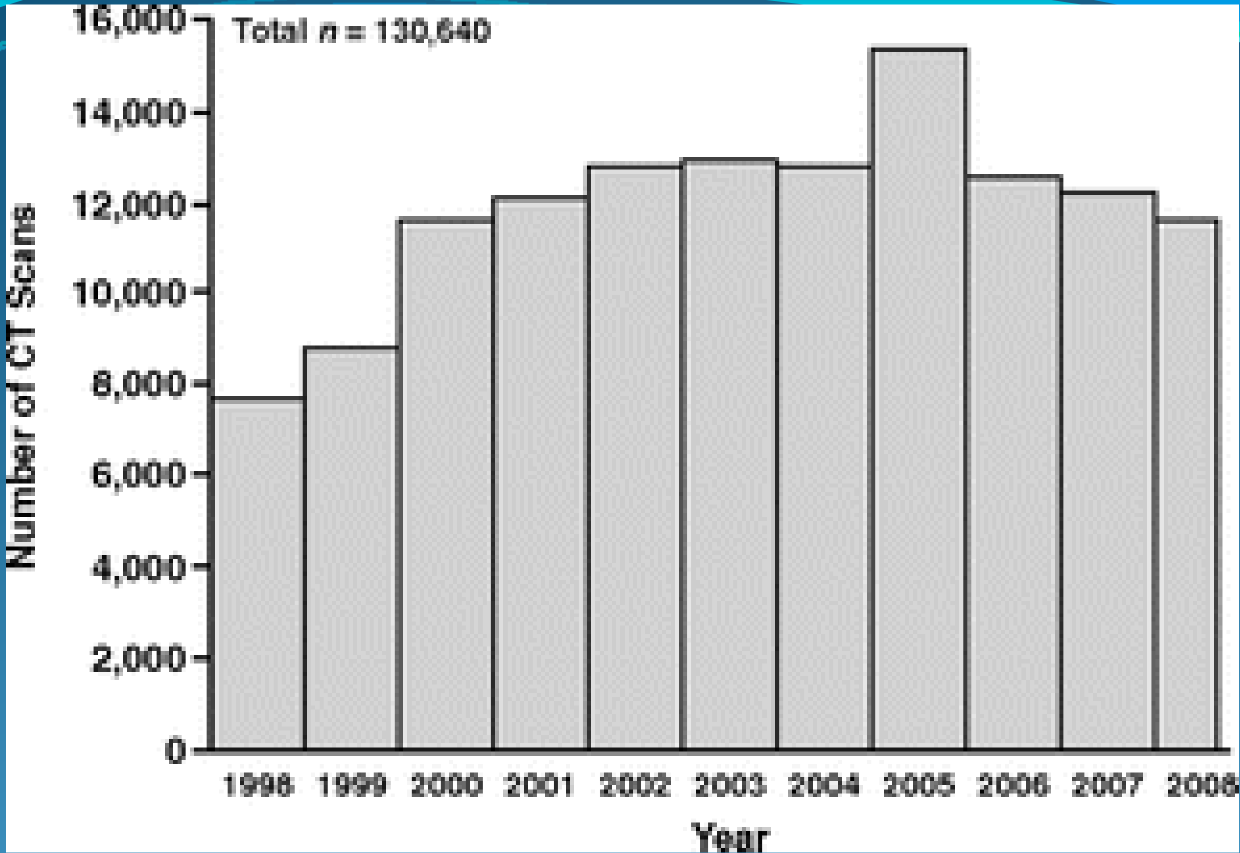
Tube Current (mA)

LNT – Linear No Threshold Theory

ALARA –
As Low As Reasonably Achievable



http://www.pedrad.org



Has Pediatric CT at Children's Hospitals Reached Its Peak?

Brent A. Townsend[1 2], Michael J. Callahan[1], David Zurakowski[1] and George A. Taylor[1]

AJR, May 2010, Volume 194, Number 5

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The Lancet, Volume 380, Issue 9840, Pages 499 - 505, 4 August 2012
doi:10.1016/S0140-6736(12)60815-0 Cite or Link Using DOI
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Radiation exposure from CT scans in childhood and subsequent risk of leukaemia and brain tumours: a retrospective cohort study

Kim PhD [a], Nicola L Howe MSc [a], Cecile M Ronckers PhD [c, f], Preetha Rajaraman PhD [c], Alan W Craft MD [b], Louise Parker PhD [g], Amy Berrington de González DPhil [c]

Download images

Findings

During follow-up, 74 of 178 604 patients were diagnosed with leukaemia and 135 of 176 587 patients were diagnosed with brain tumours. We noted a positive association between radiation dose from CT scans and leukaemia (excess relative risk [ERR] per mGy 0·036, 95% CI 0·005—0·120; p=0·0097) and brain tumours (0·023, 0·010—0·049; p<0·0001). Compared with patients who received a dose of less than 5 mGy, the relative risk of leukaemia for patients who received a cumulative dose of at least 30 mGy (mean dose 51·13 mGy) was 3·18 (95% CI 1·46—6·94) and the relative risk of brain cancer for patients who received a cumulative dose of 50—74 mGy (mean dose 60·42 mGy) was 2·82 (1·33—6·03).

Interpretation

Use of CT scans in children to deliver cumulative doses of about 50 mGy might almost triple the risk of leukaemia and doses of about 60 mGy might triple the risk of brain cancer. Because these cancers are relatively rare, the cumulative absolute risks are small: in the 10 years after the first scan for patients younger than 10 years, one excess case of leukaemia and one excess case of brain tumour per 10 000 head CT scans is estimated to occur. Nevertheless, although clinical benefits should outweigh the small absolute risks, radiation doses from CT scans ought to be kept as low as possible and alternative procedures, which do not involve ionising radiation, should be considered if appropriate.

of brain tumour per 10 000 head CT scans is estimated to occur. Nevertheless, although clinical benefits should outweigh the small absolute risks, radiation doses from CT scans ought to be kept as low as possible and alternative procedures, which do not involve ionising radiation, should be considered if appropriate.

Funding
US National Cancer Institute and UK Department of Health.

Review Chernobyl-related ionising radiation exposure and cancer risk: an epidemiological review

Seminar Aetiology of acute leukaemia

Point ... | Radiation exposure fr... | image gently in hebre... | SPR Response to Lan...

AMERICAN DAILY HERALD

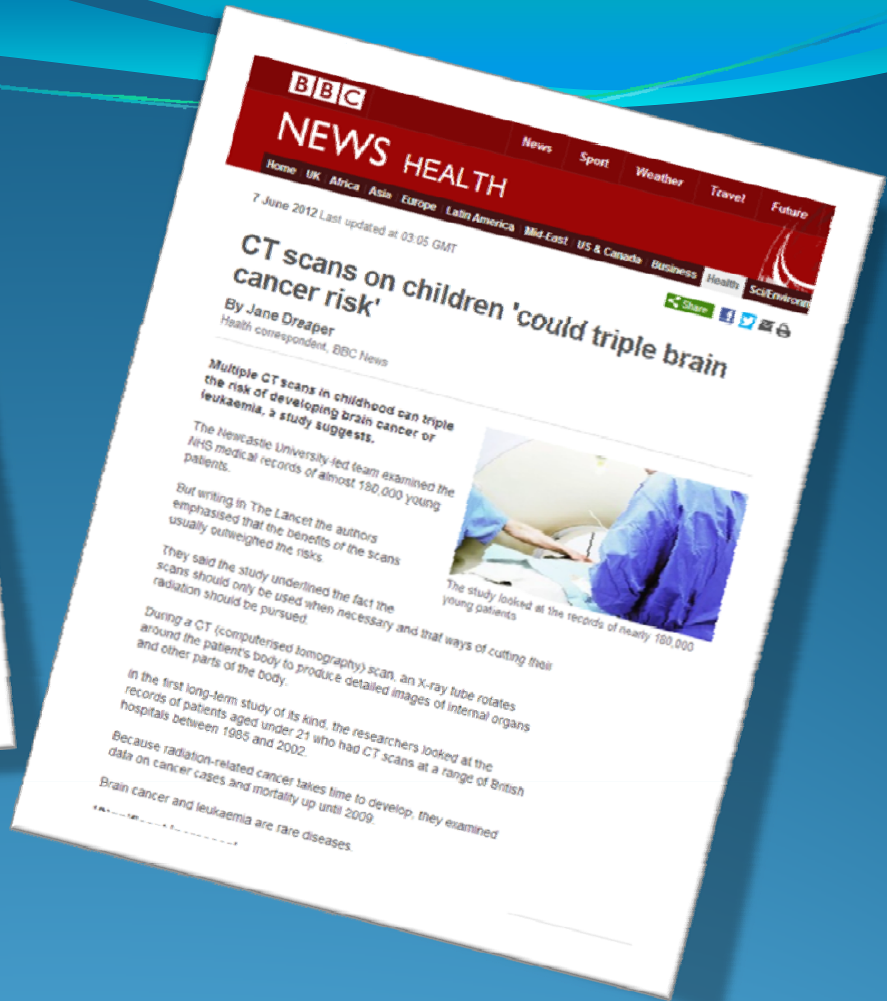
VERITAS, LIBERTAS, PAX ET PROSPERITAS

NIH STUDY FINDS CHILDHOOD CT SCANS LINKED TO LEUKEMIA AND BRAIN CANCER LATER IN LIFE

A NEW STUDY FINDS THAT CHILDREN EXPOSED TO CT SCANS MAY HAVE A SLIGHTLY ELEVATED RISK OF DEVELOPING CANCER IN THE FOLLOWING DECADE

Children and young adults scanned multiple times by computed tomography (CT), a commonly used diagnostic tool, have a small increased risk of leukemia and brain tumors in the decade following their first scan. These findings are from a study of more than 175,000 children and young adults that was led by researchers at the National Cancer Institute (NCI), part of the National Institutes of Health, and at the Institute of Health and Society, Newcastle University, England.

The researchers emphasize that when a child suffers a major head injury or develops a life-threatening illness, the benefits of clinically appropriate CT scans should outweigh future cancer risks. The results of the study were published online in The Lancet on June 7, 2012.



BBC NEWS HEALTH

7 June 2012 Last updated at 03:05 GMT

CT scans on children 'could triple brain cancer risk'

By Jane Dreaper
Health correspondent, BBC News

Multiple CT scans in childhood can triple the risk of developing brain cancer or leukaemia, a study suggests.

The Newcastle University-led team examined the NHS medical records of almost 180,000 young patients.

But writing in The Lancet the authors emphasised that the benefits of the scans usually outweighed the risks.

They said the study underlined the fact the scans should only be used when necessary and that ways of cutting their radiation should be pursued.

