2nd PANHELLENIC CONGRESS OF MEDICAL PHYSICS
4-6 OCTOBER 2024| EUGENIDES FOUNDATION

A comparative study of effective doses in C-arm CT 3D neuroradiological procedures and MSCT brain scans

C. Tierris[1], PhD, I. Tatsis[1], PhD and K. Lagios[2], MD

[1]Radiation Physics Department, 251 Hellenic Air Force Hospital, Athens, Greece

[2]Interventional Radiology & Neuroradiology Department, 251 Hellenic Air Force Hospital, Athens, Greece

1. Background-Aim

Rotational acquisitions, as performed on a digital C-arm angiography system with a flat panel detector, are a very useful tool for the treatment of various complex cerebral conditions in interventional neuroradiological procedures and particularly important in life threatening situations, where good quality images are crucial.

Nevertheless, these views are usually associated with increased radiation dose to both patients and personnel.

The purpose of this study was to estimate effective doses, EDs, from C-arm flat panel rotational acquisitions, (CT & 3D) used in common neuro-radiological procedures and to compare them to EDs from brain Multi Slice Computed Tomography, MSCT scans in the 251 Hellenic Airforce Hospital, (251 HAF Hospital) in Athens, Greece.

2. Materials & Methods

Teamplay software by Siemens Healthineers, was used to collect dosimetric data from patients undergoing 3 general neuroradiological procedures:

- ❖ aneurysm embolization
- ❖ embolization of arteriovenus malformation
- ❖ arteriography of 4 cerebral vessels,

on a dual C-arm (Siemens Icono Biplane) digital angiography system, using measurements from the Dose Area Product, DAP meter attached to the tube housing.

The study data consisted of DAP values ($Gycm^2$) (corrected for inaccuracy, by a mean factor of 0,944) from 957 rotational scans, performed on 94 patients, with 11 acquisition protocols, in 2023. Mean DAP values, as well as mean use (no of events per procedure) were calculated for each protocol.

2. Materials & Methods

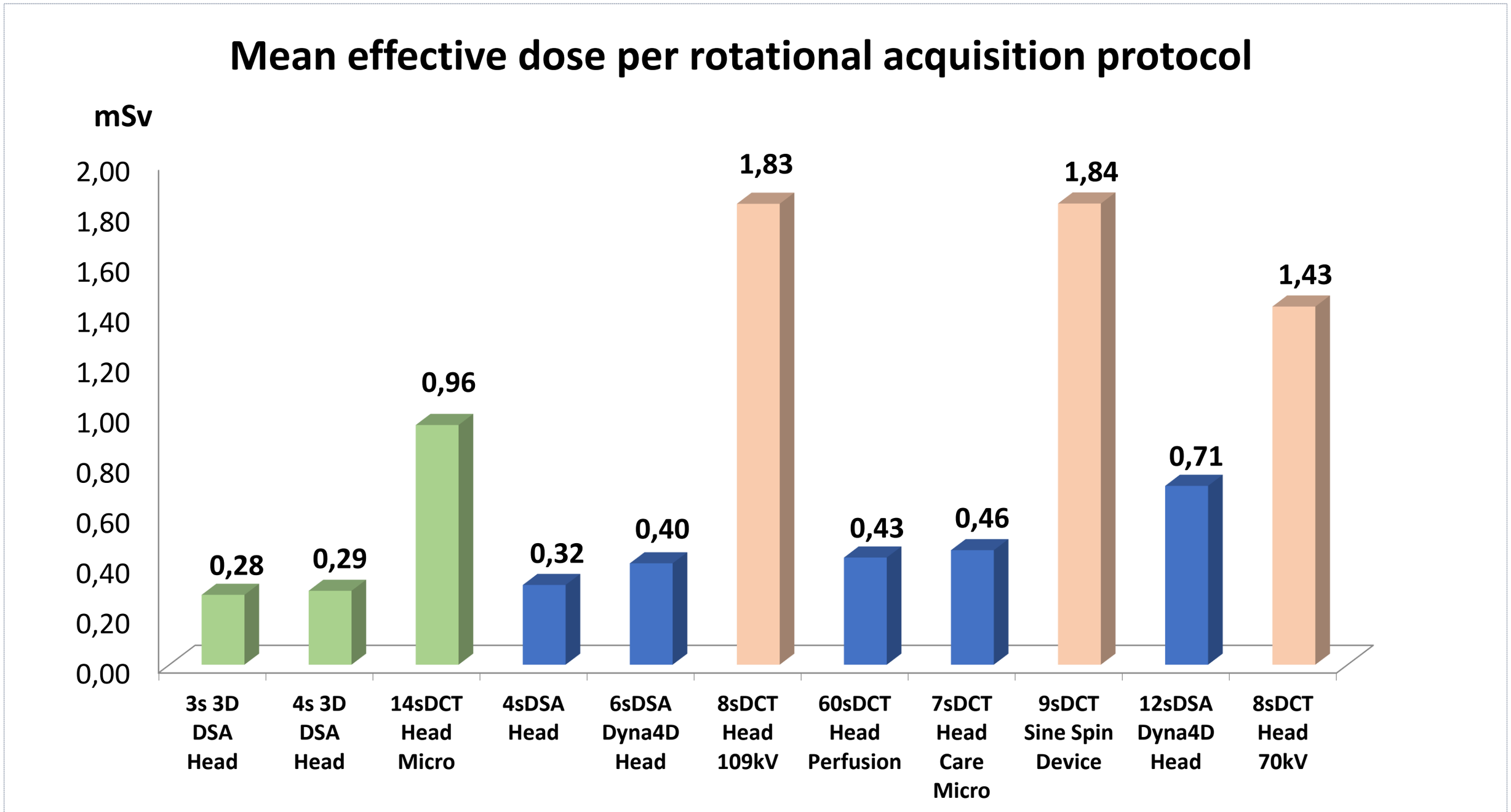
Effective Doses, EDs, were calculated using the factor: 0,035 mSv/Gycm^2, as proposed by Mei Bai et al, 2013[1].

