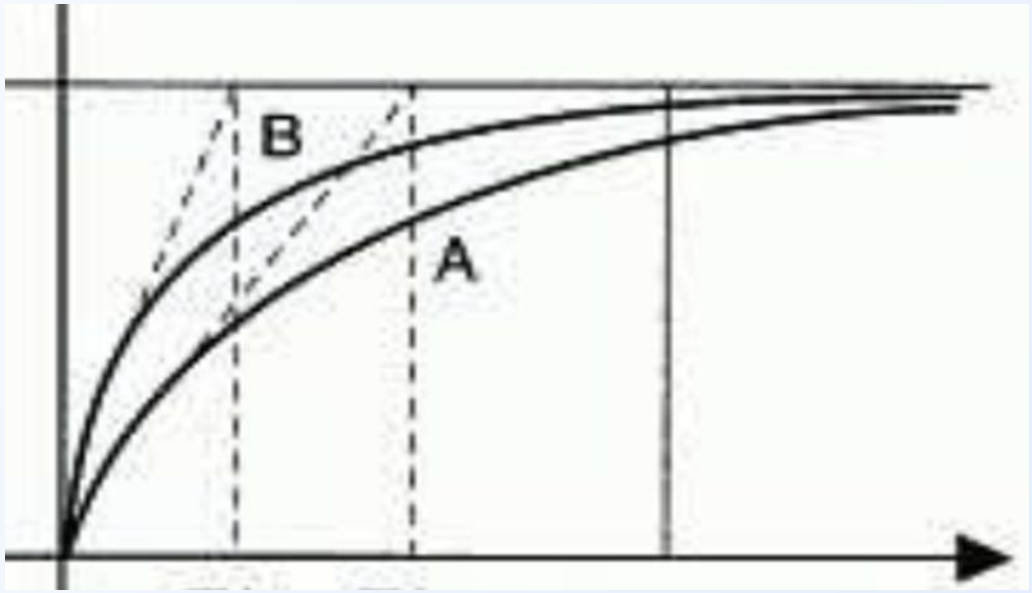
Lesson 5 (B): T1 contrast

Aims

- Learning the following topics about T1 contrast:
- TR and T1 effect
- Ideal TR
- T1 and signal intensity

Tissues with different T1s

- Which tissue has the longer T1?

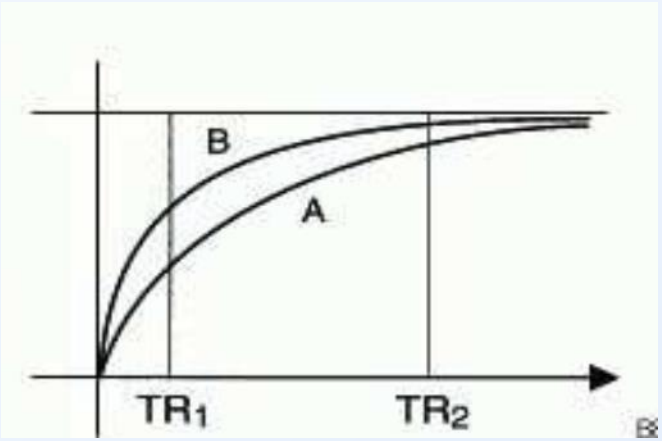


TR and T1 effect

- There are 3 situations:
- Long TR and T1 effect
- Short TR and T1 effect
- Very short TR and T1 effect

Long TR and T1 effect

- SI = N(H)(e-TE/T2*)(1 - e-TR/T1)
- If TR → ∞
- 1 - e-TR/T1 → 1
- SI → N(H)(e-TE/T2*)
- What this means in practice?
- We eliminate (or, more realistically, reduce) the T1 effect by having a very large TR.

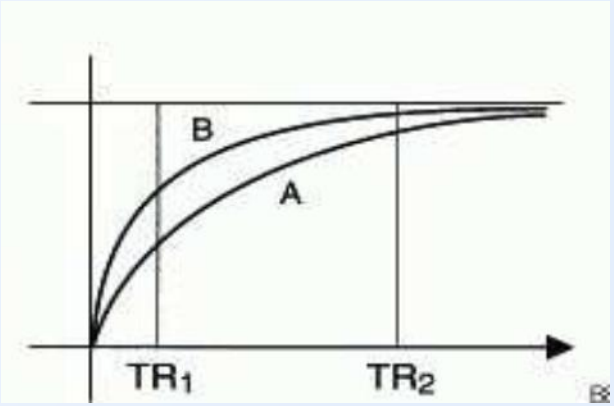


Long TR reduces the T1 effect

- Can we achieve a long enough TR in practice to eliminate totally the T1 effect 100% ?
- We can certainly minimize the T1 effect with a TR of 2000 to 3000 msec
- Important point: In general, if TR is 4 to 5 times T1, then the T1 effect becomes negligible.

