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ORIGINAL ARTICLE

An assessment of set up position for MRI scanning for the purposes of rectal cancer radiotherapy treatment planning

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Abstract

Introduction: A magnetic resonance (MR) scanner for radiotherapy treatment simulation was commissioned in our department in June 2013. Practical set up and MR image quality trade-offs using a variety of patient positions and immobilisation devices routinely used in the treatment planning of rectal cancer patients were considered. The study also aimed to investigate the MR compatibility of the device materials with a focus on temperature changes during routine clinical examinations. **Methods:** Ten volunteers were scanned: (1) Prone on a Civco Contoura Bellyboard (BBB), (2) Prone on a Civco MR Series Bellyboard (WBB), (3) Prone with no bellyboard and (4) Supine. All scans were performed with a T_2 weighted (T_2-w) turbo spin echo (TSE) sequence. Images were scored by five assessors for: (1) ease of identifying specific organs, (2) overall image quality and (3) signal to noise ratio (SNR). Temperature changes were measured for each volunteer in each position. **Results:** Both expert scores and SNR analysis demonstrated that images obtained in the supine position allowed for easier and clearer delineation of the organs. Image factors such as artefacts and noise, along with the overall image quality, also performed better in the supine position. The carbon fibre bellyboard did not demonstrate significant heating during scanning with the T_2-w TSE transverse sequence. **Conclusions:** A supine position was determined to be superior to the other positions in a majority of comparisons. The volunteers did not experience any increased temperature changes during scanning on the bellyboard in comparison to the other positions.

Introduction

Radiation therapy (RT) is recommended for 58% of rectum cancer patients.[1] Achieving high quality RT requires accurate, consistent patient set up throughout the treatment course and accurate definition of the target volume and surrounding normal tissues for RT treatment planning (RTP). Computed tomography (CT) imaging is the standard imaging modality used to define RT target volumes as well as providing necessary electron density information for accurate radiation dose calculations.

Magnetic resonance imaging (MRI) provides superior soft tissue contrast compared to CT, and in addition provides functional information.[2] The use of CT co-registered with MRI has become the standard imaging approach for rectal cancer RTP.[3] There is also interest in the potential for functional MRI to provide information on treatment response and tumour aggressiveness.[4] However, patient set up in MRI is a major challenge for imaging patients in their treatment position. This is due to compatibility of RT immobilisation equipment with MRI systems including size and material. There are also current limitations in commercially available radiofrequency (RF) coils which can hinder image quality, due to limited signal availability, particularly for RTP imaging. Although many scanners have integrated RF coils in the MRI table, the use of devices can increase the distance between the anatomy of interest and coil elements. As a consequence of this increased distance, there will be less signal and greater noise introduced in the image therefore decreasing the signal to noise ratio (SNR) of the image.

For conventional rectal cancer RT treatment, patients have historically been positioned on a bellyboard to displace the small bowel out of the treatment field. As techniques develop in RTP and treatment, such as intensity-modulated radiation therapy (IMRT) and volumetric-modulated arc therapy (VMAT), supine positioning is become more common. The prone set-up poses many challenges to optimise image quality in MRI as the anatomy of interest is further away from the RF coil channels decreasing the overall SNR. Some materials that are used in bellyboards, in particular carbon fibre, are also known to cause heating while undergoing MRI scanning and should be considered carefully. This theory was investigated by Jafar et al.,[5] whereby they tested the heating properties of a carbon fibre couch during MRI using spin echo (SE) and turbo spin echo (TSE) sequences. They found that there was no significant heating of the couch during their testing. Large items consisting of carbon fibre have been shown to significantly attenuate RF signal but otherwise cause no heating. However, smaller materials may produce less image quality issues but could in turn cause localised heating.

The purpose of this study was to assess anatomical MR image quality for different RT set up positions, considering a standard prone position using two different commercially available bellyboards, and prone and supine positions on a RT flat table top. The effect of any potential heating due to materials in the bellyboards was also assessed.

