CANCER CARE SERVICES
ROYAL BRISBANE AND WOMEN'S HOSPITAL

HERSTON IMAGING RESEARCH FACILITY

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Appearance and minimisation of respiratory motion artefacts in thoracic MRI images of prone patients

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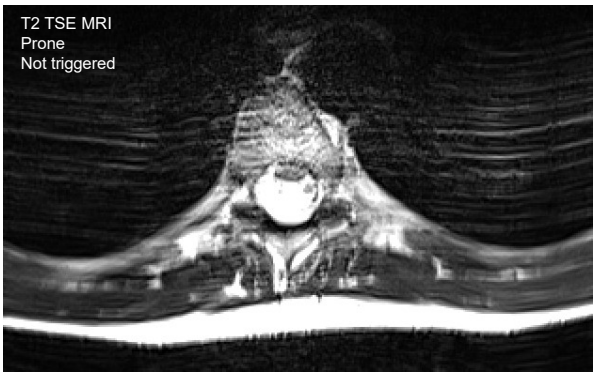
INTRODUCTION

Prone positioning during magnetic resonance imaging (MRI) has been reported as advantageous in particular situations, to reduce feelings of claustrophobia [1], to clarify and distinguish the appearance of specific anatomical structures [2] and to provide images that replicate the prone positioning of some radiotherapy treatments, so that consistent positioning of the patient and their internal anatomy can be achieved throughout the treatment planning and delivery process [3]. However, prone positioning is used rarely during thoracic MRI imaging, especially since the advent of triggered (respiratory-gated) MRI, which can be used to minimise the effects of respiration on thoracic images of supine patients [4]. This study involved the development of a method to perform triggered MRI imaging on prone patients, in order to evaluate and minimise the appearance of respiratory motion artefacts in MRI images of patients in the prone position.

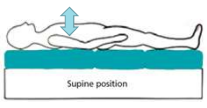
MATERIALS & METHODS

T2-weigted turbo skin echo (TSE) MR images of the upper-thoracic spine of a healthy volunteer were obtained, while the volunteer was lying prone and free breathing. Initially, body coils were used without with no triggering. Thereafter a process of trial-and-error was undertaken, to optimise the setup of the displacement transducer used to trigger MR image acquisition (strapped to abdomen / placed under coils on back / strapped under coils on back), adjust the triggering settings (acquire during exhale only / acquire during exhale and first 10% of inhale) and refine the verbal instructions given to the volunteer (breathe slowly / breathe normally). The final set of triggered MRI images was acquired during normal free breathing with the displacement transducer strapped firmly to the volunteer's back, beneath the body coils.

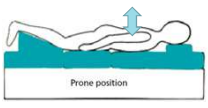
RESULTS & DISCUSSION



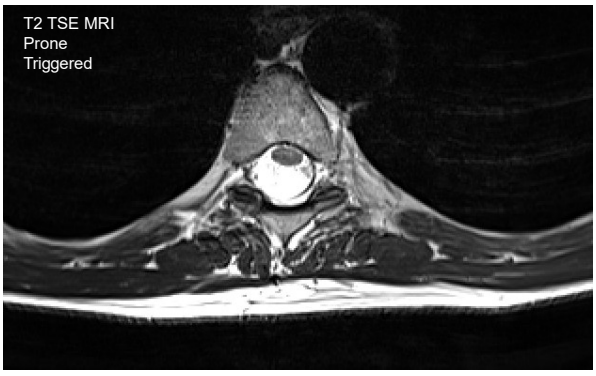
Without triggering, anatomy that is moving with respiration appears blurred and is affected by streaking arefacts in the MRI images. For prone patients, the moving anatomy is on the dorsal side of the thorax [5], leading to poor images of dorsal anatomy, including vertebra and spinal cord.



Supine position: Dorsal anatomy is stabilised by MRI couch. Ventral anatomy rises up and down with respiration.



Prone position: Ventral anatomy is stabilised by MRI couch. Dorsal anatomy rises up and down with respiration.



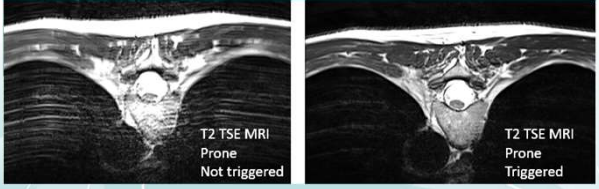
The figure above provides an example of how the resolution of the streaking artefacts throughout the lungs were reduced and the resolution of the spinal anatomy was improved through the use of respiratory triggering during prone MRI.

Variable	Result
Displacement transducer strapped to front of abdomen	No usable triggering signal
Displacement transducer under coils on back	Unstable triggering signal
Displacement transducer strapped under coils on back	Stable and usable triggering signal
Acquire during exhale only	MRI acquisition time extended to > 6 min
Acquire during exhale and first 10% of inhale	MRI acquisition time kept < 6 min, with minimal effect on image quality
Ask volunteer to breathe slowly	MRI acquisition time extended to ~ 12 min
Ask volunteer to breathe normally	MRI acquisition time kept < 6 min, with minimal effect on image quality

CONCLUSION

For patients lying prone, the chest and abdomen are effectively fixed against the surface of the MRI couch, so the dorsal side of the patient rises and falls with respiration. This study has shown that triggered MRI imaging, with the displacement transducer carefully strapped to each patient's back, has the potential to dramatically reduce the appearance of respiratory motion artefacts in thoracic images of patients in the prone position.

Extra bonus info for ROMPs: Yes, these images were acquired with the volunteer in a prone position. This is how the images would appear in your radiotherapy treatment planning system:



REFERENCES

1. Hricak H, Amparo EG (1984). Body MRI: alleviation of claustrophobia by prone positioning. Radiol 152(3): 819-819.
2. Cronin CG, Lohan DG, Mhuircheartaigh JN, et al (2008) MRI small-bowel follow-through: prone versus supine patient positioning for best small-bowel distention and lesion detection. Am J Roentgenol 191(2): 502-506.
3. Kairn T (2018) Patient rotation during linac-based photon and electron radiotherapy. J Med Imaging Radiat Oncol 62(4): 548-552.
4. Janssen NN, ter Beek LC, Loo CE, et al (2017) Supine breast MRI using respiratory triggering. Acad Radiol 24(7): 818-825
5. Prone and supine diagram adapted from Pak CS, Heo CY (2015) Prevention and treatment of pressure ulcers. Journal of the Korean Medical Association. 58(9): 786-794

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