During a CT (computerised tomography) scan, an X-ray tube rotates around the patient's body to produce detailed images of internal organs and other parts of the body.

In the first long-term study of its kind, the researchers looked at the records of patients aged under 21 who had CT scans at a range of British hospitals between 1985 and 2002.

Because radiation-related cancer takes time to develop, they examined data on cancer cases and mortality up until 2009.

Brain cancer and leukaemia are rare diseases.

The study looked at the records of nearly 180,000 young patients

SPR Response to *Lancet article re Radiation Exposure from CT Scans in Childhood and Subsequent* Risk of Leukemia and Brain Tumors – June 6, 2012

The

BMJ

BMJ 2013;346:f2360 doi: 10.1136/bmj.f2360 (Published 22 May 2013)

RESEARCH

Cancer risk in 680 000 people exposed to computed tomography scans in childhood or adolescence: data linkage study of 11 million Australians

John D Mathews *epidemiologist*[1], Anna V Forsythe *research officer*[1], Zoe Brady *medical physicist*[1 2], Martin W Butler *data analyst*[3], Stacy K Goergen *radiologist*[4], Graham B Byrnes *statistician*[5], Graham G Giles *epidemiologist*[6], Anthony B Wallace *medical physicist*[7], Philip R Anderson *epidemiologist*[8 9], Tenniel A Guiver *data analyst*[8], Paul McGale *statistician*[10], Timothy M Cain *radiologist*[11], James G Dowty *research fellow*[1], Adrian C Bickerstaffe *computer scientist*[1], Sarah C Darby *statistician*[10]

[1]School of Population and Global Health, University of Melbourne
Vic, Australia; [3]Medical Benefits Scheme Analytics Section, Depar
Imaging, Southern Health, and Monash University Southern Clini
Research on Cancer, Lyon, France; [6]Cancer Epidemiology Centre
Medicine Section, Australian Radiation Protection and Nuclear Sa
Health and Welfare, Canberra, Australia; [9]Faculty of Health, Univers
Studies Unit, University of Oxford, Oxford, UK; [11]Medical Imaging

For brain cancer and for all cancers combined, IRRs were highest for CT exposures in children younger than 5 years, and decreased with increasing age at first exposure (P=0.001 for trend for brain cancer, P<0.001 for trend for all cancers; table 7⇓). For all solid cancers other than brain cancer, the IRR also tended to decrease with increasing age at first exposure (P=0.06 for trend). Despite these reductions, the IRR remained significantly increased in the oldest group at first exposure, for brain cancers, all cancers combined, and all solid cancers other than brain cancer. For lymphoid and haematopoietic cancers

Conclusions The increased incidence of cancer after CT scan exposure in this cohort was mostly due to irradiation. Because the cancer excess was still continuing at the end of follow-up, the eventual lifetime risk from CT scans cannot yet be determined. Radiation doses from contemporary CT scans are likely to be lower than those in 1985-2005, but some increase in cancer risk is still likely from current scans. Future CT scans should be limited to situations where there is a definite clinical indication, with every scan optimised to provide a diagnostic CT image at the lowest possible radiation dose.

What is already known on this topic

CT scanning rates have risen substantially since the 1980s. Although large doses of ionising radiation are known to cause cancer, there is uncertainty about the risks following the lower doses from CT scans (5-50 mGy per organ)

A recent study of 180 000 young people exposed to CT scans in the United Kingdom found an increasing risk of leukaemia and brain cancer with increasing radiation dose

What this study adds

Among 680 000 Australians exposed to a CT scan when aged 0-19 years, cancer incidence was increased by 24% (95% confidence interval 20% to 29%) compared with the incidence in over 10 million unexposed people. The proportional increase in risk was evident at short intervals after exposure and was greater for persons exposed at younger ages

By 31 December 2007, with an average follow-up of 9.5 years after exposure, the absolute excess cancer incidence rate was 9.38 per 100 000 person years at risk

Incidence rates were increased for most individual types of solid cancer, and for leukaemias, myelodysplasias, and some other lymphoid cancers

מה נייעץ להורים?

כיצד נחסוך קרינה לילדים

- האם נדרשת בדיקת הדמייה? (האם בדיקה דרושה לשם האבחנה והאם הטיפול ישתנה בהתאם לתוצאות הבדיקה)
- כאשר נדרשת בדיקה – מה היא הבדיקה המתאימה ביותר? (האם בדיקות אשר אינן מייצרות קרינה מייננת מתאימות לענות על השאלה)