Methodology

Clinical imaging study

Following local ethics board approval through both SSWAHS and the University of Queensland, ten volunteers were recruited and imaged in four different RT set up positions. The volunteers were aged between 25 and 50, with five females and five males consenting to the study. Three prone set-up positions were considered, the first with the volunteer positioned on a Civco (CIVCO Medical Solutions, Orange City, IA) Contoura Bellyboard (BBB), which is made of carbon fibre (Fig. 1), the second with the volunteer positioned on a Civco MR Series Bellyboard (WBB) (Fig. 1) and the third with the volunteer positioned on the flat table top without a bellyboard. The fourth set up position involved the volunteer lying supine on the flat MRI couch top.

All images were acquired with a RT dedicated wide bore 3 Tesla MRI scanner (Siemens Skyra, Erlangen, Germany) with a maximum amplitude of 45 mT/m and slew rate of 200 T/m per sec. For all set up positions, a transverse T_2-w TSE sequence was acquired with an 18-channel body coil held in position with a coil bridge to minimise deformation and a 32-channel spine coil integrated into the MR scanner couch. Each sequence was acquired with contiguous 3 mm slice thickness, two signal averages, and in-plane resolution of 0.9 mm^2. The T2-w TSE sequence was selected to be tested in this study, as it is utilised clinically for all rectal cancer treatment planning scans for delineation of tumour volumes and nodes, and to contour organs at risk.

Temperature changes

To investigate possible temperature changes experienced by the volunteers, surface temperature indicating strips (TMC Thermax) were used on all volunteers for all scans. The strips were able to identify temperatures from 29 to 43°, in 4° increments. The room temperature was controlled to 19 ± 1°C. The positions of the strips are detailed in Table 1. A smaller number of strips were used for the non-bellyboard scans as there was no bellyboard to consider. The reason for continuing to monitor any possible temperature changes on the patient, even without a bellyboard present, was to ensure that any changes experienced by the volunteers could be attributed to the bellyboard alone.

The maximum temperature reached on each of the strips in each position for each volunteer was recorded immediately after each scan.

