



BODY TOMOSYNTHESIS

A. INTRODUCTION/CURRENT PRACTICE

MAGNUS BÄTH, UNIVERSITY OF GOTHENBURG AND SAHLGRENKA UNIVERSITY HOSPITAL, SWEDEN

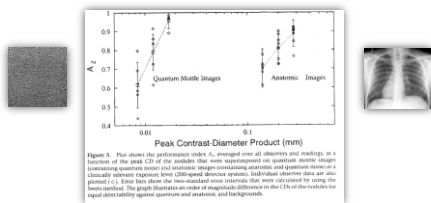


Conventional radiography (X-ray)

- Still fundamental examination in radiology
- Short examination time
- Easy accessibility
- Low cost
- Low radiation dose
- Limited sensitivity and specificity for many tasks

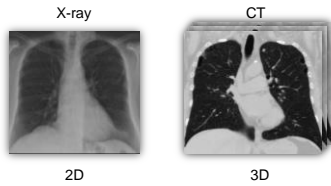


Effect of the anatomical background in conventional radiography





CT solves the problem



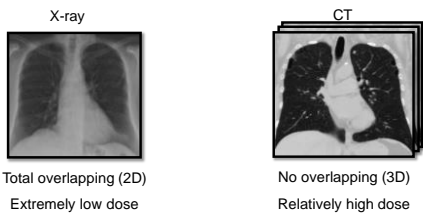


Some disadvantages of CT

- High radiation doses
 - CT: E-1-10 mSv
 - X-ray: E-0.01-0.1 mSv
- Complicated equipment
 - Expensive examination
- For many hospitals: limited resource
 - Delayed diagnostics

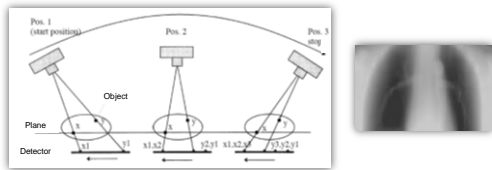


Bridge the gap?





Conventional tomography

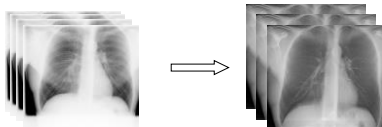


Dose proportional to number of sections
 Problem with overlapping
 Limited use today



Tomosynthesis (TS)

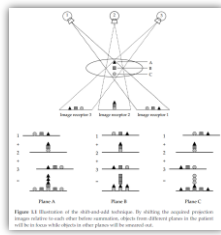
- Modern version of conventional tomography
- A number of projections are acquired at a low dose - over a limited angular range - and used to reconstruct section images of the patient (=limited angle CT)





Tomosynthesis

- Two main improvements from conventional tomography
 - Reconstruction of arbitrary number of section images from one acquisition
 - Reduction of surrounding anatomy
- Why today?
 - Availability of suitable detectors (FPD)
 - Efficient with fast readout
 - Computer power
 - Reconstruction
 - Radiation dose concerns





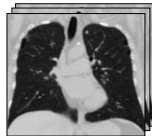
X-ray



TS



CT









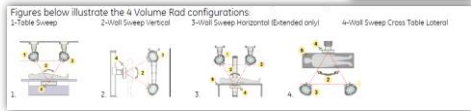
Common system configurations

- TS add-on to existing system
- Parallel planar scanning (linear movement of tube, linear movement or stationary detector)
- Flat panel detectors
- Mainly FBP, but iterative techniques under development



GE Healthcare (VolumeRAD)

- >1200 installations worldwide
- CsI detector
- No. of exposures: 25 - 60
- Swing angle: 20° - 40°
- Acquisition time: ~10 s



© GE Healthcare



Fujifilm (FDR AcSelerate)

- CsI detector
- No. of exposures: 20 - 60
- Swing angle: 10° - 60°
- Acquisition time: 4 - 12 s



© Fujifilm



Shimadzu (RADspeed Pro EDGE)

- CsI detector
- No. of exposures: up to 60
- Swing angle: 20° - 60°
- Acquisition time: ~10 s
- Iterative reconstruction (T-smart)





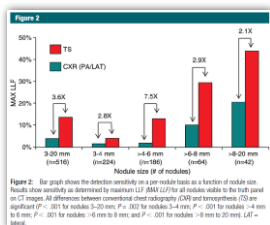
Shimadzu (SONIALVISION G4)

- Radiography/fluoroscopy system
- Acquisition time: <5 s (15 or 30 fps)
- CsI detector
 - Earlier system (Safire) a:Se
- No. of exposures: up to 75
- Swing angle: 8° - 40°





Thoracic imaging



Dobbins et al. Radiology doi:10.1148/radiol.2016150497 (published online 2016)



X-ray



TS





X-ray



TS





X-ray



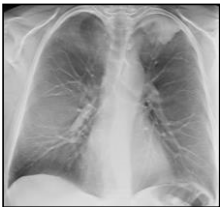
TS



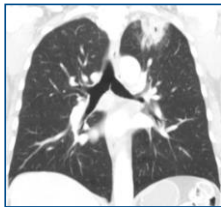
X-ray



TS



CT





Other proposed/established use in thoracic imaging

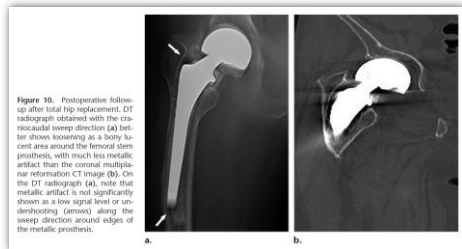
- Follow-up of patients with cystic fibrosis
- Follow-up of nodules
- Lung cancer screening
- ...



Musculo-skeletal imaging



Machida et al. Radiographics 2016;36:755-770



Machida et al. Radiographics 2016;36:755-770



Abdominal imaging



Wells et al. Br. J. Radiol. 2011;84:464-469



"In my opinion, chest tomosynthesis is a failed technology in the UK. I am disappointed as I think that tomosynthesis has a great deal to offer a general radiography department. I have spoken with suppliers in the UK and systems are not being purchased. Essentially, I think tomosynthesis is seen as a 'poor man's CT' rather than an improvement to chest radiography and perhaps relieve some of the strain from CT." (anonymous reviewer, 2015)





TS as problem solver after non-conclusive X-ray

- Suspicious finding on X-ray
- Previously: patient sent to CT (radiological referral)
 - waiting time, etc.
- Now: patient goes to TS (without waiting time)
 - Conclusive: good
 - Still non-conclusive: patient sent to CT (with possibly higher priority)
- Chest: TS obviates the need for CT in 75% of these cases
 - Vikgren et al, RSNA 2011
 - Quaia et al, Eur Radiol 2012;22:1912-1922
- Similar experience of TS as problem solver in musculoskeletal imaging



TS as problem solver





TS as problem solver






"However, even with the remarkable functionality of tomosynthesis, it will not be utilized unless the environment for using this technology is provided and information is provided to the doctors that order examinations."

Y. Uchida (Japan) MEDICAL
NCW No. 75, 2014.8



Summary

- TS is a quick, cheap, low-dose technique for section imaging of the body
- TS is more of a rich man's X-ray than a poor man's CT – but mostly a modality of its own
- TS is established in clinical practice at many institutions – both as a problem solver and as a first examination
- TS has potential to optimize the use of imaging resources at a department – medical physicists important for establishing its proper use



UNIVERSITY OF GOTHENBURG

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Magnus Båth, Ph.D.
magnus.bath@gu.se