מניעת בדיקת CT מיותרת

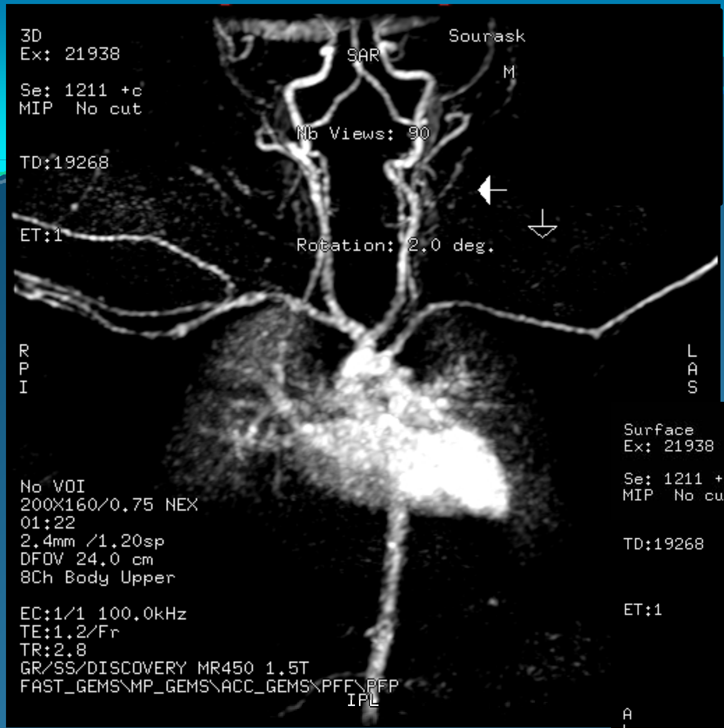
MRA

- Non ionizing radiation
- **Better temporal resolution**

CTA

- Ionizing radiation
- **Better spatial resolution**


Warning: Not for diagnostic use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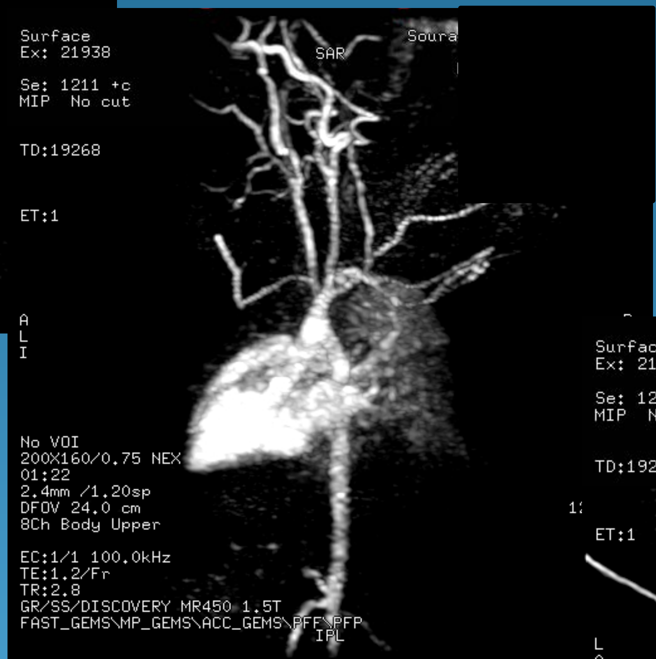
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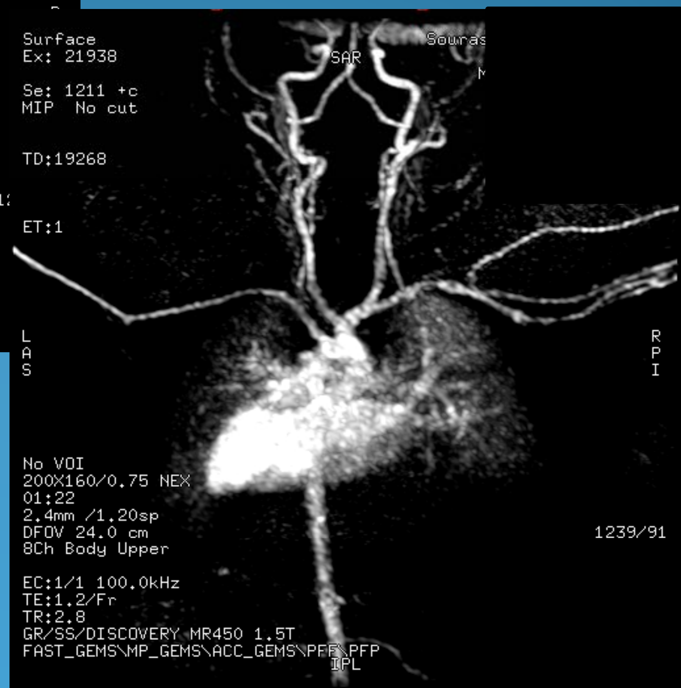
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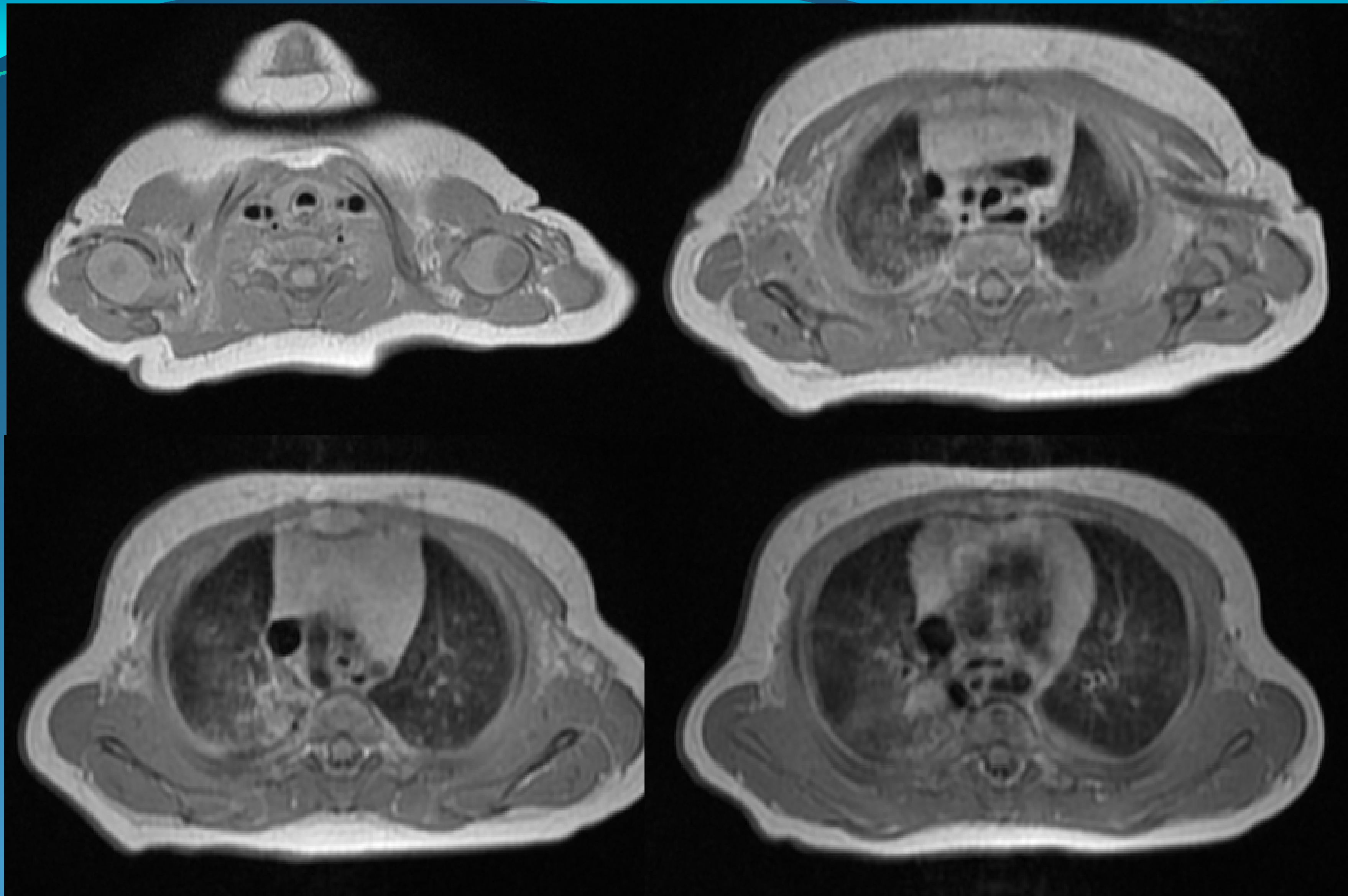
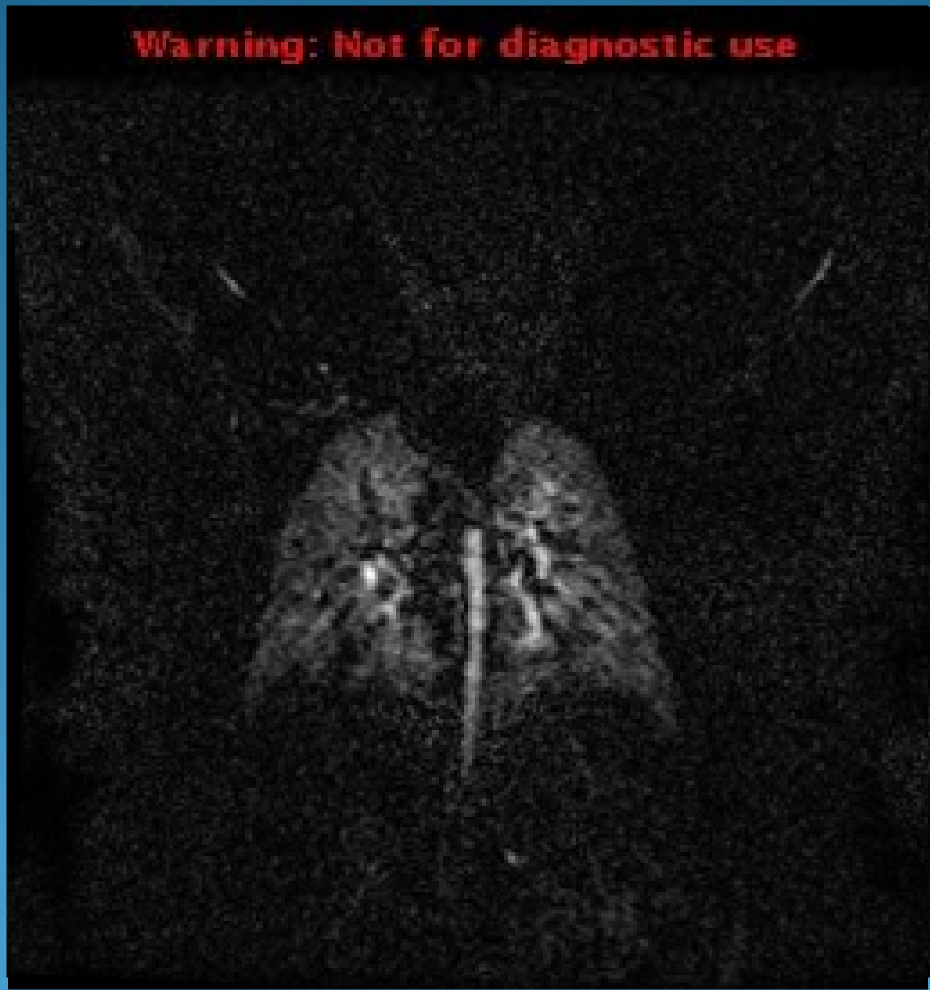
IPL

מקרה 1

- בן 3 חודשים
- מצוקה נשימתית מתגברת עם רעש נשימתי
- FTT
- בברונכוסקופיה היצרות ניכרת מלווה בלחץ פועם בשליש התחתון של הקנה
- חשד לטבעת וסקולרית

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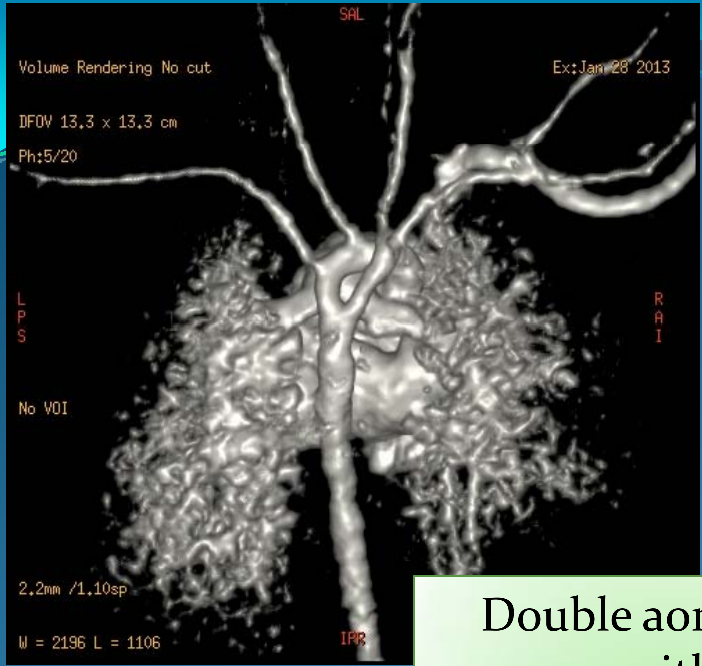
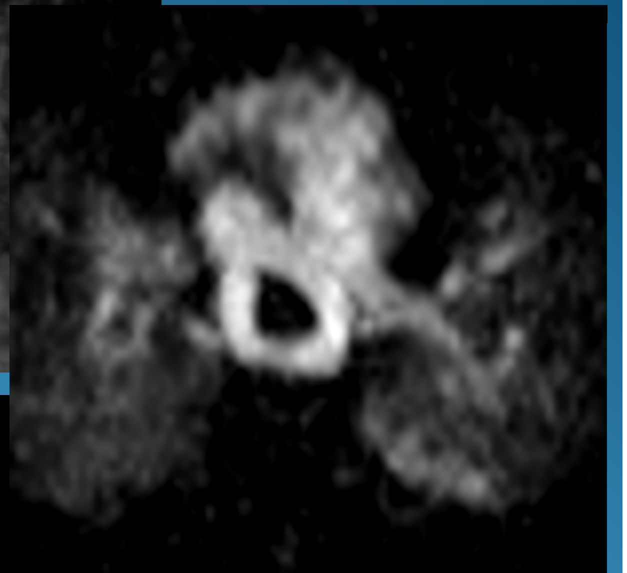
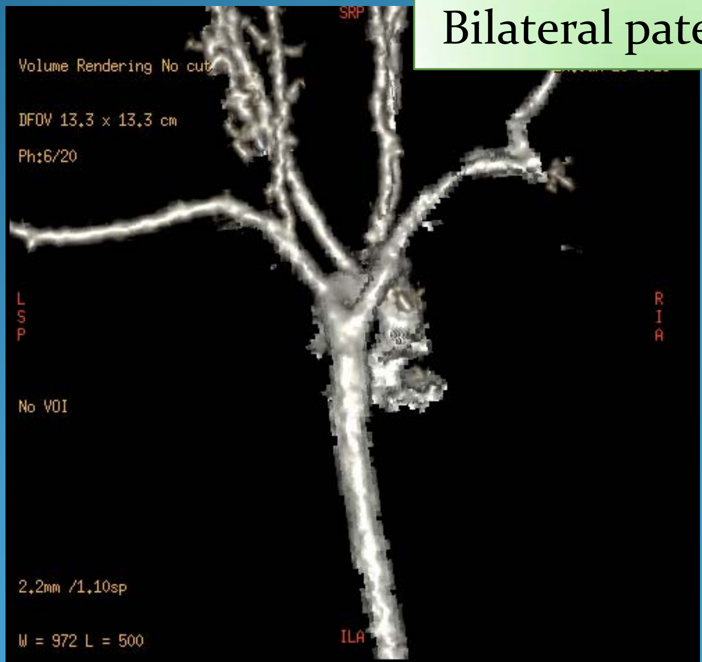


