# Supplementary Material

The following data tables group individual studies examining strategies to address pelvic internal organ motion with a suggested level of evidence and grade recommendation. A reference list for these individual studies is included.

## Diet/laxatives

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Author | Patient population | Intervention | Patient number | Type of study | Outcome | Suggested level of evidence | Suggested grade recommendation |
| Lips[1] | Prostate cancer | Diet + laxative versus (vs) diet plus placebo | 46+46 | RCT | Magnesium oxide did not reduce intra-fraction prostatic motion | 1b | A |
| Smitsmans[2] | Prostate cancer | Diet + laxative vs none | 23+26 | Prospective vs retrospective cohort | Reduction in rectal faeces and moving gas with dietary protocol/laxative | 2b | B |
| Oates[3] | Prostate cancer | Diet + laxative vs none | 15+15 | RCT | Trend to improved consistency of rectal volume with diet/laxative | 1b | A |
| Nichol[4] | Prostate cancer | Diet + laxative vs none | 42+42 | Internal control prospective cohort | Anti-flatulent diet/milk of magnesia did not reduce rectal volume/intra-fraction prostatic motion | 2b | B |
| Darud[5] | Prostate cancer | Diet + laxative vs none | 17+15 | Prospective cohort | Diet/laxative did not reduce variation in inter-fraction prostate position | 2b | B |
| Stillie[6] | Prostate cancer | Laxative (rescan if distended rectum) | 89 | Prospective cohort | No relationship between rectal distension at planning and prostatic inter/intra-fraction motion if rescanned for distended rectum | 2b | B |
| McNair[7] | Prostate cancer | Diet | 22 | Internal control prospective cohort | No improvement in consistency of rectal filling | 2b | B |

## Anti-foaming medication

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Author | Patient population | Intervention | Patient number | Type of study | Outcome | Suggested level of evidence | Suggested grade of evidence |
| Madsen[8] | Prostate cancer | Simeticone | 47 | Phase 1 study | Use of rectal catheter to remove gas confounded potential benefit from simeticone | 2b | B |

## Probiotics

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Author | Patient population | Intervention | Patient number | Type of study | Outcome | Suggested level of evidence | Suggested grade of evidence |
| Ki[9]  | Prostate cancer | Probiotic | 20+20 | RCT | Reduced variation in inter-fraction rectal volume but some patients demonstrated excessive rectal distension | 1b | A |

## Rectal emptying

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Author | Patient population | Intervention | Patient number | Type of study | Outcome | Suggested level of evidence | Suggested grade of evidence |
| Fuji[10] | Prostate cancer | Rectal emptying tube | 21 | Internal control prospective cohort | Reduced variation in rectal volume and prostatic motion | 2b | B |
| Stasi[11] | Prostate cancer | Emptying bowel before scan | 10 | Prospective cohort | Improved rectal dosimetry with rectal emptying | 2c | B |
| Ogino[12] | Prostate cancer | Manual evacuation | 42+34 | Prospective cohort | Reduced rectal volume and prostatic motion | 2b | B |

## Enemas

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Author | Patient population | Intervention | Patient number | Type of study | Outcome | Suggested level of evidence | Suggested grade of evidence |
| Fiorino[13] | Prostate cancer | Enema | 21 | Prospective cohort | Limited prostatic motion with use of enema | 2b | B |
| Graf[14] | Prostate cancer | Enema + diet | 38 | Prospective cohort | Limited prostatic motion with use of enema/diet | 2b | B |
| Seo[15] | Prostate cancer | Enema | 15 | Prospective cohort | Reduced prostatic motion with enema | 2c | B |
| Villeirs[16] | Prostate cancer | Enema | 7 | Internal control cohort | PTV coverage maintained with use of enema/bladder filling | 2c | B |
| Yahya[17] | Prostate cancer | Diet, enema or nothing | 10+10+10 | Retrospective cohort | Reduced rectal volume and prostatic motion with enema | 2c | B |
| Sabater[18] | Endometrial cancer | Enema | 59 | Internal control prospective cohort | No reduction in rectal dosimetry with enema | 2b | B |

