The Royal Liverpool and Broadgreen University Hospitals NHS

Haemodialysis and Sequential I131 Ablation Therapy for Metastatic Follicular Ca: A Radiation Protection Perspective

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Clinical Background and Objective

A patient with lung metastases secondary to primary thyroid carcinoma was referred for potential I131-Sodium Iodide radionuclide ablation therapy which is an established technique at our centre.

Following administration of 74MBq of I131 sodium-iodide, SPECT/CT imaging on a Siemens Symbia T system localised intense uptake to a lymph node (figure 1) and to a moderate degree in lung metastases (figure 2).

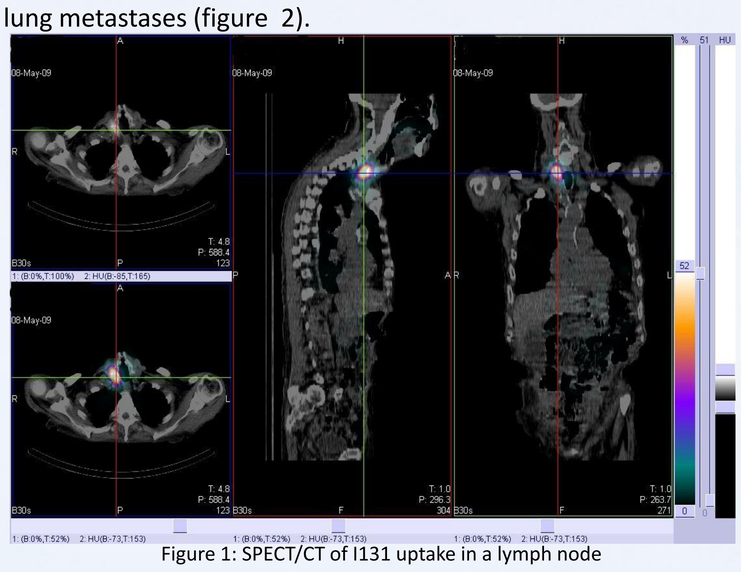

Figure 1: SPECT/CT of I131 uptake in a lymph node

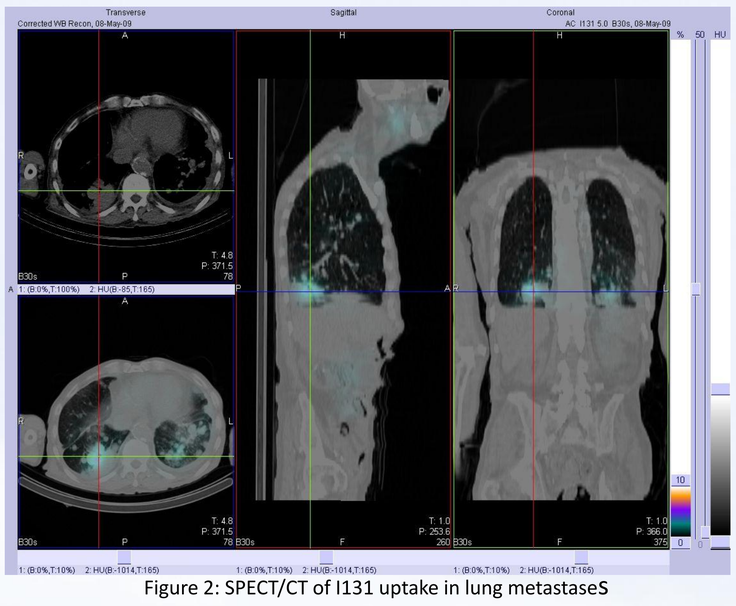

Figure 2: SPECT/CT of I131 uptake in lung metastaseS

However, this patient had chronic renal failure, requiring haemodialysis thrice weekly at a centre operating under The Radioactive Substances (Hospitals) Exemption Order 1990 with a monthly non-Tc99m liquid waste authorisation limit of 500MBq.

Literature Survey

A review of published literature saw a mixed approach to I131 treatment of patient on Haemodialysis.

Administering a lower activity (25% of the normal), performing dialysis at 24hours to reduce the quantity of I131 in the blood pool and repeating in 6 months was successful for one group [1].

Daily haemodialysis following treatment using the full activity on 3 different patients was carried out by Jimenez et al [2].

Analysis of the average clearance curve produced an effective half life of 3.9days

Another group analysed the dialyzate waste samples for dialysis sessions at 24, 72 and 144 hours to calculate the effective half-life of I131 sodium-iodide during haemodialysis to be 2.7± 0.8hours compared to 11.4hours in a patient with normal renal function [3].

References

[1]Daumerie C et al, 1996, radioiodine Treatment of Thyroid Carcinoma in Patients on Maintenance Hemodialysis, Thyroid, vol 6, No 4, 301-304

[2]Jimenez et al. 2002, Treatment of Thyroid Papillary Carcinoma in Patients Undergoing Dialysis of Chronic Renal Faiure: A Dosimetric Method, Thyroid Vol 11, No 11:1031-1034

[3]Magne et al, 2002, disposition of Radioiodine 131I therapy for Thyroid Carcinoma in a Patient with Severely Impaired Renal Function on Chronic Dialysis: a Case Report, Jpn J clin Oncol 32(6)202-205

Practical Considerations

- Activity to be administered, initial and follow-up therapies
- Frequency and location of Haemodialysis
- Contamination of haemodialysis equipment
- Clearance rate
- Dose to the patient
- Dose to the staff (both on the ward and the Dialysis Unit)
- Dose to the patient's family and friends
- Dose to the General Public
- Management of Radioactive Waste

Treatment Schedule

	T1	T2	T3
Pre-Treatment haemodialysis	-1	-1	-1
Therapy Administered	0	0	0
Post Treatment haemodialysis 1	1	1	0.6
Post Treatment haemodialysis 2	3	3	2.6
Post Treatment haemodialysis 3	6	5	6.1
Post Treatment haemodialysis 4	-	-	7.6
Discharged	7	6	8.5

Figure 3: Summary of treatment schedules and haemodialysis sessions whilst an in-patient. (Numbers represent days since I131 was administered.)

