Supplementary material for Lens E, et al. Considerable pancreatic tumor motion during breath-holding, Acta Oncologica, **Submitted 2016**

Example breath-hold movies

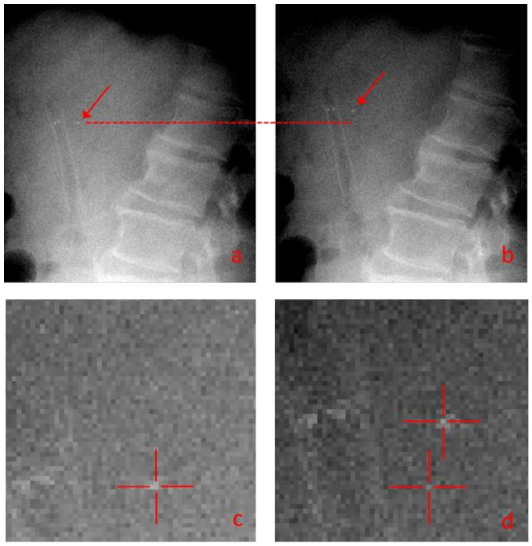
Three example fluoroscopy breath-hold (BH) movies can be found in the Supplementary Materials (Appendix Movies A1--A3). The movies were made during the first BH measurements of patient 1, 2 and 3. The 30-second BHs play at twice the normal speed and are cropped in size to exclude the parts where no image was visible due to the used level-window settings. The projection images in Appendix Figures B1--B3 were taken from these three movies.

Example projection images and fiducial displacement

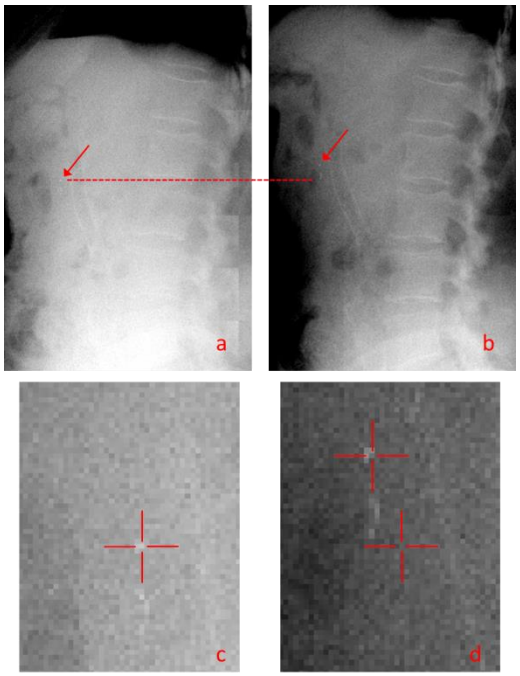
To illustrate the type of images that were used for the 2-dimensional image correlation and to demonstrate the algorithm's ability of correctly measuring the motion of the intratumoral fiducials we show three examples (Appendix Figures B1--B3). Each example shows the first projection image from the fluoroscopic movie and the image in which the largest fiducials displacement was observed.

Both images were cropped to the same size. The locations of the fiducials are indicated with the red arrow. The dashed line serves as a guide to the eye for the fiducial displacement in the inferior-superior (IS) direction. The figures also show the same projection images but zoomed in on the region around the fiducial and the crosshairs indicate the fiducial locations as determined by the algorithm. The crosshair on the initial projection image indicates the starting position of the fiducial. This location is copied to the later projection image and the second crosshair in this image indicates the fiducial location at the later time point given by the algorithm.

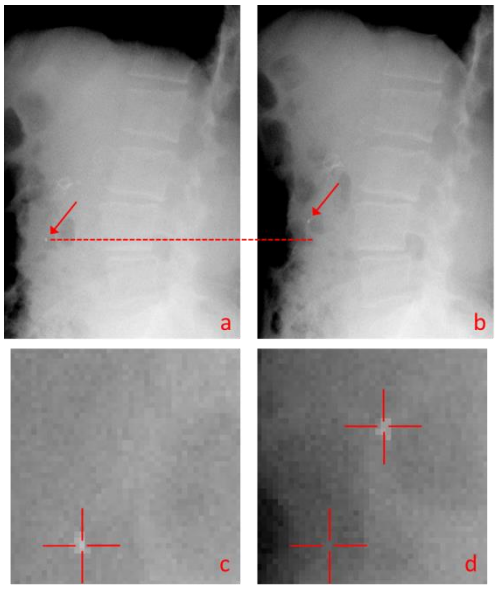
Appendix Table C1 gives the time point of the later projection image as well as the displacement in both directions as determined by the algorithm for this time point in millimeters and in pixels.



Appendix Figure B1: (a) Initial and (b) 128th projection image during the first BH on the first measurement day of patient 1. The red arrow points to the intratumoral fiducials for which the location in pixel values is given relative to the first image. The red dashed line serves a guide to the eye. (c) Initial and (d) later projections shown while zoomed in on the fiducials. The crosshairs indicate the locations of a fiducial as indicated by the algorithm at the start of breath-hold and at the later time point.