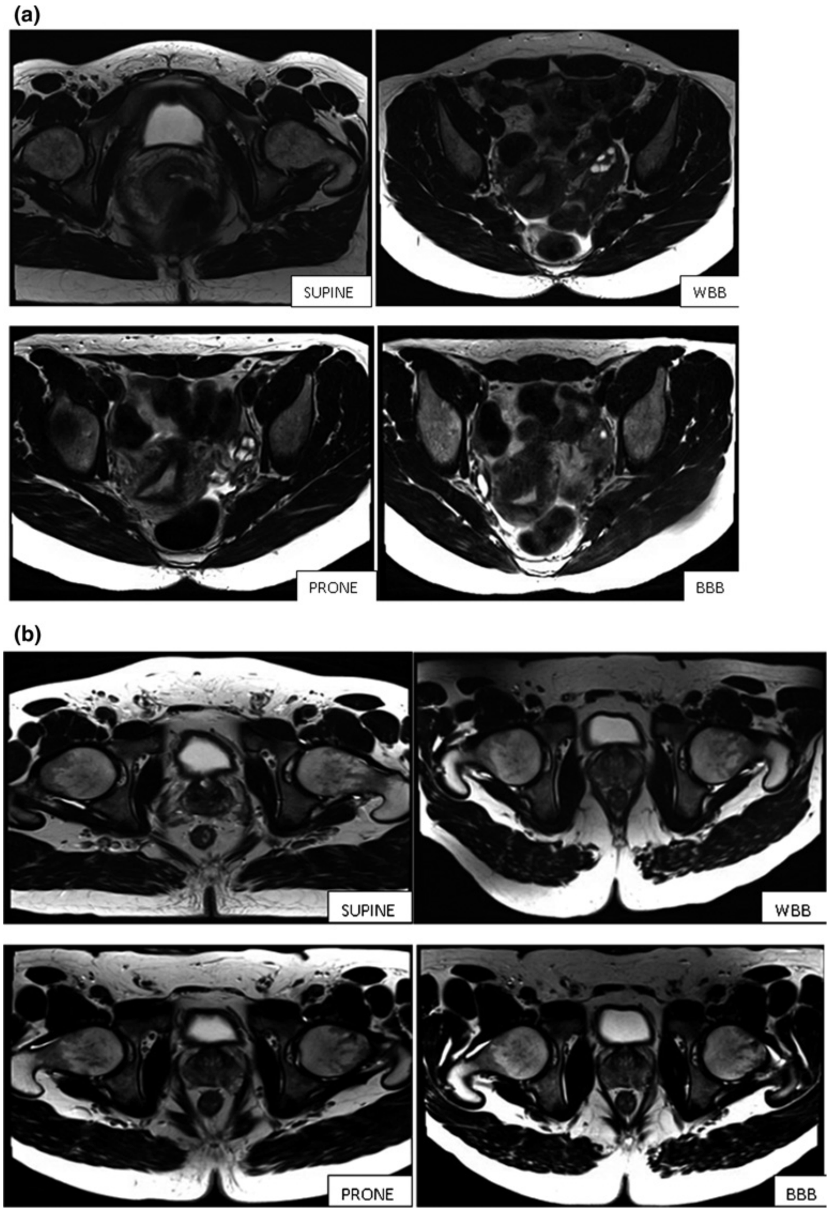

Figure 1. (a) MRI scans from Volunteer 1, images are in the prone, supine, prone with the MR compatible bellyboard (WBB) and the Contoura bellyboard (BBB) setup positions. (b) MRI scans from Volunteer 8 images are in the prone, supine, prone with the MR compatible bellyboard (WBB) and the Contoura bellyboard (BBB) set up positions.

MR images

The MR images were reviewed both on the MRI console for quantitative analysis and were transferred to the Pinnacle[3] treatment planning system (V9.8, Philips, The Netherlands) for semi-quantitative analysis. Scans from the different set up positions were randomly assigned a number from one to four for each volunteer, to help prevent bias in the assessment of each image. To further reduce bias, scans were imported into the planning system to be reviewed in a supine position, irrespective of the original scanning position, noting that it was impossible to remove all set up information from the images. The image quality was assessed for SNR, and clarity for ease of organ delineation.

Data analysis

Quantitative analysis of images was assessed with SNR values determined for five regions of interest (ROIs): an anterior portion of fatty tissue on midline, the rectus abdominus on the left hand side, a region within the

Table 1. Position of the temperature strip placement as used for assessment of potential temperature changes during MRI scans.

Volunteer positioning	Temperature strip location
Supine	• Inferior part of the volunteer bellybutton • The small of the volunteers back
Prone (No Bellyboard)	• Inferior part of the volunteer bellybutton • The small of the volunteers back
Prone (On Bellyboard)	• Pubic symphysis • Inferior part of the volunteer bellybutton • The small of the volunteers back • On the curved ridge of each bellyboard, on a foam blue sponge.

prostate or uterus, a region within the gluteus maximus muscle close to the fatty posterior tissue, to the left hand side of midline and a region within the fatty posterior tissue, just off midline. This was achieved using the ROI tools available within the MRI scanning console to define a 1 cc volume from which the SNR values were determined for each image, on one slice per scan. A slice was chosen where the bladder, rectum and prostate or uterus were all on the same slice. This was often within two centimetres from the isocentre of the scan. A ROI was also placed outside of the volunteers' body to calculate the noise of each image. SNR was calculated as the ratio between the mean signal of the ROI and the standard deviation of background noise.

Semi-quantitative analysis was undertaken using an expert scoring system, based on the table developed by Hunold et al.,[6] which can be seen in Table 2. Two radiation oncologists, one radiologist and one MRI radiographer were asked to independently evaluate the ease with which they were able to identify the rectum, mesorectum, bladder, prostate or uterus and small bowel, for all images according to the scoring system in Table 2.

Table 2. Image scoring system used for semi-quantitative analysis. A score of 1 demonstrating a highly useful image for radiotherapy contouring purposes and a score of 4 demonstrating an image of limited usefulness for radiotherapy contouring purposes.