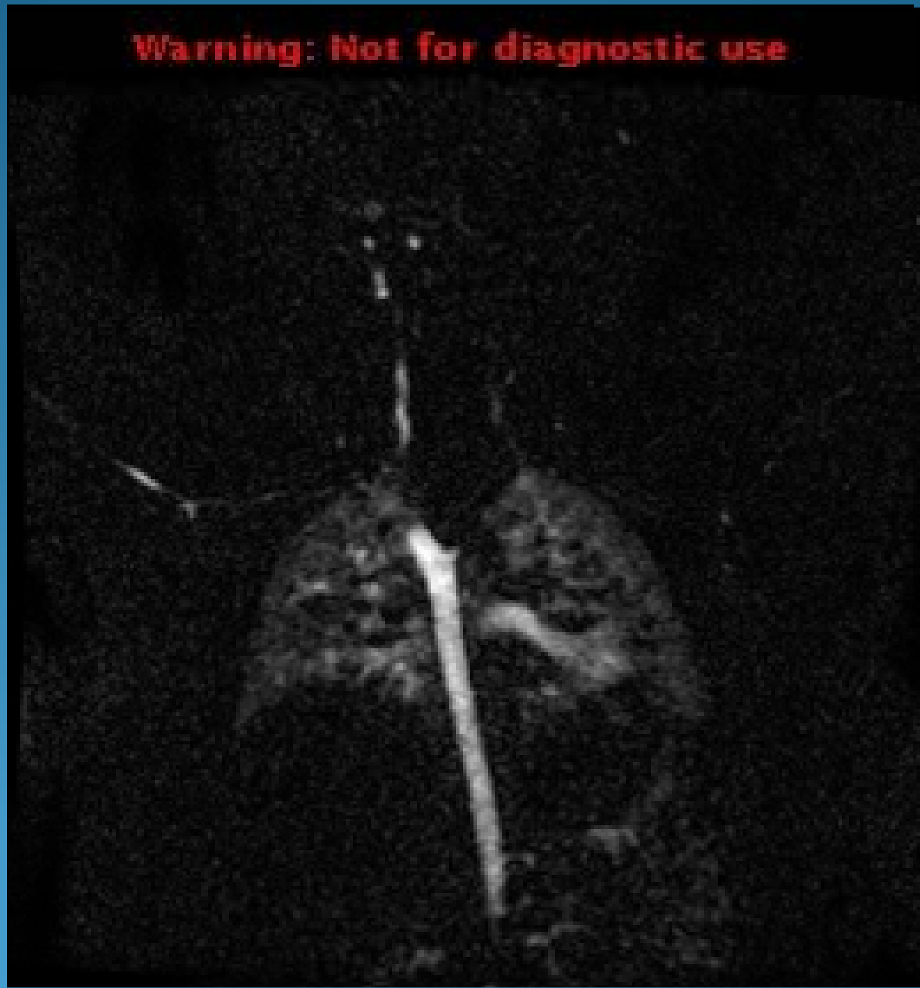


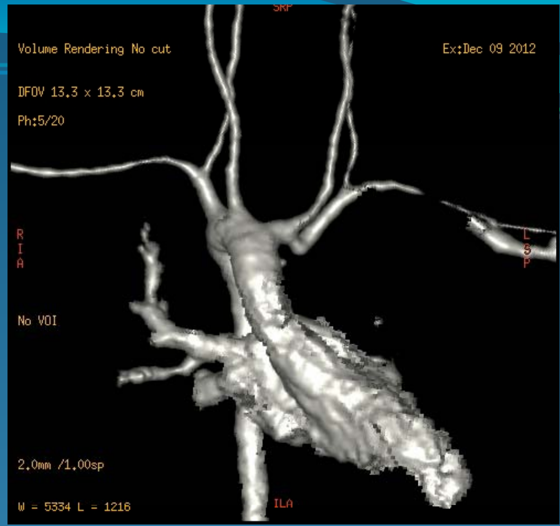
Double aortic arch
with
Bilateral patent arches

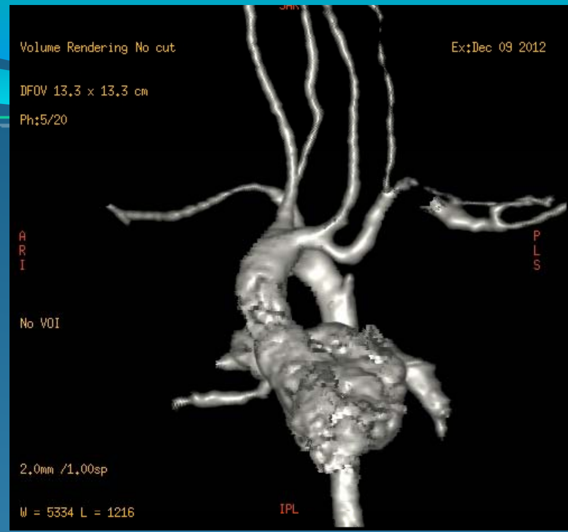


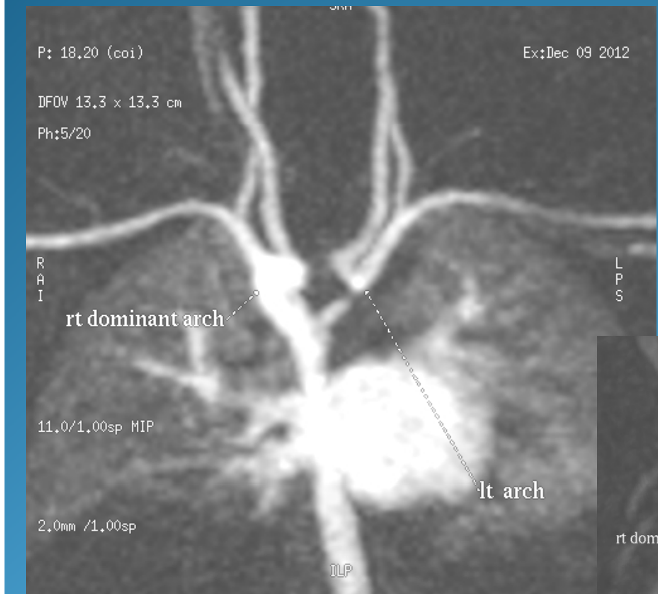
מקרה 2

- בן 12 חודשים
- קוצר נשימה וארועי השתנקות בעת אכילה
- בברונכוסקופיה הצרות קשה של הקנה עם לחץ קידי פועם
- חשד לטבעת וסקולרית