In Computed Tomography, CT, DoseWatch software by General Electric, was used to collect Dose Length Product, DLP (mGycm) values for helical head CT: Head/Brain 1,25 mm STD scans, performed on a MSCT system (GE Revolution GSI) for a total of 138 patients in 2024. The mean value of DLP was calculated.

The factor: 0,0021 mSv/mGycm (ICRP 102, 2007)[2] was used to convert DLP to ED.

3. Results

Acquisition Protocol	n of patients	% of use	Mean no of events/procedure	Corrected DAP Gy cm^2	SD Gy cm^2	Eff Dose mSv	SD mSv
3s 3D DSA Head	75	37	4,7	8,0	2,1	0,28	0,07
4s 3D DSA Head	52	23	4,2	9,0	1,4	0,29	0,07
14sDCT Head Micro	56	10	1,8	27,3	12,7	0,96	0,44
4sDSA Head	14	6	4,3	9,1	1,0	0,32	0,04
6sDSA Dyna4D Head	19	6	2,7	11,6	2,4	0,40	0,08
8sDCT Head 109kV	34	5	1,4	52,4	10,3	1,83	0,36
60sDCT Head Perfusion	3	4	13,3	12,2	11,2	0,43	0,39
7sDCT Head Care Micro	24	3	1,3	13,0	2,7	0,46	0,09
9sDCT Sine Spin Device	18	2	1,2	52,4	19,5	1,84	0,68
12sDSA Dyna4D Head	7	2	2,6	20,4	2,3	0,71	0,08
8sDCT Head 70kV	13	1	1,1	40,7	22,1	1,43	0,77


Mean effective dose per rotational acquisition protocol
mSv
2,00
1,80
1,60
1,40
1,20
1,00
0,80
0,60
0,40
0,20
0,00
0,28
0,29
0,96
0,32
0,40
1,83
0,43
0,46
1,84
0,71
1,43
3s 3D DSA Head
4s 3D DSA Head
14sDCT Head Micro
4sDSA Head
6sDSA Dyna4D Head
8sDCT Head 109kV
60sDCT Head Perfusion
7sDCT Head Care Micro
9sDCT Sine Spin Device
12sDSA Dyna4D Head
8sDCT Head 70kV

3. Results

The mean value of DLP was: 953 ± 107 mGycm. Mean ED from Helical Head/Brain 1,25 mm STD MSCT scan was: **2,00 ± 0,22 mSv.**

EDs for the 2 most commonly used rotational acquisition protocols:

- 3s 3D DSA Head (37%),
- 4s 3D DSA Head (23%) were the **lowest**, compared to the other protocols and accounted for **14,0%, 14,5%** the dose from a Helical Head/Brain MSCT scan respectively (mean value). These protocols had also the highest use/patient: 4,5 events/procedure on average.
- 14sDCT Head Micro, with a moderate use (10%), had also a **moderate ED**, corresponding to **48,0%** the dose from a Helical Head/Brain MSCT scan.
- 9sDCT Sine Spin Device,
- 8sDCT Head 109kV and
- 8sDCT Head 70kV, with a relatively low use (9% in total) and the lowest mean use/patient: 1,2%, had the **highest mean EDs**, corresponding to **91,5%, 92,0% and 71,5%** respectively the dose from a Helical Head/Brain MSCT scan.

4. Conclusions

In conclusion, **effective doses** from the most frequently used rotational C-arm acquisition protocols in neuroradiological procedures are more than **50% lower** than EDs from helical brain MSCT scans.

The protocols with the highest EDs, similar to that of a brain MSCT scan, are not so frequent and have the smallest use/patient.

Therefore in general, rotational acquisitions can be justified, in terms of radiation dose and procedure benefits to the patient.

5. References

1. Bai M, Liu X, Liu B. Effective patient dose during neuroradiological C-arm CT procedures. Diagn Interv Radiol 2013; 19:29–32.
2. ICRP 102. Annals of the International Commission on Radiological Protection. Managing Patient Dose in Multi-Detector Computed Tomography (MDCT). J Valentin. 2007 ICRP. Published by Elsevier Ltd.