Specific Absorption Rate

What is Specific Absorption Rate?

Specific Absorption Rate, often shortened to SAR, is an estimate of the the RF energy (watts/kilogram) deposited into the patient while scanning that may result in body temperature rise. SAR is not an exact 'amount' of RF, nor a specific level of heating, but an estimate based on patient weight, orientation, pulse sequence, acquisition parameters, and scan time. Each MR vendor utilizes different modeling for estimating SAR, so there may not be a 1-to-1 comparison between scanners, but broadly several things regarding SAR are constant:

- SAR will increase with field strength
- SAR will be higher with pulse sequences that use a lot of strong RF pulses
- SAR will be higher if strong RF pulses are closely spaced
- SAR will be higher as the number of slices increases
- SAR will be higher with many consecutive pulse sequences

SAR and Scanning

On even relatively older scanners, SAR is tracked throughout the scan, typically in 15 minute intervals. If the scanner senses SAR limits being exceeded, scanning will be prohibited and a 'cool down' time will have to elapse before scanning can resume. When scanning veterinary patients, body weights are typically far lower than the SAR model was meant to be used with, leading to inaccurate estimates and SAR errors preventing scanning unnecessarily. Additionally, animals under anesthesia do not have the same thermoregulatory capacity as when they're awake, often leading to patients being too cold despite what the scanner SAR level reads. Generally, the best approach is to maintain adequate patient temperature with blankets and warmers, and mitigate SAR errors so they don't prolong anesthesia time.

Reducing SAR

The first part of knowing how to reduce SAR errors is knowing where and when they are likely to occur:

- Small animals; <10kgs
- RF heavy pulse sequences: Fast spin echo, HASTE/ SS-FSE, FIESTA/TruFISP, IR-FSE
- T1 weighting, due to the short TR FSE's
- Large axial stacks of T1's
- Post contrast imaging: lots of T1's back to back
- Very high bandwidth sequences; results in shorter spacing between RF pulses

SAR reduction strategies are pretty straightforward: reduce the amount, frequency, and strength of RF pulses!

- Increase TR (but stay within contrast ranges!)
- Reduce the number of slices
- **Reduce the refocus flip angle for FSE's**

- Use a GRE instead of an FSE
- Choose Low SAR RF mode
- Space out T1 FSE with T2's or GRE's
- Decrease bandwidth

While not explicitly a 'safe' thing to do, it is possible to trick the scanner with very very small patients by inputting a weight of 10kg or above. This can be done if needed to prevent the scanner from stopping scanning because the SAR model is inaccurate for very small animals, and SAR becomes overestimated.

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