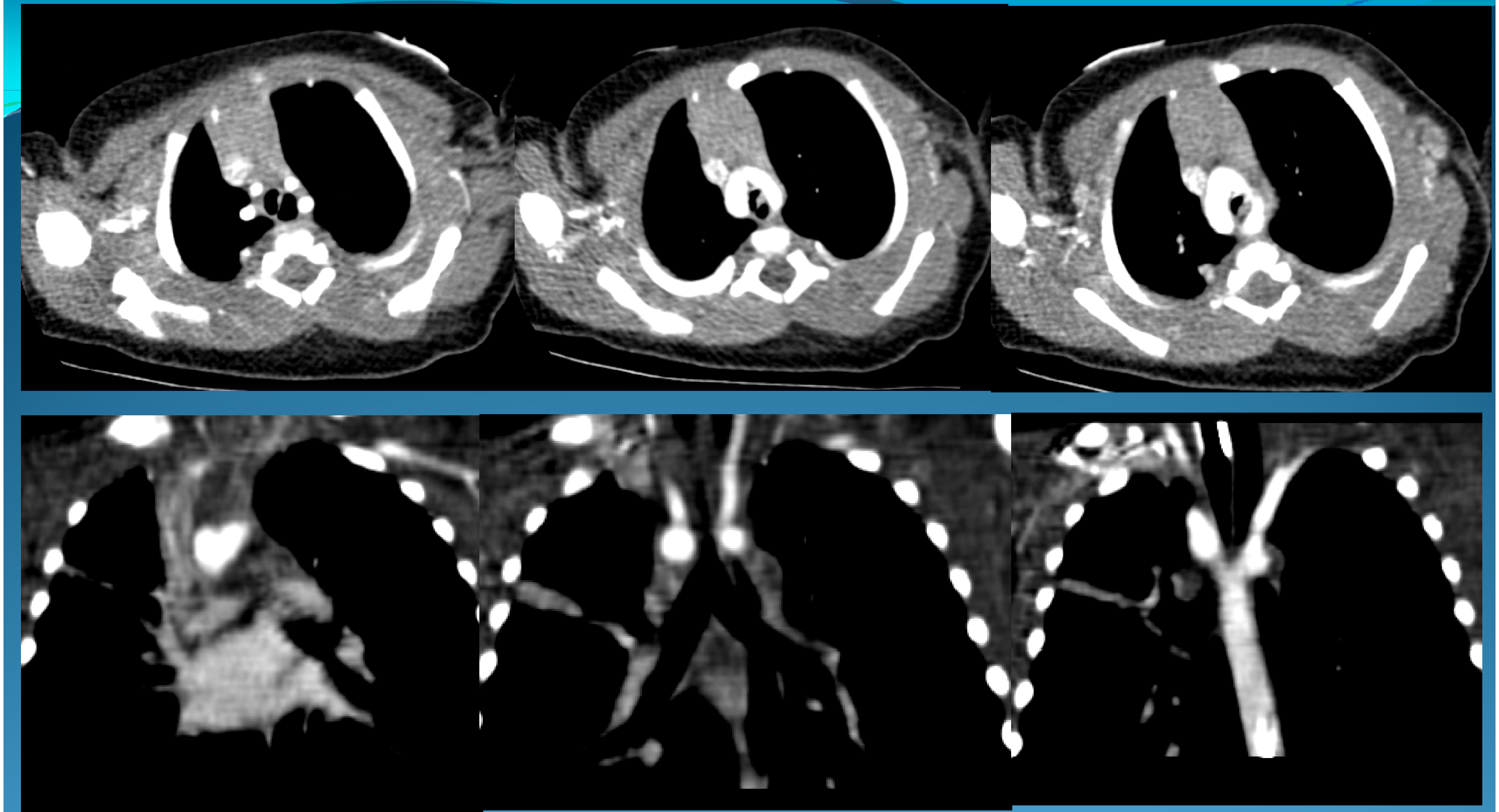

Warning: Not for diagnostic use



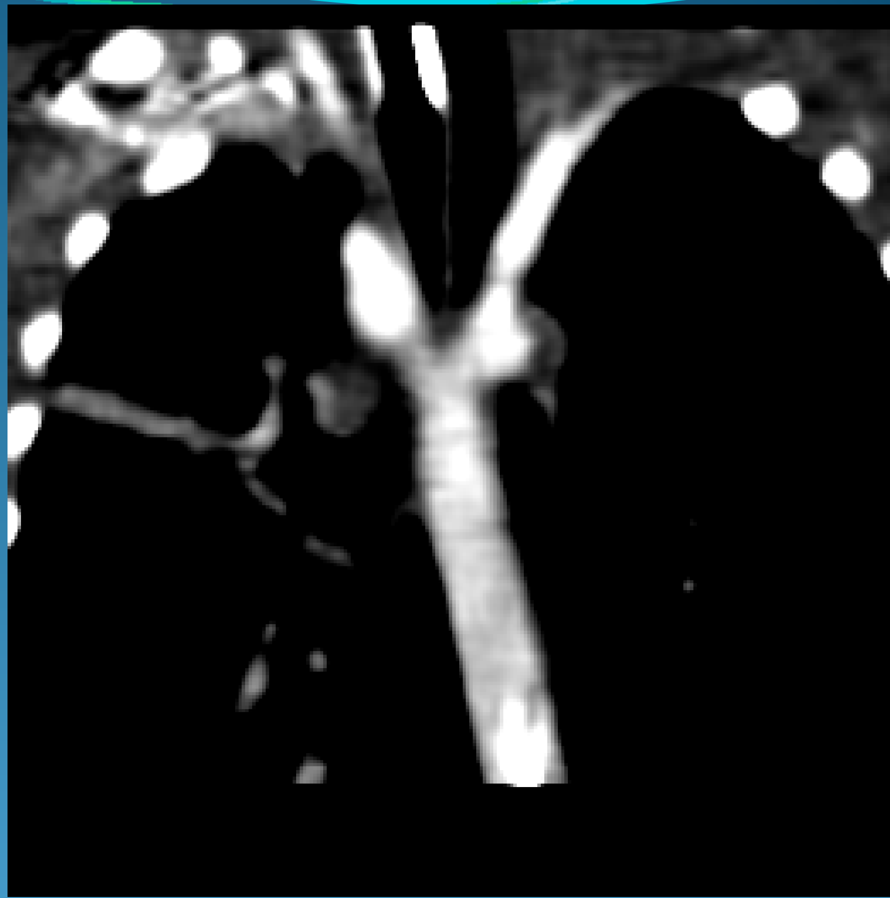




Double aortic arch
with
Dominant right arch
and short segment
atresia in left arch



Double aortic arch
with
Bilateral patent arches



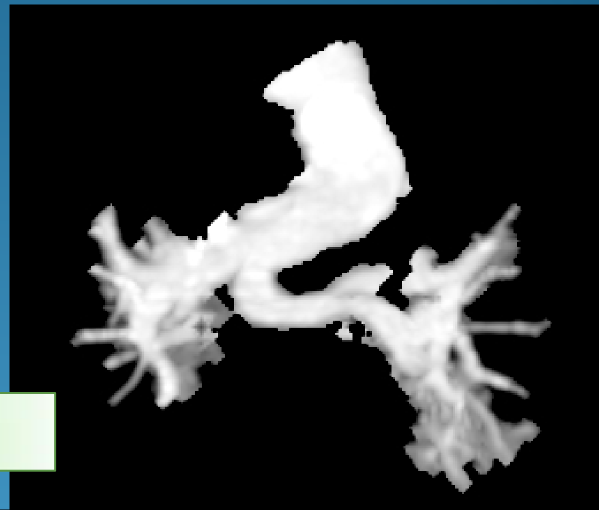
MRA

CTA

מקרה 4

בת 9 חודשים, אשר אושפזה עם אי ספיקה נשימתית

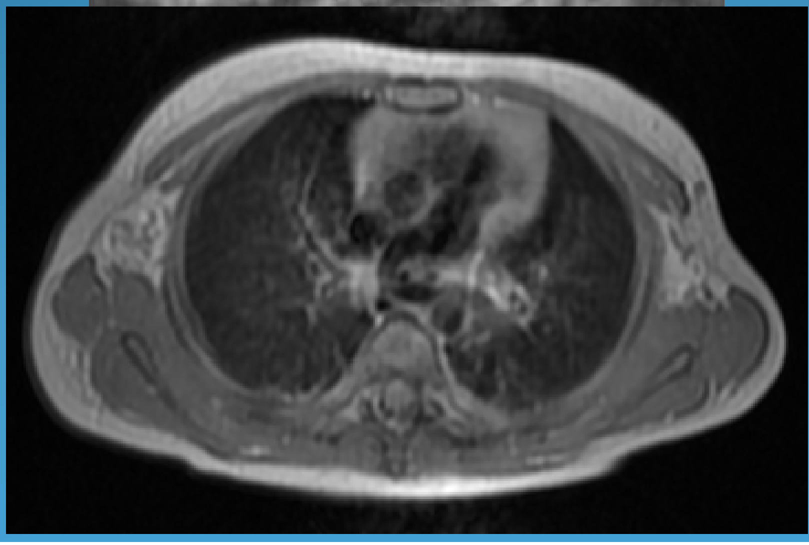
בברונכוסקופיה הצרות קשה בקנה על רקע טבעת סחוסית מלאה



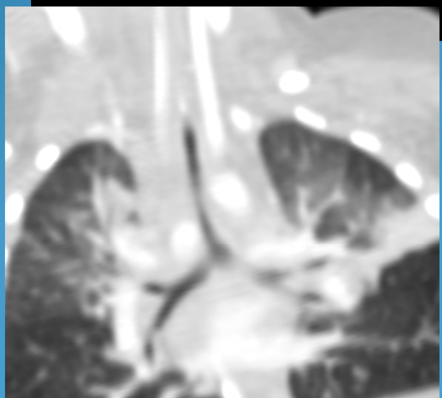
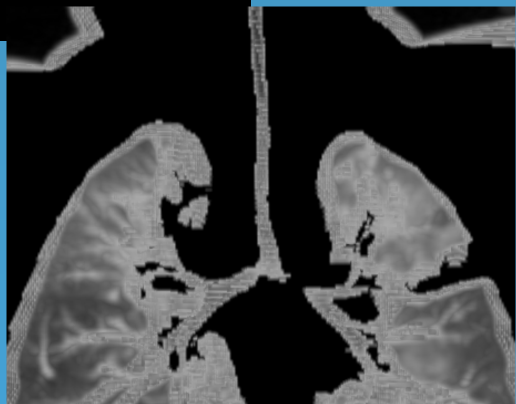
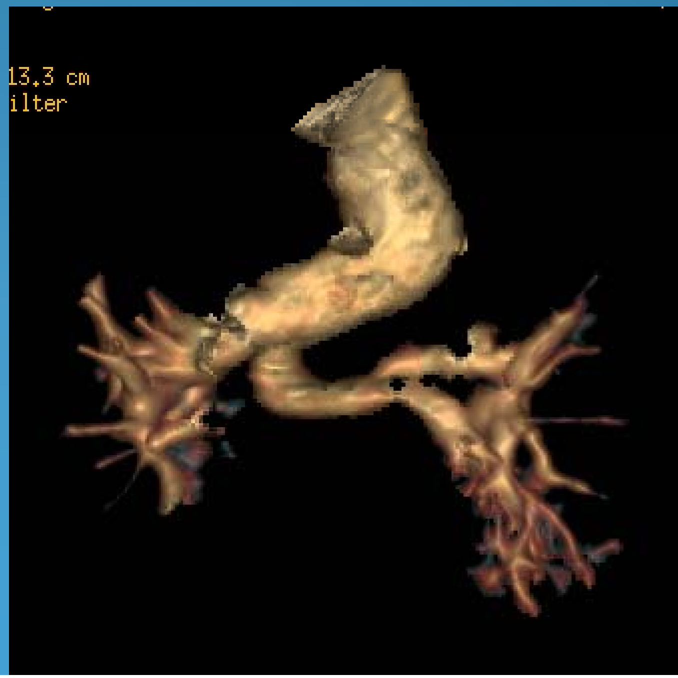
מקרה 5

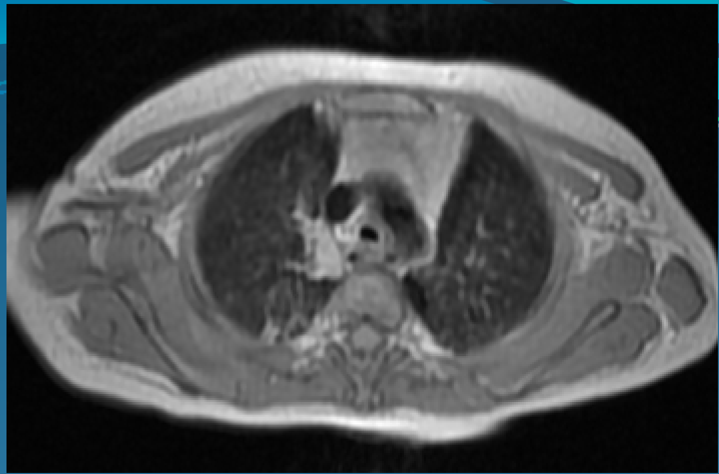
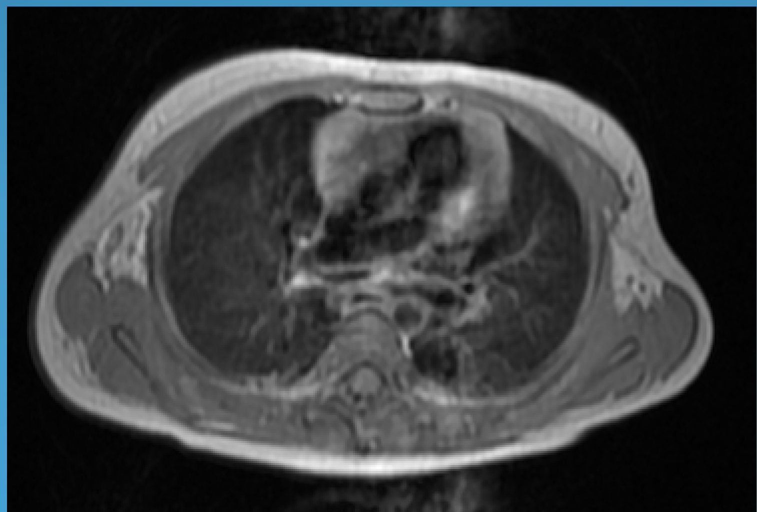
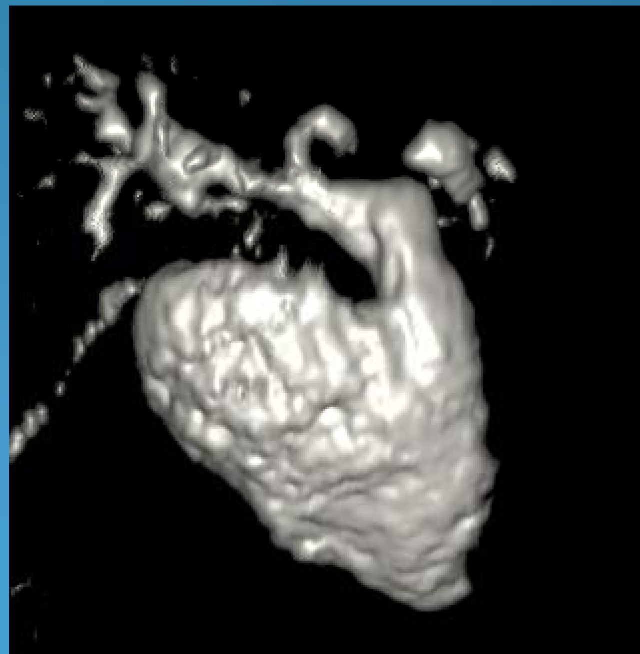
בן 9 חודשים, מצוקה נשימתית עם רעש נשימתי קבוע