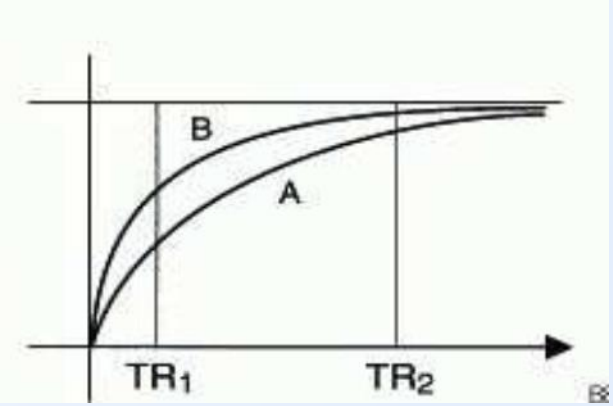
Short TR and T1 effect

- SI = N(H)(e-TE/T2*) (1 - e-TR/T1)
- At TR1 point, the TR is not long enough to eliminate the T1 term in the equation (1 – e-TR/T1).
- Because the T1s of tissue A and tissue B are different, the short TR brings out the difference in contrast between tissue A and tissue B.



Very short TR and T1 effect

- SI = N(H)(e-TE/T2*) (1 - e-TR/T1)
- If TR is close to zero →
- e-0/T1 = e0 = 1
- 1 - e-TR/T1 = 1 - 1 = 0 →
- No signal

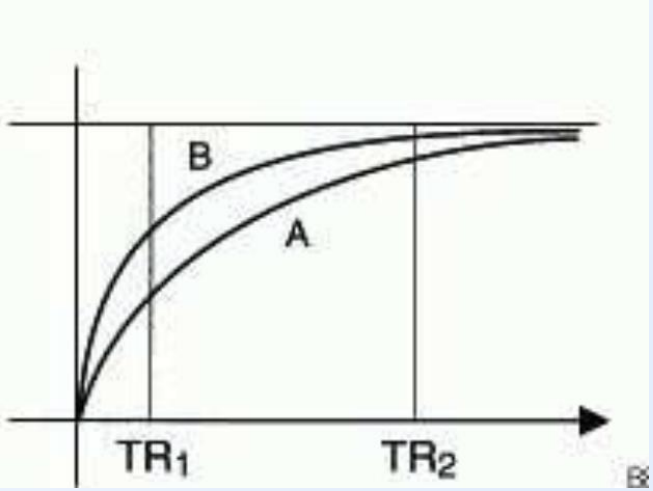


Important points

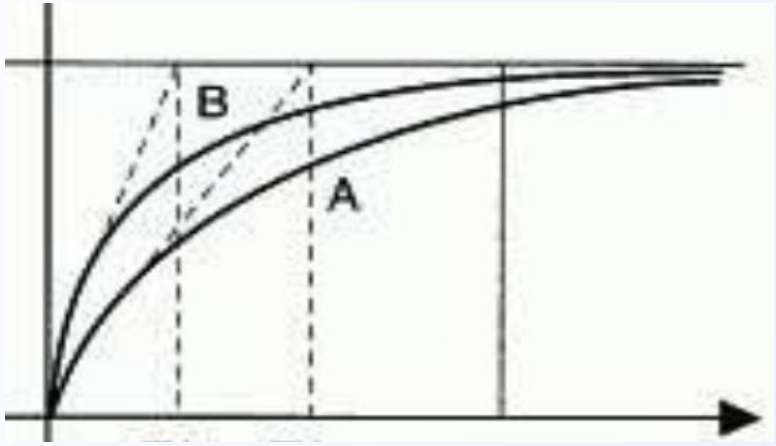
- Long TR: ……T1 effect.
- reduces
- Short TR: enhances T1 effect.