Score	1	2	3	4
Rectal wall definition	Rectal wall clearly defined	Rectal wall edge slightly blurred, not impairing definition of Rectal Wall boundary.	Considerable blurring of rectal wall edge impacting on accurate definition of Rectal Wall boundary.	Significant blurring of rectal wall, definition of rectal wall boundary not achievable
Mesorectum definition	Mesorectum clearly defined	Mesorectum slightly blurred, not impairing definition of mesorectum boundary.	Considerable blurring of mesorectum impacting on accurate definition of rectal wall boundary.	Significant blurring of mesorectum, definition of mesorectum boundary not achievable
Bladder definition	Bladder wall clearly defined	Bladder wall slightly blurred, not impairing definition of bladder boundary.	Considerable blurring of bladder wall impacting on accurate definition of bladder boundary.	Significant blurring of bladder wall, definition of bladder boundary not achievable
Prostate/uterus definition	Prostate/uterus edge clearly defined	Prostate/uterus edge slightly blurred, not impairing definition of prostate/uterus boundary.	Considerable blurring of prostate/uterus edge impacting on accurate definition of prostate/ uterus boundary	Significant blurring of prostate/uterus edge, definition of prostate/uterus boundary not achievable
Small bowel definition	Small bowel edge clearly defined	Small bowel edge slightly blurred, not impairing definition of small bowel boundary.	Considerable blurring of small bowel edge impacting on accurate definition of Small Bowel boundary	Significant blurring of small bowel edge, small bowel boundary not achievable
Artefacts	No artefacts	Little artefact not impairing image quality	Considerable artefact impacting evaluation of anatomical structures	Extreme artefacts obscuring delineation of anatomical structures
Image noise	Minimal noise	Little noise not impairing diagnostic image quality	Considerable noise impacts the evaluation of anatomical structures.	Extreme noise obscuring delineation of anatomical structures.
Overall image quality	Very good image quality	Fair image quality not impairing the delineation of structures	Impaired image quality that may lead to incorrect delineation	Structures not definable

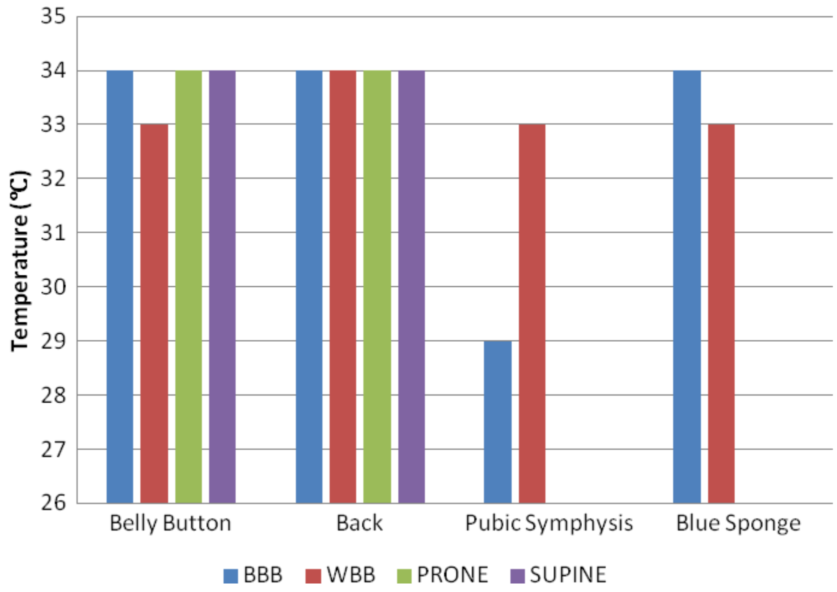

Figure 2. Average maximum recorded temperature at each of the measurement positions for the different set up positions.

Statistics

A random coefficient linear mixed model was used to model the SNR with volunteers as random effects, and predictor variables position, section and position and section interaction. To determine qualitative image quality, a random coefficient linear mixed model was used to model the image scores using crossed random effects of volunteers and assessors, and predictor variables position, measurement type and position and measurement type interaction. The image scores of the organs (rectal wall, mesorectum, bladder, prostate/uterus and small intestines) were modelled with a random coefficient linear mixed model with crossed random effects between volunteer and assessor, and predictor variables position, organ and an interaction between position and organ. SAS (version 9.3, SAS Institute Inc., Cary, NC, USA) was used for statistical analysis.