## Endorectal balloons

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Author | Patient population | Intervention | Patient number | Type of study | Outcome | Suggested level of evidence | Suggested grade of evidence |
| Krol[19] | Prostate cancer | Endorectal balloon | 60 | Prospective cohort | Rectal capacity and sensory function post IMRT/ERB | 2b | B |
| Smeenk[20] | Prostate cancer | Endorectal balloon | 24 | Internal control planning study | Reduced anal wall dose with ERB for CRT and IMRT | 2c | B |
| van Lin[21] | Prostate cancer | Endorectal balloon | 22+30 | Prospective cohort | ERB did not reduce random inter-fraction prostatic motion | 2b | B |
| Wortel[22] | Prostate cancer | Endorectal balloon | 85 | RCT | ERB associated with reduced rectal dose and toxicity | 1b | A |
| van Lin[23] | Prostate cancer | Endorectal balloon | 24+24 | Randomised cohort study | ERB associated with reduced rectal dose and toxicity | 2b | B |
| van Lin[24] | Prostate cancer | Endorectal balloon | 20 | Internal control planning study | ERB associated with reduced rectal dose for CRT | 2c | B |

## Rectal spacers

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Author | Patient population | Intervention | Patient number | Type of study | Outcome | Suggested level of evidence | Suggested grade of evidence |
| Chapet[25] | Prostate cancer | Hyaluronic acid injection | 16 | Internal control planning study | Hyaluronic acid reduced dose to rectal wall | 2c | B |
| Noyes[26] | Prostate cancer | Collagen injection | 11 | Internal control planning study | Collagen reduced dose to rectal wall | 2c | B |
| Pinkawa[27] | Prostate cancer | Spacer gel injection | 18 | Internal control planning study | Spacer gel reduced dose to rectal wall | 2c | B |
| Mariados[28] | Prostate cancer | Spacer gel injection | 222 | RCT | Spacer gel reduced dose to rectal wall and rectal toxicity | 1b | A |

## Electromagnetic transponders

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Author | Patient population | Intervention | Patient number | Type of study | Outcome | Suggested level of evidence | Suggested grade of evidence |
| Tong[29] | Prostate cancer | Electromagnetic transponder | 236 | Retrospective cohort | Generally limited intra-fraction prostate motion | 2b | B |

## Bladder filling

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Author | Patient population | Intervention | Patient number | Type of study | Outcome | Suggested level of evidence | Suggested grade of evidence |
| Kim[30] | Rectal cancer pre-operative | Distended bladder/belly board | 20 | Internal control planning study | Distended bladder alone and combined with belly board reduced volume of irradiated small bowel | 2c | B |
| Kim[31] | Rectal cancer post-operative | Distended bladder/belly board | 20 | Internal control planning study | Distended bladder alone and combined with belly board reduced volume of irradiated small bowel | 2c | B |
| Pinkawa[32] | Prostate cancer | Full/empty bladder | 30 | Internal control planning study | Higher dose to bladder and small bowel with empty bladder | 2c | B |
| Pinkawa[33] | Cervical/endometrial cancer | Bladder filling/prone or supine position | 20 | Internal control planning study | Lower dose to bladder and post-operative bowel with bladder filling | 2c | B |
| Czigner[34] | Prostate cancer | Supine/prone position + belly board with full/empty bladder | 25 | Internal control planning study | No significant difference found between supine/prone + belly board. Full bladder associated with lower doses to most OARs  | 2c | B |
| Zellars[35] | Prostate cancer | Full bladder | 24 | Prospective cohort | Prostate displacement with large bladder volumes late in treatment | 2b | B |
| Roeske[36] | Prostate cancer | Full bladder | 10 | Prospective cohort | Bladder volume varied +-30% on weekly cone beam CT | 2c | B |
| Casares-Magaz[37] | Prostate cancer | Full bladder | 27 | Prospective cohort | Considerable variation in bladder volume during course of RT | 2b | B |
| Cramp[38] | Prostate cancer | Bladder scan/none | 17+17 | Prospective cohort | Greater consistency in bladder volume using bladder scan | 2b | B |
| Mullaney[39] | Prostate cancer | Two different drinking protocols | 110 | RCT | 540ml water associated with better reproducibility of bladder volume than 1080ml | 1b | A |
| Mullaney[40] | Prostate cancer | Bladder ultrasound measurements | 190 | Prospective cohort | Strong positive correlation between ultrasound and CT bladder volumes | 2b | B |
| Eminowicz[41] | Cervical cancer | Drinking protocol | 10 | Retrospective cohort | Ideal planning bladder volume 150-300ml  | 2c | B |
| Umesh[42] | Cervical cancer | Bladder ultrasound measurements | 46 | Prospective cohort | Bladder filling to 300ml feasible throughout treatment | 2b | B |