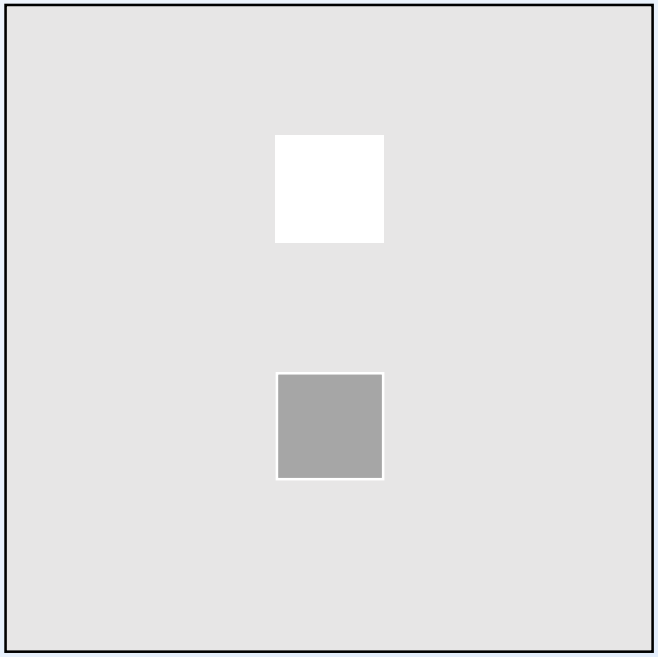
What is the ideal TR?

- Ideally, we would like to have a TR that is not much different from the T1 of the tissue under study.



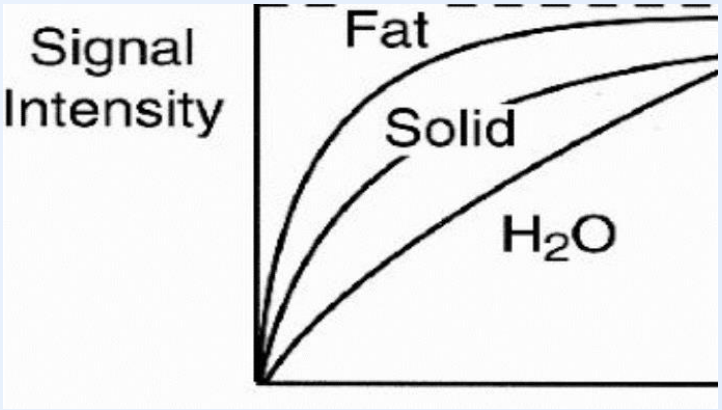
T1 Relaxation





T1 curves of fat, water, and a solid tissue

- Fat has the shortest T1 →
- Bright
- H2O has the longest T1 →
- Dark
- Solid tissue has intermediate T1 →
- Gray

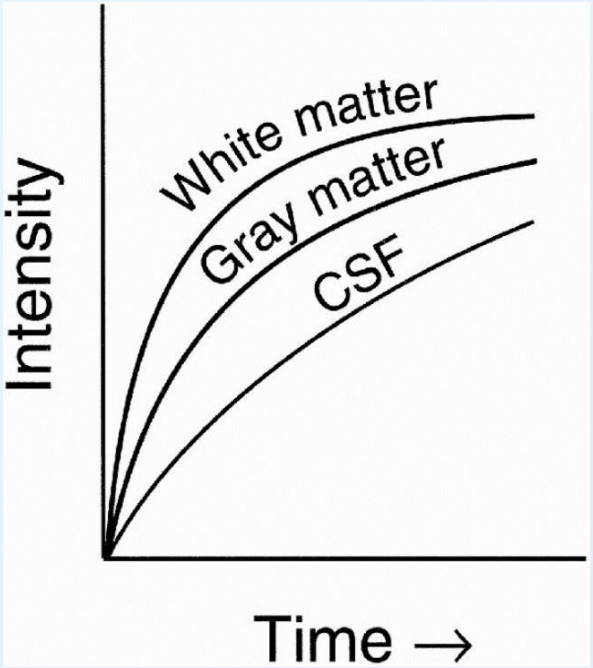


T1 recovery curves of WM, GM and CSF

- White matter: bright
- The myelin sheath acts like fat

- CSF: dark
- like water

- Gray matter: intermediate
- it acts more like a typical solid tissue



Summary

- Long TR and T1 effect
- Short TR and T1 effect
- Very short TR and T1 effect
- Ideal TR
- T1 and signal intensity

Reference

- Hashemi, RH and Brandy, WG. MRI the Basics, Second Edition