Activities administered, 5209MBq (Therapy1), 5413MBq (Therapy2), 7513MBq (Therapy3).

Retained Activity

The quantity of I131 retained by the patient following therapy episodes was estimated at several time points during the in-patient phase using a fixed measurement geometry in the patient's en-suite Controlled Area facility.

Equipment

- Dose Rate Monitor: Mini-Rad 1000 Survey Meter (Thermo Electron Corporation)
- Ratemeter: Radiation Alert Inspector EXP+ (S.E.International)

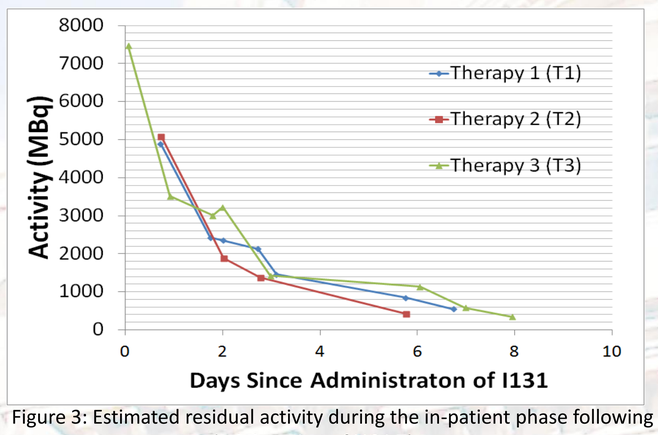

Figure 3: Estimated residual activity during the in-patient phase following administration of I131 Therapy

Therapy Session	Activity (MBq)
T1 (5209MBq)	540
T2 (5431MBq)	420
T3 (7513MBq)	327

Figure 4: Activity on board the patient when leaving the Temporary Controlled Area

Survey of the dialysis suite found no residual contamination following removal of the waste generated by the procedure.

Occupational Dosimetry

The occupational doses of the dialysis unit staff were monitored using Siemens Electronic Personal Dosimeters. The cumulative whole body effective dose for each of the first two therapy episodes (approx. 5500GBq) were approximately at the 0.3mSv threshold. Therefore it is recommended that multiple staff members spread the dose.

Therapy Episode	Activity (MBq)	WB Eff Dose (µSv)
T1	5209	304
T2	5413	299
T3	7513	367

Figure 5: Whole Body Effective Dose received by Dialysis Unit Staff

Using the first therapy episode as an example; the average dose rate received by the staff group during each dialysis session (figure 6) shows a marked decrease between the first dialysis session (1.73µSv/min) and the second session (0.53µSv/min). Indicating a significant reduction in dose rate about the patient following the first dialysis session.

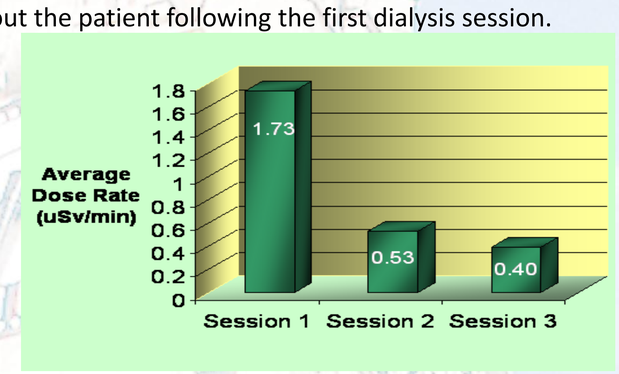

Figure 6: Average observed dose rates received by staff during dialysis sessions

Conclusions

Following simple radiation protection measures it is possible to provide high activity radionuclide therapy for patients on haemodialysis and still satisfy occupational and environmental radiation protection legislation in the UK.

Providing;

- Adequate Local Rules for radiation protection and prior Risk Assessments are carried out in advance of treatment
- Multiple staff members are utilised in the dialysis unit to spread the dose and reduce individual exposure
- Staff doses are recorded to ensure the threshold of 0.3mSv is exceeded by any individual

Follow Up

Since these treatment episodes were carried out;

- It was appropriate to follow the same schedule and work procedures for a patient treated with Y90-Dotatate for neuroendocrine metastases.
- Regarding disposal of radioactive waste in human excretia, The Radioactive Substances Act 1993 has been superseded by The Environmental Permitting Regulations 2010 and The Environmental Permitting (England and Wales) (Amendment) Regulations 2011.

Legislative Issues Addressed

IRR99, Occupational dosimetry: Staff in the dialysis suite are non-Radiation workers and were treated as 'members of the public' regarding Dose Limits. 1mSv per year with a limit of 0.3mSv per episode.

IRR99, Controlled Areas: the dialysis suite was designated as a Controlled Area for the duration of the haemodialysis sessions. Local rules were defined for the staff with necessary precautions practised.

The temporary Controlled Area was surveyed for residual radioactive contamination before declassification.

RSA93, Liquid waste authorisation: non-Tc99m exemption order limit of 500MBq at the regular dialysis centre was satisfied by retaining the patient at our own centre until the estimated retained activity was less than 550MBq (figure 3). As a regular treatment centre, our own Waste Authorisation is ample for several ablation therapies each month and no adjustment was required. Note treatment sessions pre-date EPR2010.

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