Results

All images were successfully acquired, demonstrating the practical feasibility for all set-up approaches; Figure 1 shows some typical images for two volunteers demonstrating the differences between the image quality for the different set up positions. Images for volunteer 1 (Fig. 1a) were scored quite poorly across all categories. Meanwhile, images for volunteer 8 demonstrated higher scores, with clearer and easier to identify anatomical data (Fig. 1b).

The temperature strips did not demonstrate a large change in temperature in the area that was in contact with either of the bellyboards when compared to the prone and supine image sequences taken without the bellyboards. The temperatures observed ranged between 29 and 34°C across all scanning positions. Figure 2 demonstrates an average of the maximum temperatures captured across all volunteers in each set up position.

Table 3 shows the comparison of SNR for the different set up positions and different ROIs that were assessed. These were compared to one another in regard to signal and noise against one another. The overall interaction between volunteer positioning and SNR ROI location was significant ($P < 0.0001$). The highest SNR was observed in the fatty regions in the supine positions. For the anterior fatty tissue, the SNR for the supine position was superior compared to the BBB ($P < 0.0001$), prone positioning ($P < 0.0001$), and the WBB ($P < 0.0001$), while the prone positioning was superior to the BBB ($P < 0.009$) For the posterior fatty tissue, the SNR for the WBB was superior to the BBB ($P = 0.002$) and prone position ($P < 0.0001$). Furthermore, using all of the other measurements in Table 3 as a guide, the supine position would indeed be superior to that of the WBB.

In assessing the expert image review, the mean of all items scored was compared to the individual scored items For the mean scores of all items, the supine scans were superior with a mean anatomical score of 1.96 (range 1.45–2.45) and an overall mean image quality score of 1.75 (range 1.33–2.17). The mean anatomical score and mean image quality score were 2.19 (range 1.55–3.45) and 2.13 (range 1.5–3.08) respectively for WBB, 2.20 (range 1.45–2.9) and 2.18 (range 1.33–3) for prone and 2.40 (range 1.7–3.25) and 2.16 (range 1.67–3.08) for BBB.

Table 3. Comparison of image signal to noise ratio (SNR) between positions by section.

Comparison	Difference	95% confidence interval	*P*-value
Fatty anterior			
BBB versus Prone	−120.7	(−211.0, −30.5)	0.009
BBB versus WBB	−62.8	(−153.0, 27.5)	0.170
BBB versus Supine	−339.2	(−429.5, −249.0)	<0.001
Prone versus WBB	58.0	(−32.3, 148.2)	0.210
Prone versus Supine	−218.5	(−308.8, −128.2)	<0.001
WBB versus Supine	−276.5	(−366.7, −186.2)	<0.001
Fatty posterior			
BBB versus Prone	90.2	(−0.1, 180.5)	0.050
BBB versus WBB	−146.9	(−237.2, −56.6)	0.002
BBB versus Supine	57.1	(−33.2, 147.4)	0.210
Prone versus WBB	−237.1	(−327.4, −146.9)	<0.001
Prone versus Supine	−33.1	(−123.4, 57.1)	0.470
WBB versus Supine	204.0	(113.7, 294.3)	<0.001
Muscle anterior			
BBB versus Prone	−15.9	(−106.2, 74.4)	0.728
BBB versus WBB	−4.0	(−94.2, 86.3)	0.931
BBB versus Supine	−19.9	(−110.1, 70.4)	0.665
Prone versus WBB	12.0	(−78.3, 102.2)	0.794
Prone versus Supine	−4.0	(−94.2, 86.3)	0.931
WBB versus Supine	−15.9	(−106.2, 74.4)	0.728
Muscle posterior			
BBB versus Prone	4.9	(−85.4, 95.2)	0.915
BBB versus WBB	−18.4	(−108.7, 71.8)	0.687
BBB versus Supine	2.7	(−87.6, 92.9)	0.954
Prone versus WBB	−23.3	(−113.6, 66.9)	0.611
Prone versus Supine	−2.3	(−92.5, 88.0)	0.961
WBB versus Supine	21.1	(−69.2, 111.4)	0.645
Organ mid			
BBB versus Prone	−11.0	(−101.2, 79.3)	0.810
BBB versus WBB	−24.1	(−114.4, 66.2)	0.599

(*Continued*)

Table 3. Continued.

