



Gadolinium Based Contrast Agents for CMR imaging

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Introduction

MRI contrast is administered to patients to increase the diagnostic utility of MR imaging by improving its specificity and sensitivity.¹ Cardiac MRI examinations can provide essential tissue characterisation and vascular visualisation by enhancing the properties of paramagnetic contrast known as gadolinium-based contrast agents (GBCA).

Key words

Paramagnetic, Macrocyclic, dosage, safety

Physics/chemistry

Due to their paramagnetic properties, GBCA's shorten the T1 relaxation time of the surrounding tissues which increases the signal. In clinical practice this will mean on T1 based sequences, tissues with GBCA will have a brighter appearance to those without contrast².

There are two main types of GBCA's which are defined by their molecular construction.

- Linear
- Macrocyclic

Macrocyclic agents are considered the safest agents for intravenous use². The two most frequently used of these **in the CMR unit** are gadobutrol (Gadovist) & gadoteric acid (Dotarem).

Clinical Uses

The use of GBCA's is currently widely implanted in many different CMR protocols, the principal ones are listed below.

- **Contrast angiography** for vascular visualisation during clinical surveillance and surgery planning.
- **First pass perfusion** imaging to identify perfusion defects related to coronary artery disease and the diagnoses of myocardial ischemia.



- **Late Gadolinium imaging** for assessment of various myocardial gadolinium enhancement patterns to differentiate between cardiomyopathies, infiltrative diseases and tumours.

Contrast dosage

The dose of contrast prescribed to the patient is calculated by using their weight, the type of GBCA and its concentration. See table below.

Manufacturer	Name	Concentration	Dose per kg
Bayer	Gadovist (Gadobutrol)	1.0 mmol/mL	0.1ml per Kg
Guerbet	Dotarem (Gadoteric acid)	0.5 mmol/mL	0.2mls per Kg
GE	Clariscan (Gadoteric acid)	0.5 mmol/mL	0.2mls per Kg

The Society of CMR 2020 standardized CMR protocols recommends a gadolinium contrast dose of between 0.1 and 0.2 mmol/kg (body weight) is given to the patient ³.

In standard practice a single dose of contrast is usually prescribed to the patient, but local protocols may vary. It is important to understand that the dose of contrast will affect your late gadolinium technique. For example, a prescribed dose higher than that of a single dose, will mean your wash out time will be longer, and your inversion time may be shorter when nulling the myocardium. The important subject of LGE imaging will be available in a dedicated article.

GBCA's safety

As previously stated, macrocyclic agents are considered the safest agents for intravenous use². However there has been concerns regarding the use of GBCA's and potentially harmful side effects. Below are the key points of recent GBCA safety topics.





- **Nephrogenic systemic fibrosis (NSF)** is a rare but serious and potential life-threatening disease, which has been linked to linear contrast agents used in patients with severe renal impairment. No cases of NSF have been reported in patients with normal renal function or with the use of macrocyclic contrast agents⁴
- **Gadolinium brain deposition** has been documented in some patients during the use of linear contrast. Although no harm has been caused to patients it has resulted in some linear contrast being suspended, and others to be used under strict guidelines, such as in liver imaging only²
- **Renal impairment.** GBCA's are appropriate to use in patients with chronic renal impairment, but should be avoided in acute disease while creatine is rising⁵
- **Pregnancy.** Not to be used in pregnant patients, unless the benefit will outweigh any possible risks. However, affects to the developing foetus is not anticipated⁵
- **Breastfeeding.** Patients can continue to breastfeed after the administration of a GBCA as no risk to the baby/child⁶

Conclusion

The use of GBCAs throughout CMR imaging continues to play an important role in providing specific and sensitive data to aid accurate diagnosis and prognostic information to the clinician and patient.

Macrocyclic contrast agents are the safest to use intravenously due to their molecular structure. All GBCAs are required to be given safely by following manufacturer's instructions, local rules and CMR protocols so not to cause harm to the patient.

Training and knowledge on how to optimise image quality when using GBCAs across the many different CMR protocols is essential for all AHP's.

References

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List of supporting educational materials

Link to CMR Pocket guide webpage – PDF downloads currently available in 5 languages, link below.

[https://www.escardio.org/Sub-specialty-communities/European-Association-of-Cardiovascular-Imaging-\(EACVI\)/Research-and-Publications/CMR-Pocket-Guides](https://www.escardio.org/Sub-specialty-communities/European-Association-of-Cardiovascular-Imaging-(EACVI)/Research-and-Publications/CMR-Pocket-Guides)

Articles

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