בברונכוסקופיה הצרות פועמת בשליש תחתון של הקנה



Pulmonary Sling





13.3 cm
ilter

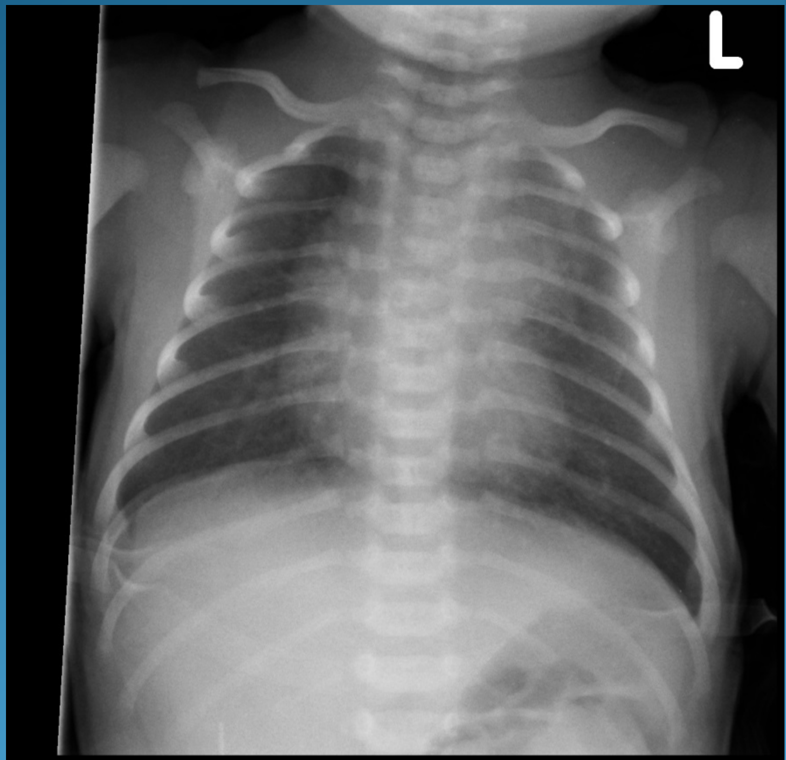
MRA

- Non Ionizing Radiation
- Better temporal resolution
- **Better delineation of mediastinal structures**
  - **Better soft tissue characterization**
  - **Demonstrates segmental bronchii**

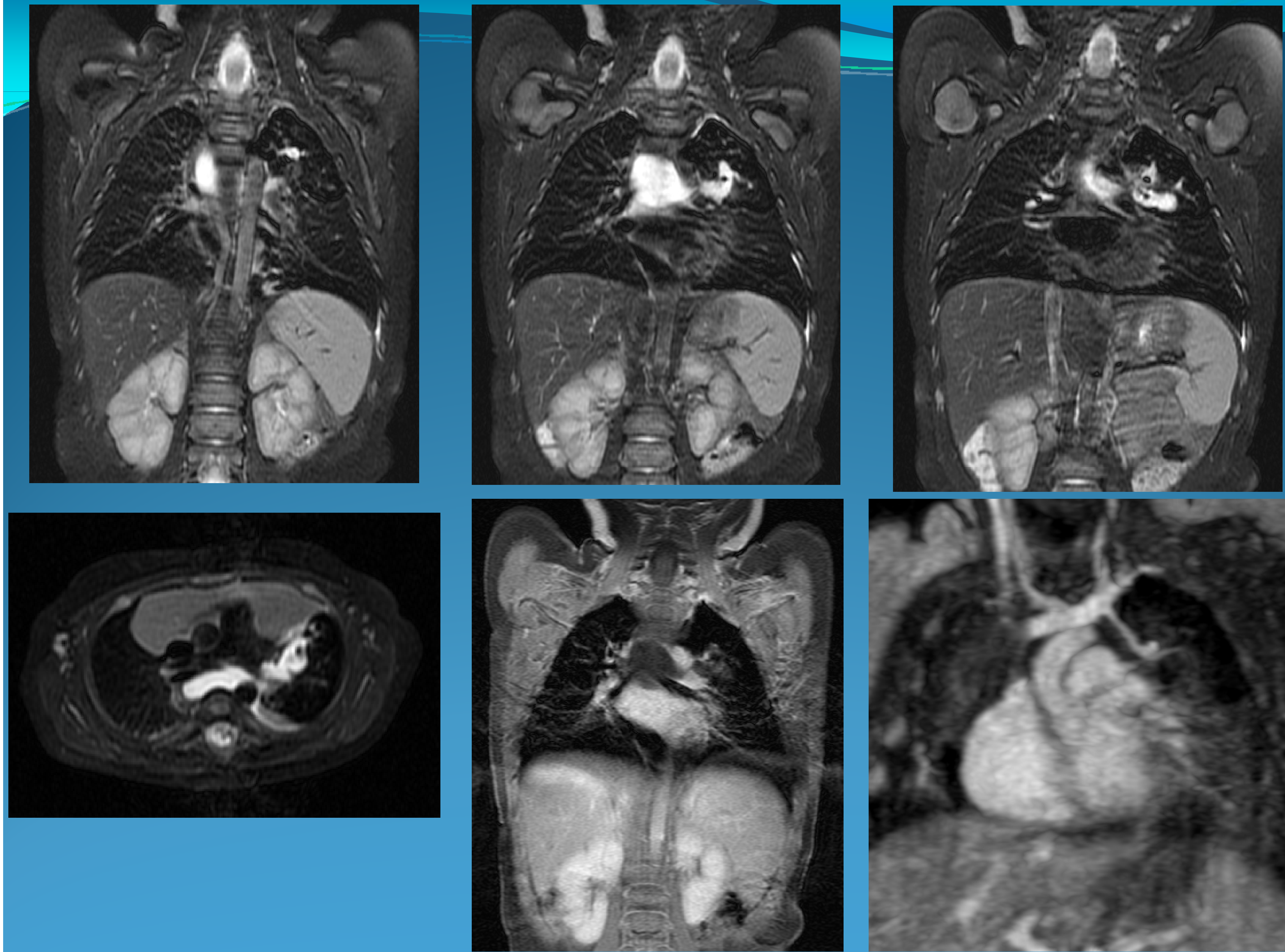
CTA

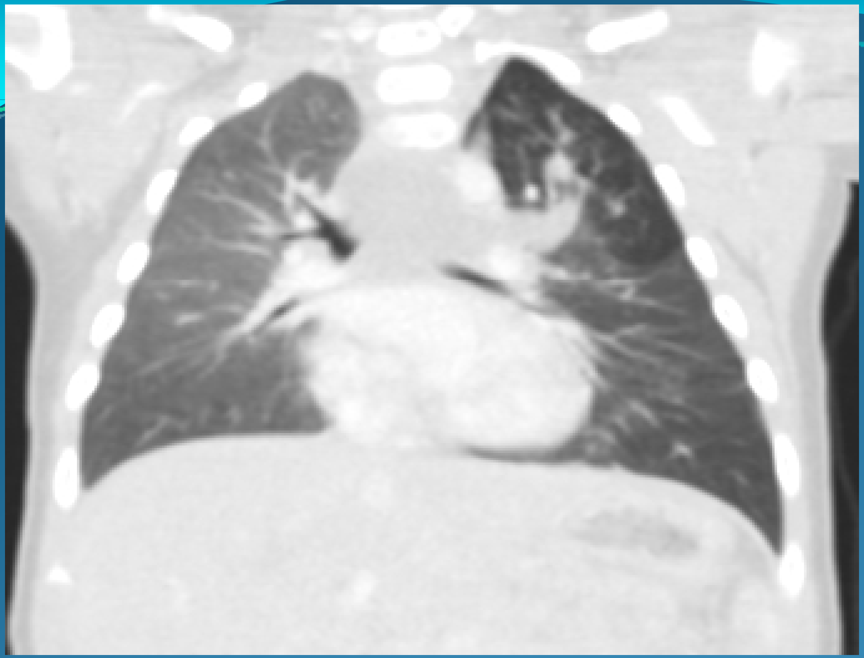
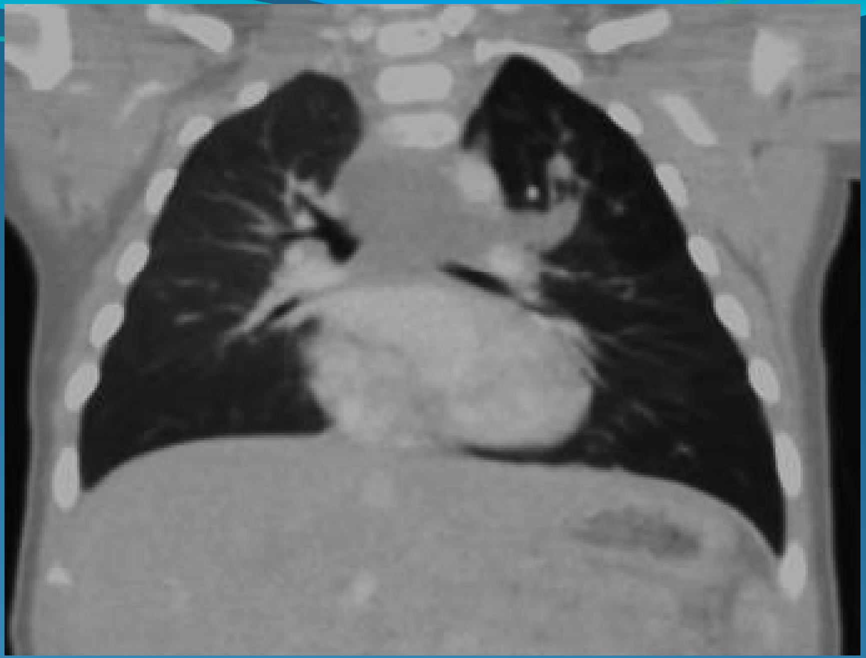
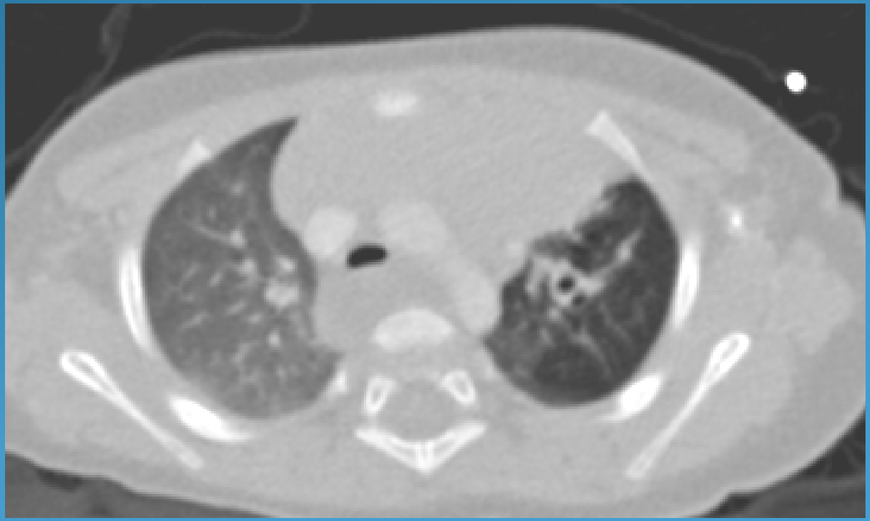
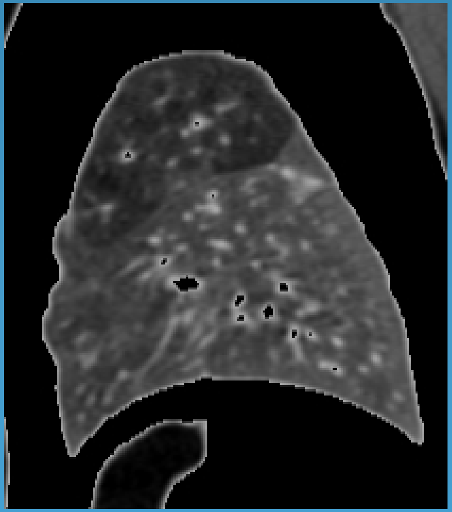
- Ionizing Radiation
- Better spatial resolution
- **Better delineation of lung parenchyma**
  - **Demonstrates the 2ed pulmonary lobule**
  - **Demonstrates down to 6-8 generation bronchii**