Comparison	Difference	95% confidence interval	*P*-value
BBB versus Supine	−41.2	(−131.5, 49.0)	0.369
Prone versus WBB	−13.1	(−103.4, 77.2)	0.775
Prone versus Supine	−30.2	(−120.5, 60.0)	0.509
WBB versus Supine	−17.1	(−107.4, 73.2)	0.709

Results are based on a random coefficient linear mixed model using volunteers as the random effect, with variables position, section and an interaction between position and section (Interaction $P < 0.0001$). BBB, Civco Contoura Bellyboard; WBB, MR Series Bellyboard.

A comparison of the scores for the delineation of each organ is presented in Figure 3 and Table 4. The overall test of the interaction between organ and position was not significant ($P = 0.749$). The mesorectum was significantly more clearly identified on the supine scans when compared against the BBB ($P = 0.0003$), prone ($P = 0.003$) and WBB ($P = 0.004$). When identifying the prostate or uterus within our sample, all set up positions were significantly superior to the BBB ($P = 0.026$ when compared with both prone and WBB; $P = 0.002$ compared with supine.). For rectal wall delineation, supine was superior compared to BBB ($P = 0.002$), however, no statistical difference was seen between supine and WBB ($P = 0.08$) and supine and prone ($P = 0.056$). Similar to rectal wall, supine set up demonstrated a statistically significant improvement compared to BBB for small bowel BBB ($P = 0.017$), however, there was no statistically significant difference between supine and prone ($P = 0.426$) and supine and WBB ($P = 0.426$). There was also no statistically significant difference between prone and WBB and prone and BBB.

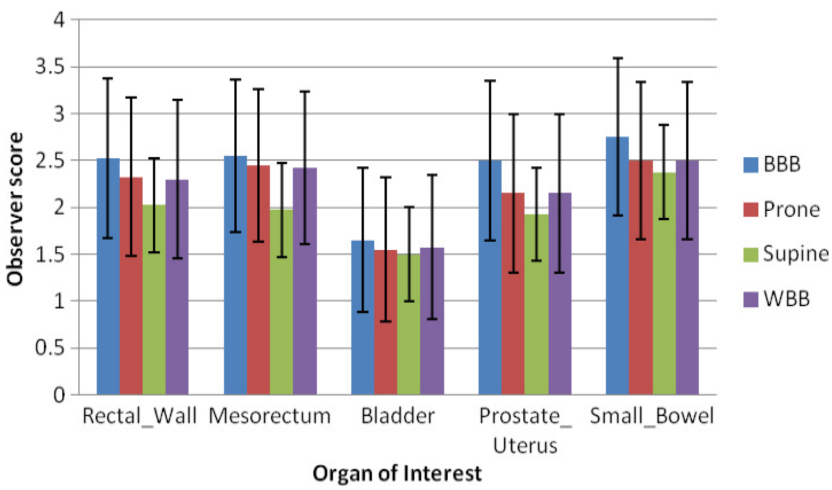

Figure 3. Mean overall observer scores for each organ considered and each imaging set up position, the error bars represent a single standard deviation.

Table 4. Comparison of image scores between positions by organ.