## Belly board/prone position

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Author | Patient population | Intervention | Patient number | Type of study | Outcome | Suggested level of evidence | Suggested grade of evidence |
| Kim[30] | Rectal cancer pre-operative | Distended bladder/belly board | 20 | Internal control planning study | Distended bladder alone and combined with belly board reduced volume of irradiated small bowel | 2c | B |
| Kim[31] | Rectal cancer post-operative | Distended bladder/belly board | 20 | Internal control planning study | Distended bladder alone and combined with belly board reduced volume of irradiated small bowel | 2c | B |
| Kim[43] | Rectal cancer pre-operative | Prone/prone + belly board | 20 | Internal control planning study | Reduced volume of irradiated small bowel with prone position + belly board | 2c | B |
| Beriwal[44] | Endometrial cancer | Prone/supine position | 21+26 | Prospective cohort | No difference in bowel dosimetry or toxicity with supine position | 2b | B |
| Martin[45] | Gynaecological cancer post-operative | Supine/prone + belly board | 32 | Prospective cohort | Reduced volume of small bowel irradiated using prone position + belly board plus low rates of acute toxicity | 2b | B |
| Bayley[46] | Prostate cancer | Prone/supine position | 28 | RCT | Lower doses to rectum, bladder and bowel and reduced prostate motion in supine position | 1b | A |
| Bajon[47] | Prostate cancer | Prone/supine position | 24 | Internal control planning study | Reduced doses to rectum and bladder in prone position | 2c | B |
| O'Neill[48] | Prostate cancer | Prone/supine position | 26 | Internal control planning study | Reduced doses to rectum and bladder in prone position | 2c | B |
| Adli[49] | Cervical cancer | Prone + belly board/supine position | 16 | Internal control planning study | Lower small bowel doses with prone position plus belly board | 2c | B |
| Huh[50] | Cervical cancer | Prone with/without belly board | 10 | Internal control planning study | Lower volume of small bowel received prescription dose | 2c | B |
| Pinkawa[33] | Cervical/endometrial cancer | Bladder filling/prone or supine position | 20 | Internal control planning study | Lower dose to bladder and post-operative bowel with bladder filling | 2c | B |
| Stromberger[51] | Cervical cancer | Prone + belly board/supine position | 10 | Internal control planning study | Lower volume of small bowel received higher doses | 2c | B |
| Greer[52] | Prostate and rectal cancer | Prone/supine position | 11+8 | Prospective cohort | Larger average random and systematic errors in prone position | 2c | B |
| Kitamura[53] | Prostate cancer | Prone/supine position | 10 | Internal control study | Larger intra-fraction prostatic motion in prone position | 2c | B |
| Shah[54] | Prostate cancer | Prone/supine position | 20 | Internal control study | Larger intra-fraction prostatic motion in prone position | 2b | B |
| Weber[55] | Prostate cancer | Prone/supine position | 18 | Internal control study | Larger systematic errors in prone position | 2c | B |
| White[56] | Rectal cancer pre-operative | Prone/supine position | 25 | Internal control planning study | Larger small and large bowel doses in supine position | 2c | B |
| Heijkoop[57] | Gynaecological cancers pre/post-operative | Prone + belly board/supine position | 26 | Internal control planning study | Smaller small bowel and rectal doses in prone position + belly board only if larger nodal margins required | 2c | B |
| Sawayanagi[58] | Prostate cancer post-operative | Prone + belly board/supine position | 17 | Internal control planning study | Volume of small bowel, rectum and bladder in or near PTV lower in prone position + belly board | 2c | B |
| Koelbl[59] | Rectal cancer post-operative | Prone + belly board/supine position | 20 | Internal control planning study | Irradiated volume and total dose to bladder and small bowel lower in prone position + belly board | 2c | B |
| Hollenhorst[60] | Rectal cancer pre/post-operative | Prone with/without belly board | 20 | Internal control planning study | Lower volumes of small bowel irradiated using prone position + belly board | 2c | B |
| Czigner[34] | Prostate cancer | Supine/prone position + belly board with full/empty bladder | 25 | Internal control planning study | No significant difference found between supine/prone + belly board. Full bladder associated with lower doses to most OARs  | 2c | B |
| Estabrook |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |

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