Safety of Gadolinium Contrast for MR Imaging Compared to Iodinated Contrast

H. Zhang[1], H. Ersoy[1], M. R. Prince[1]
[1]Radiology, Weill Medical College of Cornell University, New York, NY, United States

INTRODUCTION

Contrast-enhanced MRI uses gadolinium (Gd) contrast agents and is often used in patients with renal insufficiency for whom the contrast may linger in the serum for longer periods of time thereby increasing the chance of toxicity or laboratory interferences. The possibility of interference with calcium and magnesium is known and there are case reports of elevations of serum creatinine following high-dose contrast-enhanced MR Angiography. This study investigates the effect of gadolinium-based contrast agents on serum calcium, magnesium and creatinine measurements in a typical hospital based population and compares to iodinated contrast to determine if these effects are of any importance.

MATERIAL AND METHODS

Hospital records from 9/22/1993 – 8/26//2004 were reviewed to identify inpatients with laboratory data on serum calcium, creatinine and magnesium pre and within one day post gadolinium-enhanced MRI. For 2339 examinations with calcium data, 2808 examinations with creatinine data and 2091 examinations with magnesium data, changes in laboratory measurements before and post Gadodiamide (Omniscan) and Gd-DTPA (Magnevist) injection were compared. In 529 patients who had both Gd-enhanced MRI and iodinated contrast enhanced exams including CT and DSA on different days, changes in creatinine measurements were also investigated.

RESULTS

Calcium: Following 1182 Gd-DTPA enhanced examinations, serum calcium (pre = 8.89 mg/dl; post = 8.87 mg/dl, p = 0.48) did not change with the OCP colorimetic assay used at our Hospital. Neither high-dose injection (e.g. MRA studies) nor pre-existing renal insufficiency had any effect on calcium measurements. Following 1157 Gadodiamide enhanced examinations, serum calcium dropped from 8.65 mg/dl pre MRI to 8.33 mg/dl ($p < 0.0001$). Even more dramatic decrease of calcium was noticed after high dose injection and/or in patients with renal insufficiency.

Magnesium: For magnesium measurements, there was no change following Gd-DTPA (pre = 1.61 mg/dl; post = 1.62 mg/dl, p = 0.54) nor Gadodiamide (pre = 1.64 mg/dl; post = 1.64 mg/dl, p = 0.47) injections.

Creatinine: Serum creatinine dropped slightly from 1.25 mg/dl to 1.22 mg/dl after 1651 Magnevist injections (p = 0.005). There was no change in creatinine measurements (pre = 1.19 mg/dl; post = 1.20 mg/dl, p = 0.51) following 1157 Omniscan injections. In 529 patients who had both contrast enhanced MR and iodinated contrast enhanced exams (Table 1), the serum creatinine dropped from 1.37 mg/dl pre to 1.33 mg/dl post gadolinium (p = 0.12) but increased from 1.29 mg/dl pre to 1.37 mg/dl ($p < 0.0001$) post iodinated contrast. In 84 patients with renal insufficiency, the average creatinine measurements increased by 0.37 mg/dl within one day after iodinated contrast with statistical significance (p = 0.0002). After iodinated contrast injection, 4.9% of patients experienced creatinine increase greater than 0.5 mg/dl (Table 2).

Table 2. Creatinine increase $\geq$ 0.5 mg/dl

Contrast	N	%
Gd:DTPA	30 of 1651	1.8
Gadodiamide	36 of 1157	3.1
Iodinated*	26 of 511	4.9

* note that patients at risk for contrast induced nephrotoxicity did not receive Iodinated contrast

DISCUSSION AND CONCLUSION

Many studies have demonstrated safety of gadolinium contrast agents in patients with renal insufficiency and at high doses which are important for maximizing SNR on MR Angiography studies. This is particularly important for patients with vascular disease because they often already have some deterioration in their renal function and cannot tolerate further damage to the kidneys from nephrotoxic contrast. For example diabetic patients commonly have disease affecting larger arteries (e.g. aorta, carotid artery, coronal artery or peripheral arteries) as well as microvascular disease affecting the renal parenchyma. Serum creatinine is a commonly used marker for renal function since the serum creatinine level rises as the kidneys' ability to eliminate creatinine from the body diminishes. These data from 2808 gadolinium enhanced MR examinations performed over 10 years on a single MR facility confirm again that there is no clinical evidence of gadolinium induced nephrotoxicity. Indeed for gadolinium contrast, the mean serum creatinine was actually slightly reduced following MR examinations even in patients with renal dysfunction which may reflect improved hydration or diuresis related to the gadolinium injection and saline flush. Gadolinium was significantly safer than iodinated contrast which caused a statistically significant increase in serum creatinine even though its use was restricted to those patients at low risk for contrast induced nephrotoxicity and was in spite of hydration and other measures to prevent nephrotoxicity used with iodinated contrast but not prior to gadolinium contrast.

Table 1. Effect of Gd and Iodinated Contrast on Serum Creatinine (mg/dl).

	N	*Pre*	*Post*	*Post-pre*	*p-value*
Gd:DTPA	411	1.40	1.35	-0.05	0.07
Iodinated contrast		1.29	1.37	0.08	<0.0001
Gadodiamide	118	1.28	1.29	0.01	0.66
Iodinated contrast		1.30	1.39	0.08	0.07
All gadolinium	529	1.37	1.33	-0.04	0.12
All iodinated contrast		1.29	1.37	0.08	<0.0001
With renal insufficiency (Cr > 1.5)					
Gadolinium	84	4.26	4.08	-0.23	0.12
Iodinated contrast		3.41	3.78	0.37	0.0002

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