Comparison	Difference	95% confidence interval	*P*-value
Bladder			
BBB versus Prone	0.10	(−0.21, 0.41)	0.524
BBB versus WBB	0.08	(−0.23, 0.38)	0.633
BBB versus Supine	0.15	(−0.16, 0.46)	0.339
Prone versus WBB	−0.03	(−0.33, 0.28)	0.873
Prone versus Supine	0.05	(−0.26, 0.36)	0.750
WBB versus Supine	0.08	(−0.23, 0.38)	0.633
Mesorectum			
BBB versus Prone	0.10	(−0.21, 0.41)	0.524
BBB versus WBB	0.13	(−0.18, 0.43)	0.426
BBB versus Supine	0.58	(0.27, 0.88)	<0.001
Prone versus WBB	0.03	(−0.28, 0.33)	0.873
Prone versus Supine	0.48	(0.17, 0.78)	0.003
WBB versus Supine	0.45	(0.14, 0.76)	0.004
Prostate/uterus			
BBB versus Prone	0.35	(0.04, 0.66)	0.026
BBB versus WBB	0.35	(0.04, 0.66)	0.026
BBB versus Supine	0.58	(0.27, 0.88)	<0.001
Prone versus WBB	0.00	(−0.31, 0.31)	1.000
Prone versus Supine	0.23	(−0.09, 0.53)	0.152
WBB versus Supine	0.23	(−0.09, 0.53)	0.152
Rectal wall			
BBB versus Prone	0.20	(−0.11, 0.51)	0.203
BBB versus WBB	0.23	(−0.09, 0.53)	0.152
BBB versus Supine	0.50	(0.19, 0.81)	0.002
Prone versus WBB	0.03	(−0.28, 0.33)	0.873
Prone versus Supine	0.30	(−0.01, 0.61)	0.056
WBB versus Supine	0.28	(−0.03, 0.58)	0.080
Small bowel			
BBB versus Prone	0.25	(−0.06, 0.56)	0.111
BBB versus WBB	0.25	(−0.06, 0.56)	0.111
BBB versus Supine	0.38	(0.07, 0.68)	0.017
Prone versus WBB	0.00	(−0.31, 0.31)	1.000
Prone versus Supine	0.13	(−0.18, 0.43)	0.426
WBB versus Supine	0.13	(−0.18, 0.43)	0.426

Results are based on a random coefficient linear mixed model using crossed random effects for volunteers and assessors, with variables position, organ and an interaction between position and organ (Organ by position $P = 0.7491$). BBB, Civco Contoura Bellyboard; WBB, MR Series Bellyboard.

The overall test of the interaction between measurement type and position was not significant ($P = 0.79$) (Table 5). With regard to artefact, supine scores were statistically significantly better than the BBB ($P = 0.0007$) and the WBB ($P = 0.043$). A comparison of the BBB and prone positions showed the least statistically significant difference ($P = 0.87$). When assessing image noise the supine set-up was statistically significantly improved compared with the BBB ($P =< 0.0001$), prone ($P = 0.0001$) and the WBB ($P = 0.001$), whereas the BBB and WBB showed no statistical difference ($P = 0.176$). Finally, when assessing the overall image quality, supine set up was statistically superior compared with the BBB ($P = 0.011$), prone ($P = 0.043$) and the WBB ($P = 0.028$).

Table 5. Comparison of image scores between positions by measurement type.

Comparison	Difference	95% confidence interval	*P*-value
Artefact			
BBB versus Prone	0.03	(−0.27, 0.32)	0.866
BBB versus WBB	0.10	(−0.19, 0.39)	0.498
BBB versus Supine	0.40	(0.11, 0.69)	0.007
Prone versus WBB	0.08	(−0.22, 0.37)	0.612
Prone versus Supine	0.38	(0.08, 0.67)	0.011
WBB versus Supine	0.30	(0.01, 0.59)	0.043
Image noise			
BBB versus Prone	0.10	(−0.19, 0.39)	0.498
BBB versus WBB	0.20	(−0.09, 0.49)	0.176
BBB versus Supine	0.68	(0.39, 0.97)	<0.001
Prone versus WBB	0.10	(−0.19, 0.39)	0.498
Prone versus Supine	0.58	(0.29, 0.87)	<0.001
WBB versus Supine	0.48	(0.19, 0.77)	0.001
Overall image quality			
BBB versus Prone	0.08	(−0.22, 0.37)	0.612
BBB versus WBB	0.05	(−0.24, 0.34)	0.735
BBB versus Supine	0.38	(0.09, 0.67)	0.011
Prone versus WBB	−0.03	(−0.32, 0.27)	0.866
Prone versus supine	0.30	(0.01, 0.59)	0.043
WBB versus supine	0.33	(0.04, 0.62)	0.028

Results are based on a random coefficient linear mixed model using crossed random effects for volunteers and assessors, with variables position, measurement type and an interaction between position and measurement (Interaction $P = 0.7898$). BBB, Civco Contoura Bellyboard; WBB, MR Series Bellyboard.

