

Does listening to a personal music player or reading a book during the uptake period of a PET-CT oncology scan cause extra ^{18}F -fluorodeoxyglucose (^{18}F FDG) activity in the skeletal muscles?

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Background

Mobile PET/CT units have been used to provide a local service to patients. The facilities are of a high standard, but still lack some of the comforts of static scanner sites, due to the constraints of the mobile environment. Patients have an uptake period of 1 hour between administration of radionuclide and scan. Traditionally during this uptake period the patient could not move around due to the belief that the ^{18}F -fluorodeoxyglucose (^{18}F FDG) would be absorbed by the skeletal muscles instead of the rest of the body so all patients rest in an uptake bay within the unit. Many patients have requested that they be allowed to read or listen to music via a personal music player whilst they are waiting for their scan to help pass the time. There is evidence that being tense can cause a distribution of tracer suggestive of contracting skeletal muscles (Barrington & Maisey 1996). Following discussion at the clinical leads meeting it has been agreed that with the exception of head and neck patients, patients will be advised that they can bring reading material (not broadsheet type papers) or a digital music player with headphones. Radiographers/technologists will advise them to keep their hand movements to a minimum.

Study objective

A retrospective review study to establish if reading books/small newspapers or listening to a personal music player during the uptake period increased or decreased ^{18}F FDG uptake in contracting skeletal muscle in tense patients.

Study Population

The study population includes oncology patients scanned on a mobile scanner on days when the ambient temperature was similar. 20 sets of images were reviewed.

Rationale

Patients should be as comfortable as possible during the uptake period and scan. This will enhance the patient experience as well as providing high quality images. Skeletal muscle uptake could cause confusion when reporting scans and should therefore be avoided if possible and reporters should learn to recognise the patterns of normal uptake in these muscles.

Oral Diazepam has been suggested in the literature (Barrington & Maisey 1996) as a way of avoiding skeletal muscle uptake due to contracting muscles in tense patients by relaxing the patient. The mobile environment remote from the main hospital is not an ideal environment to administer Diazepam and therefore an alternative was sought.

Patients were selected on days when the ambient temperature was similar due to the Brown Fat uptake that can occur in the neck region in cold weather (Yeung et al 2003).

Reading books or listening to personal music players could relax the patient resulting in a better patient experience and avoiding skeletal muscle uptake in the shoulder and neck area.

Hypothesis

Listening to music on a personal player or reading could reduce the uptake in contracting skeletal muscles of the neck and shoulders in tense patients.

Study design

At booking all PET/CT patients are asked to bring a book or personal music player with them to the appointment if they wished. Patients with Head & Neck pathology are excluded from listening to music or reading. The radiographers noted on the acquisition sheets whether or not patients have been listening to music or reading. The retrospective study reviewed non Head & Neck patients who either listened to music or read a book and compared them to patients who had not listened to music or read a book during the uptake period. 2 radiologists reviewed the images and marked on a 5 point scale (1=low, 5=high) the level of muscle uptake in the neck, shoulders, upper arms and legs. 20 sets of images were sent to the reporters. 10 patients had either listened to music or read a book (Average age 64.6 years 2/10 female) and 10 patients had neither listened to music nor read a book (Average age 64.4 years 2/10 female).

Need to analyse;

- If there is inter-reporter variability.
- If any region had increased uptake.
- If there was any statistical evidence that reading a book or listening to a personal music player decreased uptake.

Statistical Methods

Two assessors independently reported uptake on a scale of 1-5 for 160 images: in 8 separate locations, neck, shoulder, arm, leg on left and right side for 10 patients in a reading/listening group and 10 patients in a control group. The aims were to assess reporter agreement and identify any effect of patient group and/or body location or side. Contingency tables of frequencies of each category rating as a function of the explanatory variables of reporter, patient group, body location and body side were constructed. Log linear chi-squares were calculated for these tables to assess which, if any, of the observed differences were statistically significant.

Results

Reporter Agreement

Overall the reporters fully agreed on 128/160, 80%, of all images. The difference between reporters was 1 for a further 27/160, 17%, of images. Hence there were just 5/160, 3%, of images where the disparity between reporters was more than 1. There was no evidence of reporter bias in that the number of images where A's rating was higher than B's was 16/160, 10%; exactly the same as the number of images where B's rating was higher than A's.

This generally high level of agreement was further investigated according to patient group, body location and side of the body. Table 1 shows frequency of differences between raters broken down by patient group, body location and body side.