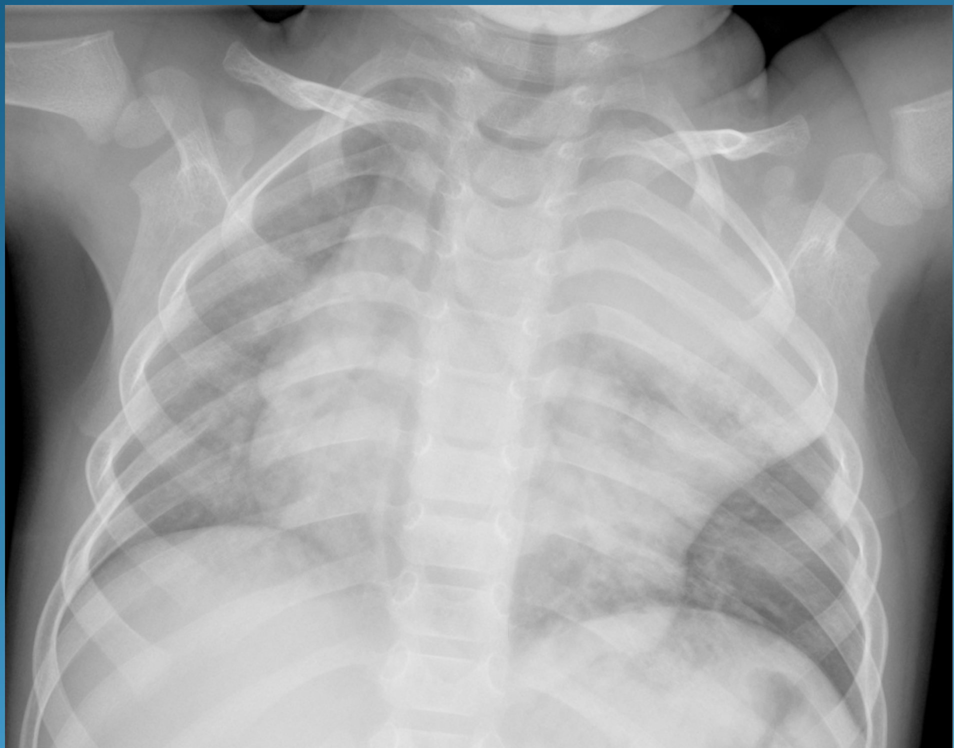
מקרה 6



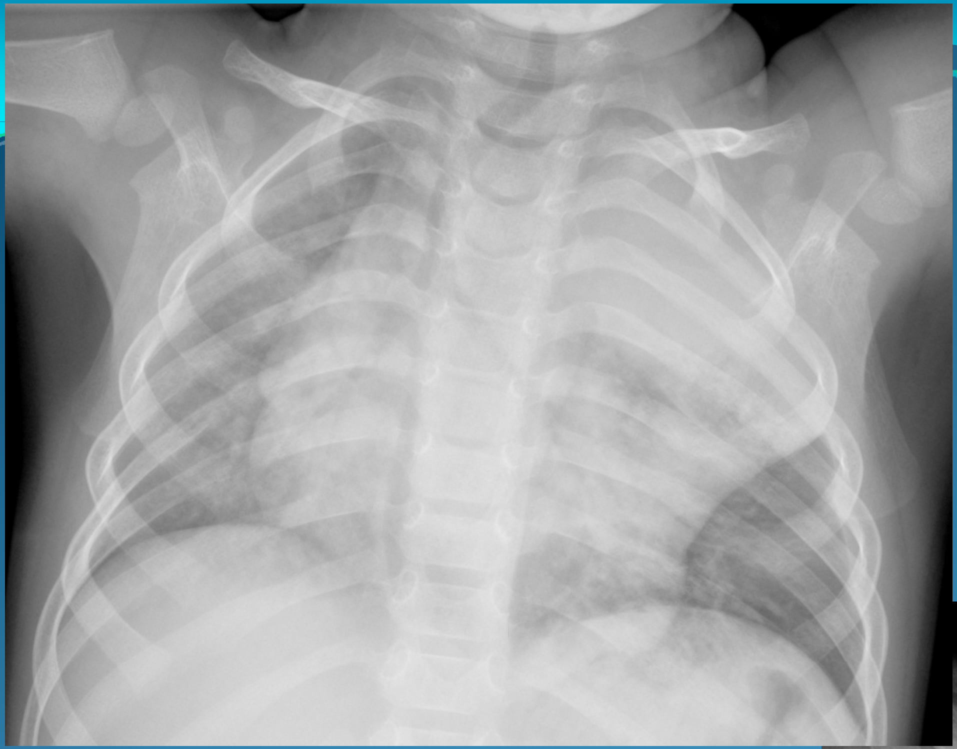
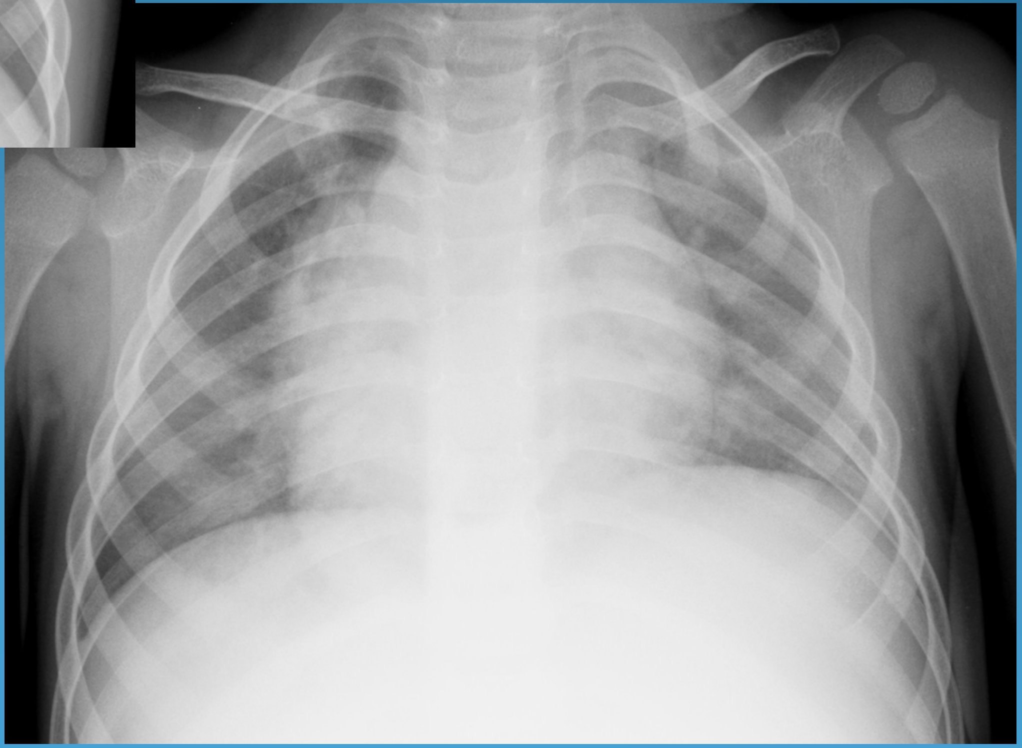
- בן 4 חודשים
- ידוע על ממצא ציסטי בפסגת ריאה שמאלית בסונר עוברי
- בצילום חזה לאחר הלידה הצללה המטשטשת גבול המייצר משמאל, עם דחיקה קלה של הקנה לימין



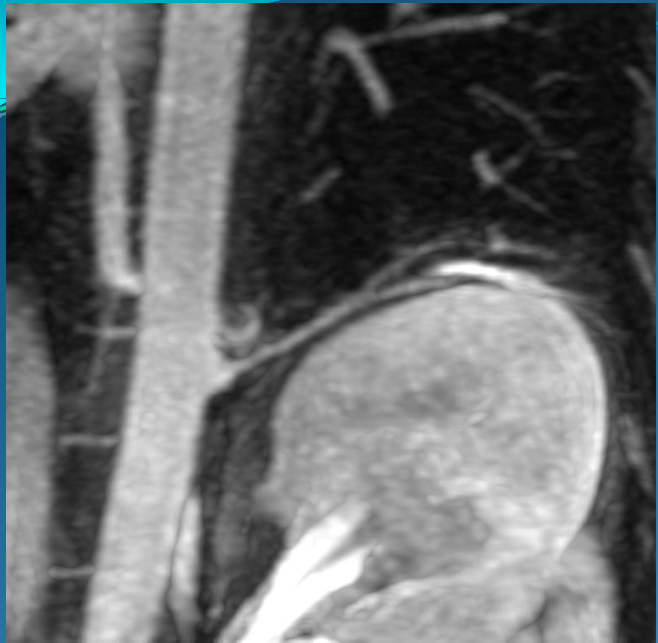







- הילד עבר ניתוח לכריתת הציסטה המדיאסטינלית
- אבחנה פתולוגית – ציסטה ממקור אזופגיאלי
- מספר חודשים לאחר הניתוח מגיע למיון עם מחלת חום ושיעול

- מקרה 7
- בת 14 שנים
- סקווסטרציה ידועה, למעקב



MRA	CTA
Non Ionizing radiation	Ionizing radiation
Better temporal resolution	Better spatial resolution
Better delineation of mediastinal structures	Better delineation of lung parenchyma
Long study time (30-60min)	**MDCT – fast Imaging (few min)**
Longer sedation	**Shorter sedation**

Unstable patient→ higher sedation risk → CTA

חשד קליני לטבעת וסקולרית או מום מבני אחר

האם הילד יציב קלינית וכשיר להרדמה ב- MRI ?