Discussion

For both the SNR and the expert scoring, the supine set up position was superior to many of the prone set up positions for rectal RT treatment planning. The difference between the prone set up positions was not as clear. Some differences were seen between the prone set up and the two bellyboard options, and very few differences were seen between the two bellyboard options.

Arguably, the least variation in organ delineation and SNR scores was seen in the centrally located organs. Statistical differences were seen for the rectal wall and small bowel. However, the clinical differences between these images were considered insignificant. Given that the main purpose of these images for RT is for delineating organs, if prone positioning was considered the most superior for other reasons (e.g. radiation beam positions or relative organ positions) the reduction in MRI quality and subsequent delineation accuracy may be considered an acceptable trade off. However, as earlier mentioned, with the changing trends of now treating rectal patients in a supine position due to advancements in planning techniques such as IMRT and VMAT, this is no longer an issue. As a result, the supine positioning is acceptable.

There are many factors that can affect the image quality and SNR. These factors include slice thickness, the number of averages used, matrix size, and number of acquisitions, magnetic field strength, number of phase encoding steps and the receiver bandwidth.[7] Many of these factors, including bandwidth, magnet strength, and slice thickness were maintained when undertaking the 40 scans for this study. Attempts were made to keep imaging parameters consistent between volunteers. However, slice coverage meant that repetition time (TR) was extended, leading to slight changes in SNR and contrast within the images.

An additional aspect influencing MRI quality is the distance between the patient/volunteer or organ of interest and the receiver coils. The further the coils are away from the region of interest, the lower the level of useful signal received. This is due to the fact that the sensitivity of the coil array drops significantly with increased distance, leading to non-uniformity in the image. By adding the bellyboards onto an already raised surface of having a flat couch top, it is not surprising that the signal and image quality suffer from reduced image quality. Xing et al[8] demonstrated a 40% reduction in SNR with the use of a RT flat couch top. McJury et al[9] also demonstrated that adding a structure such as the flat couch can lead to a reduction in SNR from 14% to 40%. An improvement in SNR may be achievable with a differently designed bellyboard. Jafar et al. found that there was an "89% reduction in SNR when a carbon fibre couch top was used for RT planning purposes on the MRI Simulator".

Heating was not found to be clinically significant for the bellyboards and sequences considered. It is important to note that the heating will change with scanner sequences and scanner set up and that this should be carefully assessed for any changes in sequences particularly functional sequences such as diffusion weighted imaging. We chose to only perform T2-w images as this is the routinely clinically used sequence for rectal patients within the department for anatomical and tumour delineation purposes.

This study focused on image quality. Another factor which should be considered in choice of positioning and may have an indirect impact on image quality is patient or volunteer comfort. It is likely that the more comfortable patients/volunteers are the less likely they are to move during imaging with a related reduction in motion artefact on images. A large proportion of volunteers commented on how uncomfortable both bellyboards were and how hard it was to remain still for the duration of the scan. Keeping in mind that the volunteers that took part in this study are all much younger than the general population of rectal cancer patients one can only imagine how uncomfortable and difficult it would be for our elderly patients to stay sufficiently still for the duration of the scan, potentially further reducing image quality with movement during the scan.

Conclusion

This study has demonstrated that a supine set up position was superior to a standard prone position, including the use of two different belly boards, for achieving a high-quality MRI in the RTP of rectal cancer patients. This was assessed by a comparison of both SNR and expert scoring of image quality and ability to delineate appropriate structures for RTP. Noting that other factors will also impact on the choice of set up position for radiotherapy, all set up options enabled images to be safely undertaken and neither of the bellyboards resulted in excessive heating for the sequences considered, although this should be carefully considered for other scanners and sequences.

Conflict of Interest

The authors declare no conflict of interest.

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