Table 1. Frequency of Reporter Differences by Group, Side and Location

Side	Group	Disparity B - A	Location				Grand Total	
			Arm	Leg	Neck	Shoulder		
Left	Listening/reading	-2			1		1	
		-1			1	2	3	
		0	10	9	6	8	33	
		1		1	2		3	
	Listening/reading Total			10	10	10	10	40
	Control	-1	1	1		1	3	
		0	9	8	9	7	33	
		1		1	1	1	3	
3					1	1		
Control Total			10	10	10	10	40	
Left Total			20	20	20	20	80	
Right	Listening/reading	-2			1		1	
		-1			1	1	2	
		0	9	10	7	7	33	
		1	1		1	2	4	
	Listening/reading Total			10	10	10	10	40
	Control	-1	1	1	1	3	6	
		0	8	9	7	5	29	
		1	1		1	1	3	
2				1		1		
Control Total			10	10	10	10	40	
Right Total			20	20	20	20	80	
Grand Total			40	40	40	40	160	

The only noteworthy feature is that inter-reporter agreement is higher for the limbs (arms & legs) at 90% full agreement than for the centre (neck and shoulders), at 70% full agreement. The reliability this observation was tested by collapsing body location into 2 categories (limbs and centre) and reporter disparity into 3 categories (agreed, A rated higher than B, B rated higher than A) and constructing the collapsed contingency Table 2. A chi-square test on the data in Table 2 gave a contingency likelihood ratio $\chi^2(2) = 8.8$, $p = .012$. Hence this lower agreement for the shoulder and neck is statically significant.

Table 2. Frequency of Reporter Disparities by Body Location

Disparity	Limbs	Centre	Total
A>B	4	12	16
A=B	72	56	128
B>A	4	10	14
Total	80	78	158

Patient Group and Body Location

The concordance between left and right images of the same body location was high with 82% full agreement, 16% with discrepancy of 1 rating point and just 2% with discrepancy greater than 1 rating point. Consequently, the effects of patient group

and location were collapsed over both reporters and body side for all analyses of patient group and location. See Tables 3a and 3b

Table 3a. Frequency of 5 Category Ratings by Patient Group and Body Location

Group	Location	Rating					Grand Total
		1	2	3	4	5	
Listening/Reading	Arm	31	3	2		4	40
	Leg	35	5				40
	Neck	30	7	3			40
	Shoulder	25	5	7	2	1	40
Listening/Reading Total		121	20	12	2	5	160
Control	Arm	33	3	4			40
	Leg	17	23				40
	Neck	30	7	3			40
	Shoulder	20	16	2	2		40
Control Total		100	49	9	2		160
Grand Total		221	69	21	4	5	320

Table 3b. Frequency of 3 Category Ratings by Patient Group and Body Location

Group	Location	Rating			Grand Total
		1	2	3 or more	
Listening/Reading	Arm	31	3	6	40
	Leg	35	5		40
	Neck	30	7	3	40
	Shoulder	25	5	10	40
Listening/Reading Total		121	20	19	160
Control	Arm	33	3	4	40
	Leg	17	23		40
	Neck	30	7	3	40
	Shoulder	20	16	4	40
Control Total		100	49	11	160
Grand Total		221	69	30	320

Table 3c. Frequency of 3 Category Ratings by Body Location and Patient Group

Location	Group	Rating			Grand Total
		1	2	3 or more	
Arm	Listening/reading	31	3	6	40
	Control	33	3	4	40
Arm Total		64	6	10	80
Leg	Listening/reading	35	5		40
	Control	17	23		40
Leg Total		52	28		80
Neck	Listening/reading	30	7	3	40
	Control	30	7	3	40
Neck Total		60	14	6	80
Shoulder	Listening/reading	25	5	10	40
	Control	20	16	4	40
Shoulder Total		45	21	14	80
Grand Total		221	69	30	320

Overall glucose uptake is LOWER in the listening/reading group (39/160 = 24.5% of images with uptake ratings greater than 1), than the control group (60/160 = 37.8% of images with ratings greater than 1). A chi-square test conducted on Table 3b collapsed over body location, gave $\chi^2 (2) = 16.7$, $p < .0005$. This effect of group was also significant at the 95% confidence level for both reporters separately

The glucose uptake ratings greater than 1 are as follows; arms 16/80 = 20%; neck 20/80 = 25%; legs 28/80 = 35%; and shoulders 35/80 = 44%. A chi-square test conducted on Table 3b, collapsed over body location, gave $\chi^2 (6) = 41.3$, $p < .0005$. Post hoc comparisons showed no significant difference between arms and neck. However, legs and shoulders both had significantly more high glucose uptake ratings than both neck and arms, while shoulders has the most high glucose uptake ratings of all, significantly more than legs (the next highest). Thus the ordering of high glucose ratings is: arms = neck < legs < shoulders. The overall effect of body location is also statistically significant for both reporters separately

Separate chi-square tests to compare groups were conducted for each body location. There were no effects of patient group for neck, $\chi^2 (2) = 0$, $p = 1.000$; or for arms $\chi^2 (2) = .5$, $p = .792$. However, the group difference was significant both for leg $\chi^2 (2) = 18.9$, $p < .0005$ and for shoulder $\chi^2 (2) = 8.9$, $p = .010$. As can be seen in Tables 3a and 3b, for both locations there are fewer high glucose uptake ratings in the reading/listening group than the controls. The group effect for legs was present for both reporters separately, but the group effect for shoulder just failed to reach the 95% confidence criterion, $\chi^2 (2) = 4.5$, $p = .106$.

Summary

The good news is that patients can safely listen to their ipods and read their books without any deleterious effect on glucose uptake. On the contrary, the reading/listening group actually had FEWER high glucose uptake ratings than the control group. These groups' differences were strongly evident in the legs, with a high number of 2 ratings. Perhaps reading or listening discourages fidgeting? Group differences were also strong in the shoulders, where the control group had more 3+ ratings than the reading/listening group.