Average RF Power Reduction for T2 FLAIR at 3.0 Tesla

H. Glenn Reynolds, *GE Medical Systems, Milwaukee WI*
John Rydberg, *Mayo Clinic, Rochester MN*

Purpose

Because of high peak average RF power, T2 FLAIR is modified for use at 3.0Tesla. The goal is to achieve ≥ 30 slices in less than 6.5 minutes without sacrificing image quality.

Introduction

After the installation of the General Electric 3.0 Tesla scanner at the Mayo Clinic, it was obvious that using T2 FLAIR for head scans was not practical because of peak average RF power limitations. Given the potential safety hazards inherent at 3.0 Tesla, General Electric decided to be conservative with SAR for its initial offering. The scanner continuously averages the sum of forward power, reflected power to the amplifier, and cable losses over a 1-second window. Losses at the coil are not considered at this time. When more than 10 Watts (SAR limit for non significant risk for head imaging) of average power is detected, the RF power monitor terminates the scan.

Methods

To reduce peak average RF power, the average B1 of the pulse sequence has to be reduced. In this case the primary parameters controlling average B1 are:

- Density of RF pulses (number of pulses per second)
- RF pulse design (pulse width)
- Flip angle of 180's in echo train

RF pulse density is obviously the first place to obtain a reduction in peak average power. Normally FLAIR implementations interleave as many slices as possible in the TR period. This results in multiple back-to-back FSE echo trains with little or no time in between. A simple interleaving technique is used to force an even distribution of the echo trains. With this method, the maximum available time separates the echo trains and the contribution of the adiabatic IR pulses becomes proportional to the TI period.

Reducing the flip angle to 160 degrees and increasing the pulse width by a factor of 1.2 reduces the power contribution from the echo train by approximately 20 and 30 percent respectively. To accommodate worst case patients and unexpected changes to the protocol, variables were added to the scanner's User CV Screen that allows the user to quickly change the flip angle and/or pulse width.

Results

The standard T2 FLAIR protocol at Mayo is:
30 slices, TR=11 sec's, TE=150 mSec,TI=2.25 sec's,
ETL=20, matrix=256x192, 1 NEX,
Inferior saturation pulse, 3 passes.

By using even distribution of the echo trains, 160-degree flip angle, and by increasing the pulse width by a factor of 1.2, the peak average power in the 1-second window drops from more than 35 Watts to 15.5 Watts. The computed average RF power in the 11 seconds TR period is 11.5 Watts. For this worst case example, the peak RF power is 800 Watts.

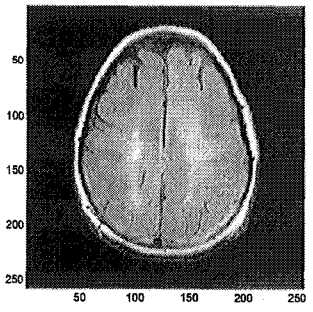
Results from clinical imaging show that patients up to 137 kg use less than 635 Watts of peak power and 12 Watts peak average power, which translates to less than 9.2 Watts of average power for the TR period.

Work done by another investigator (J. Felmlee) has shown the head coil efficiency, which is not accounted for in the power monitor, to be 60% or less. Accounting for this power loss allowed for an increased setting of the power monitor (14 Watts) while remaining within the SAR limits established for non significant risk.

Discussion

It has been demonstrated that high quality T2 FLAIR images can be obtained at 3.0 Tesla within current safety guidelines and with a reasonable amount of scan time. The ability to acquire 30 images in 6:37 minutes makes FLAIR applicable for every day clinical use.

Figure 1
T2 FLAIR Image From 3.0 Tesla



References

IEC 601-2-33

Acknowledgments

The technologist and radiologist at the Mayo Clinic who scan and diagnose patients on the General Electric 3.0T scanner