A service evaluation to determine if there is a correlation between CT SPECT and MRI in inflammatory end plate changes of the Lumbar Spine

Introduction

Back pain is one of the most common presenting complaints in the adult population and in many cases an underlying cause is difficult to diagnose. A study published in 1995 showed that there were almost 15 million visits for lower back pain in 1990 in the United States (1). More recent studies have shown the global prevalence of low back pain is on the rise. In the UK studies have shown low back pain costs the NHS £1 billion and the cost to the economy through time off work, loss of income through taxes, reduced spending etc. is estimated to be between £5 billion and £10.7 (2). This highlights the health as well as financial importance of effective management of patients with low back pain.

MRI is a useful form of imaging in detecting inflammatory end-plate changes. There are multiple techniques available which can be utilised including T1 weighted spin echo sequence, T2 weighted spin echo sequence or fat suppressing T2 weighted sequences such as short tau inversion recovery (STIR). STIR imaging suppresses hyper-translucent signal from fat which aides in detecting oedematous changes in the endplate of the lumbar vertebrae- which is associated with inflammatory end plate changes (3).

A SPECT CT scan is an emerging form of imaging which involves combining 2 separate components: a SPECT scan and a CT scan. A SPECT scan is used to monitor levels of biological activity in a 3-dimensional format. This image is then overlaid onto the CT scan that is taken. This allows us to detect a more accurate anatomical location of uptake of the injected radioisotope. In recent years multiple studies have been undertaken to investigate the utility of SPECT CT imaging in the management of patients with musculoskeletal pathology.

Aims

To undertake a service evaluation to determine if there is a correlation between CT SPECT imaging and MRI in detecting inflammatory end plate changes of lumbar vertebrae. To ultimately see is CT SPECT has more of a role in the clinical setting and guiding management.

Method

A retrospective evaluation was performed using CT SPECT imaging from X number of patients within the Cardiff and Vale health board between April 2018 and March 2019. Patients with MRI scans of the lumbar spine taken within 18 months of the CT SPECT scan were included in the sample group. Those patients with previous spinal operations were noted and excluded if the end plate involved was at the site of an operation. Patients age, gender and lumbar vertebral involvement were all included in data collection. The data collected was analysed using statistical software- SPSS and Microsoft excel. The CT SPECT uptake was categorised into mild, moderate and high and this was compared with Modic changes. This classification was developed by Dr Michael Modic and is categorised using both T1 and T2 weighted MRI scans. The table below summarises these modic changes.

Modic Classification	T1 Signal	T2 Signal	Represents
I	Hypo-signal	Hyper-signal	Vascularised bone marrow and/or oedema
II	Hyper-signal	Hyper-signal	Proliferation of fatty tissue
III	Hypo-signal	Hypo-signal	Sclerotic bone

Table 1. Modic Changes According to MRI signal intensity in vertebral endplates

There are 2 possible reasons for finding Modic changes on MRI. One reason is believed to be due to infective causes. A pathogen often bacteria can infect the disc and cause subsequent inflammation and oedema of the endplate. Another reason is due to mechanical causes. This is believed to be caused by long-term shear forces applied to the endplate which may lead to microfractures. This will again cause inflammation and oedema of the endplate. These degenerative mechanical forces are the focus of this project (4).

Results

A total of 18 patients were included in this study with 19 endplates being analysed. There were 6 males and 12 females with a mean age of 52.32 years. Only the L1/2 to L5/S1 levels were studies. Modic changes were found in 63.2% of endplates with 36.8% exhibiting type 1 changes and 26.4% exhibiting type 2 changes with no type 3 changes found. A description of the modic changes is shown in table 2.

Modic Changes

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	none	7	36.8	36.8	36.8
	type 1	7	36.8	36.8	73.7
	type 2	5	26.3	26.3	100.0
	Total	19	100.0	100.0	

Table 2. Frequency of modic changes detected on endplates.

73.7% of vertebrae with modic changes also showed increased uptake on CT SPECT with 26.3% showing modic changes with no uptake on CT SPECT. The mode vertebra with increased uptake was L5/S1 (26.3%) followed by L2/3 (21.1%) and L3/4 (21.1%)- this is highlighted in the table 3.

CT SPECT vertebral body involved

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	none	2	10.5	10.5	10.5
	L1/L2	2	10.5	10.5	21.1
	L2/3	4	21.1	21.1	42.1
	L3/4	4	21.1	21.1	63.2
	L4/5	2	10.5	10.5	73.7
	L5/S1	5	26.3	26.3	100.0
	Total	19	100.0	100.0	

Table 3. Uptake on CT SPECT by vertebral body

Using Pearson's correlation coefficient, there appears to be a weak positive correlation between uptake on CPECT and Modic changes on MRI due to a positive Pearson correlation value of 0.216. However, using a 10% confidence interval, there is no statistically significant correlation as p=0.374. Table 4 illustrates this information.

Correlations

		Uptake (none, mild moderate, high)	Modic Changes
Uptake (none, mild moderate, high)	Pearson Correlation	1	.216
	Sig. (2-tailed)		.374
	N	19	19
Modic Changes	Pearson Correlation	.216	1
	Sig. (2-tailed)	.374	
	N	19	19

Table 4. Correlation between Uptake on CT SPECT and Modic change on MRI

However, the table below shows there is a statistically significant correlation between presence of modic change on MRI and presence of uptake on SPECT with $p<0.1$

Correlations

		Presence of Modic change	Presence of Uptake on SPECT
Presence of Modic change	Pearson Correlation	1	.449
	Sig. (2-tailed)		.054
	N	19	19
Presence of Uptake on SPECT	Pearson Correlation	.449	1
	Sig. (2-tailed)	.054	
	N	19	19

Table 5. Correlation between positive modic change and positive uptake on SPECT

Discussion

In previous studies, Russo et al. investigated 99 patients with chronic lower back pain with the aim to assess the value of hybrid bone SPECT/CT imaging. They correlated Modic changes and disc abnormalities using Pfirrmann grading system on MRI with the SPECT/CT imaging patterns.

Modic changes were found in 54% of patients with the most affected levels being L4-5 (31.3%) and L5-S1 (40.9%). Bone SPECT/CT showed high metabolic activity in 96.1% of endplates with MC type I, 56% with MC type II, and 77.8% with MC type III.

They concluded that there is an agreement between modic changes and high metabolic activity on bone SPECT/CT. Modic change type 1 and Pfirrmann grade 5 indicated the strongest predictor for findings on SPECT/CT (5).

One limitation of our project was a small sample group. A larger sample group would be helpful in more accurately determining if there is a statistically significant correlation or no correlation between CT SPECT and MRI.

Another limitation of the evaluation was the difficulty in quantifying CT SPECT uptake. There is no formal classification for detecting uptake and a subjective method of mild, moderate, high uptake was the method used. An objective approach to detecting uptake would have been more accurate.

Conclusion

In this service evaluation, we found a correlation between the presence of changes on CT SPECT and MRI. However, there appears to be no correlation between Modic changes on MRI and the intensity of uptake on the SPECT. In general, lower lumbar levels were associated with increased frequency of modic changes and increased uptake on SPECT.

References

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