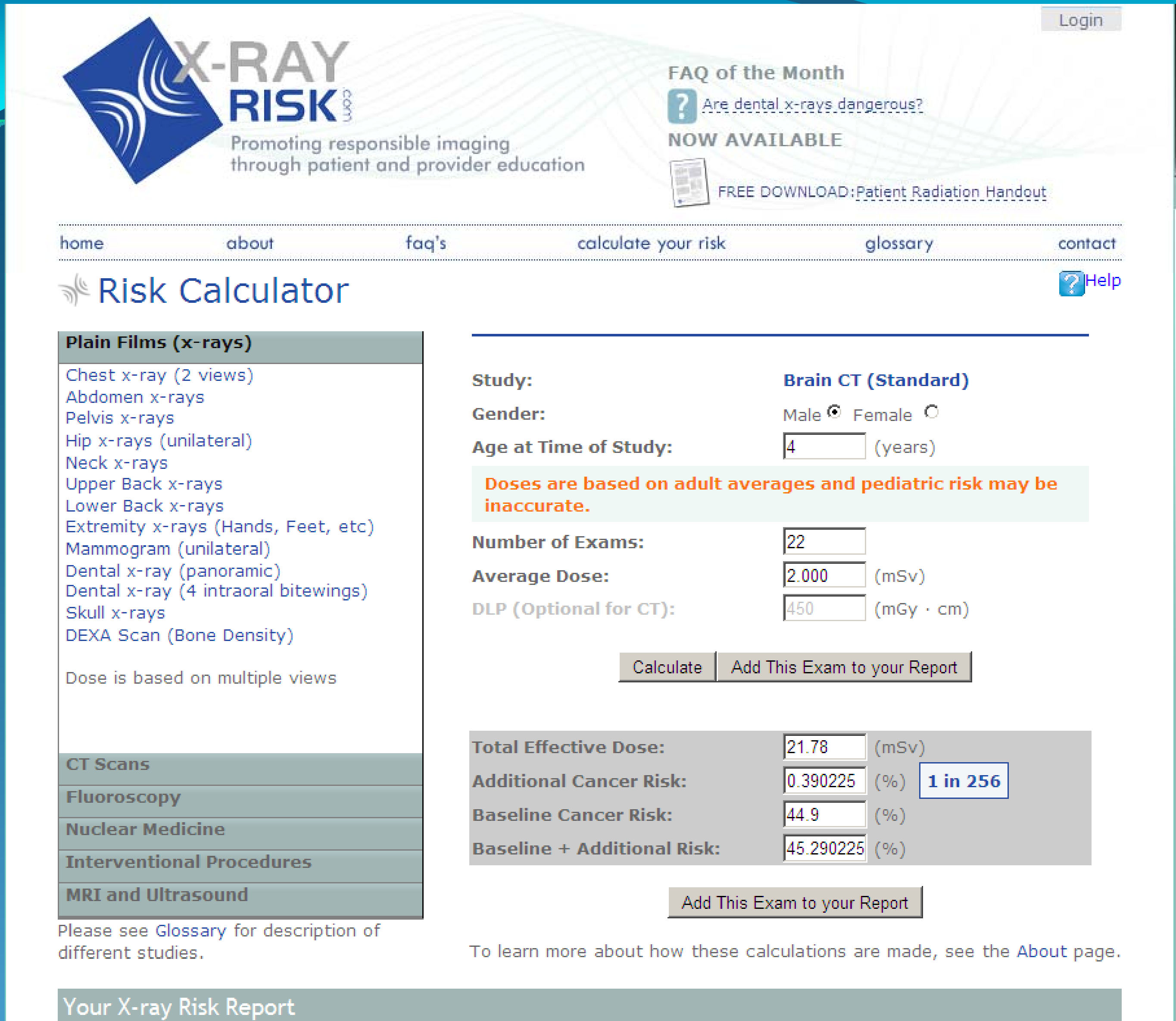
כן

לא

MRA של בית החזה

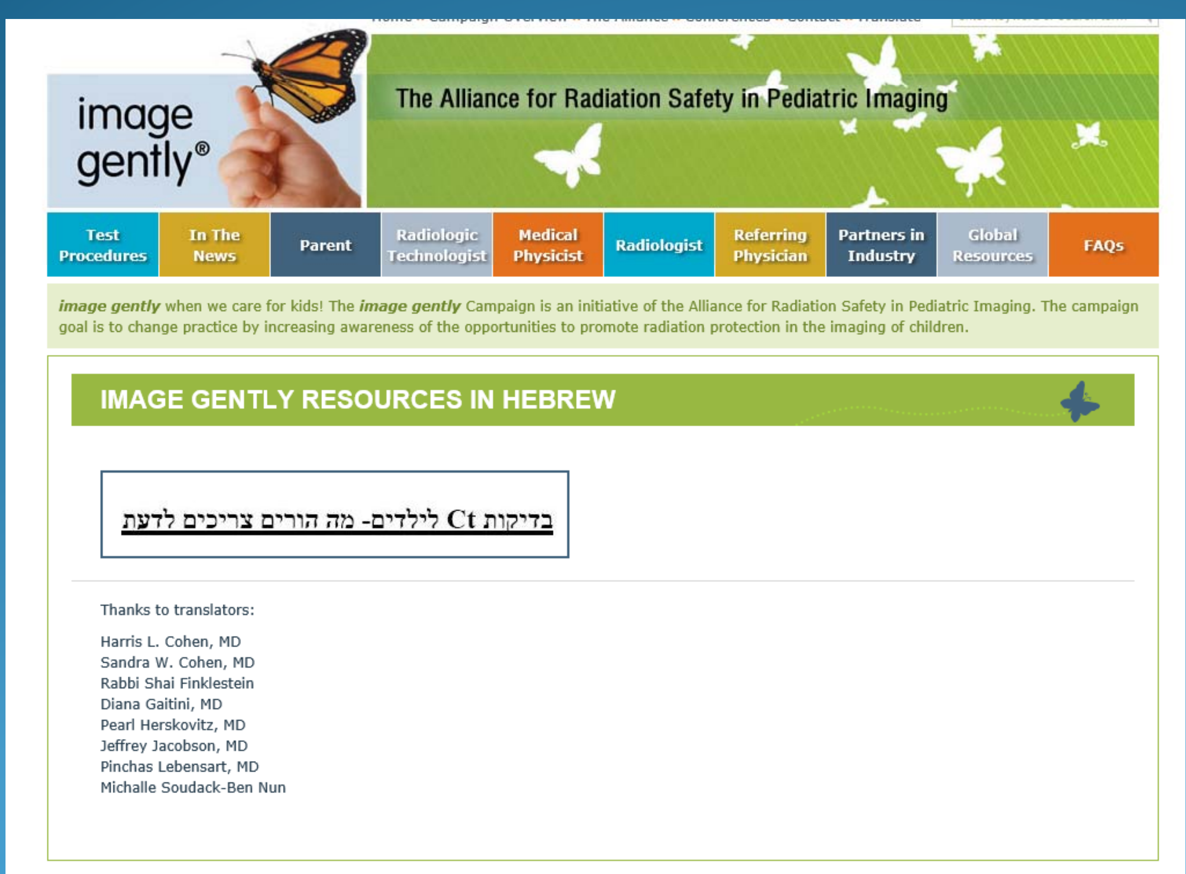
CTA של בית החזה

כאשר CTA של בית החזה הוא בדיקת הבחירה - יש לוודא שיתבצע במקום בו קיימים פרוטוקולים מותאמים לילדים, עם פרמטרים טכניים המותאמים לגיל ומשקל הילד הנבדק



http://www.xrayrisk.com

הסיכון האישי לנבדק קיים אך קטן, ולרוב זניח ביחס לפתולוגיה הדורשת ברור



Comparison Doses

Natural Background	3.1 mSv/year[10]	**Domestic Pilots**	2.2 mSv/year[11]
Average US Exposure	6.2 mSv/year[10]	**7 Hour Airline Flight**	0.02 mSv[12]
Chest x-ray (2 views)	0.10 mSv	**Chest CT**	7.0 mSv

Estimated Lifetime Risk of Death from Various Sources[13]

Motor Vehicle Accident	1% or 1 in 100 chances
Drowning	0.1% or 1 in 1000 chances
Bicycle Accident	0.01% or 1 in 10,000 chances
Lightning	0.001% or 1 in 100,000 chances

Keep in mind, the overall lifetime risk of developing an invasive cancer is 37.5% (1 in 3) for women and 44.9% (1 in 2) for men regardless of imaging history. These statistics are averages and do not predict what is going to happen to you. They do not take into consideration individual risk factors including lifestyle (smoking, diet, exercise, etc), family history (genetics) or radiation exposure. The majority of cancers occur later in life and the average lifetime risk of dying from cancer is 25% (1 in 4).

לסיכום:

להדמיית מומים מולדים בבית החזה בדיקת MRI MRA הינה בדיקה אבחנתית מצוינת, הנותנת אבחנה מדויקת בדומה ל CT עם היתרון של העדר קרינה מייננת

CTA הינה עדין בדיקת הבחירה, כאשר מדובר בנבדק לא יציב, הזקוק לקיצור משך ההרדמה לשם הבדיקה או כשקיים חשד גם לפתולוגיה פרנכימתית ריאתית

כאשר נדרשת בדיקת, CT יש לוודא ביצוע במרכז רפואי עם פרוטוקולים ופרמטרים קליניים המותאמים לגיל הנבדק

The End