Appendix Figure B2: (a) Initial and (b) 127th projection image during the first BH on the first measurement day of patient 2. The red arrow points to the intratumoral fiducials for which the location in pixel values is given relative to the first image. The red dashed line serves a guide to the eye. (c) Initial and (d) later projections shown while zoomed in on the fiducials. The crosshairs indicate the locations of a fiducial as indicated by the algorithm at the start of breath-hold and at the later time point.



Appendix Figure B3: (a) Initial and (b) 147th projection image during the first BH on the first measurement day of patient 3. The red arrow points to the intratumoral fiducials for which the location in pixel values is given relative to the first image. The red dashed line serves a guide to the eye. (c) Initial and (d) later projections shown while zoomed in on the fiducials. The crosshairs indicate the locations of a fiducial as indicated by the algorithm at the start of breath-hold and at the later time point.

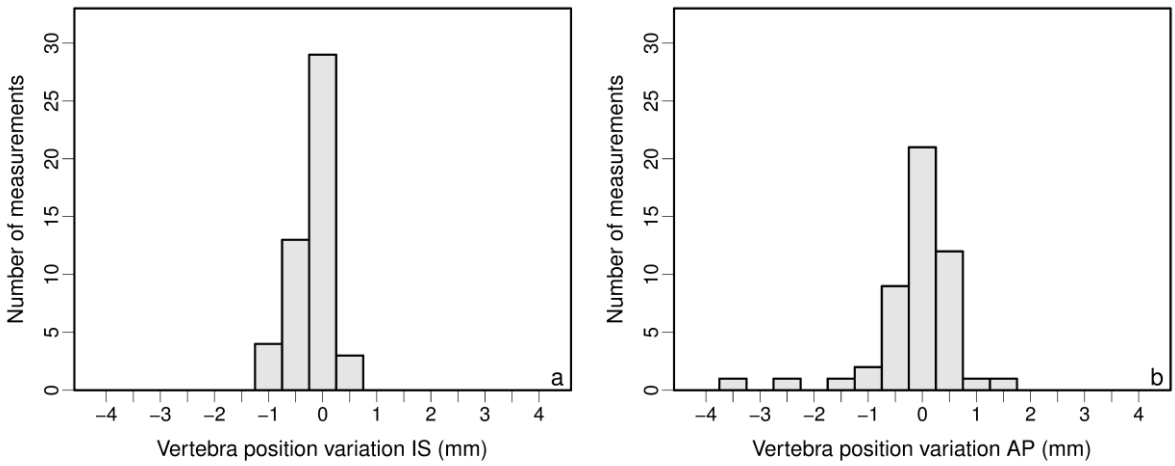
Appendix Table C1: Measured fiducial displacement during the first breath-hold of three patients.

		IS displacement		AP displacement	
	Time point (s)	**(mm)**	**(pixel)**	**(mm)**	**(pixel)**
Patient 1	25.6	7.0	14	1.5	3
Patient 2	25.4	9.0	18	–3.0	6
Patient 3	29.4	11.0	22	5.0	10

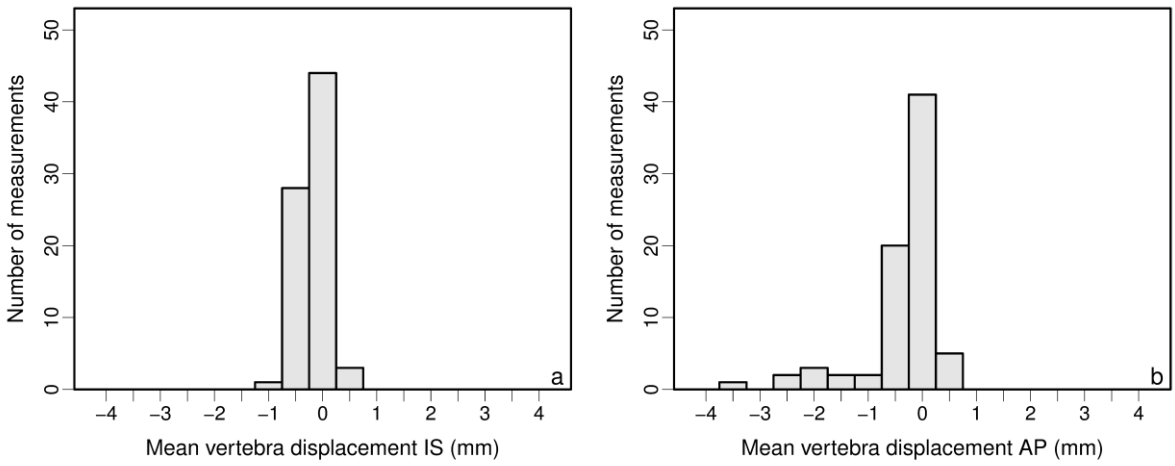
IS, inferior-superior; AP, anterior-posterior.

Vertebra position variation between breath-holds

We measured the position variation of the vertebra at the level of the tumor between consecutive BHs to determine whether the patient shifted between the BHs on a single measurement day (Appendix Figure B4). We also measured the mean vertebra displacement during all 76 BHs (Appendix Figure B5).



Appendix Figure B4: Histograms for vertebra position variation **between** consecutive breath-holds in inferior-superior (a) and anterior-posterior (b) direction.

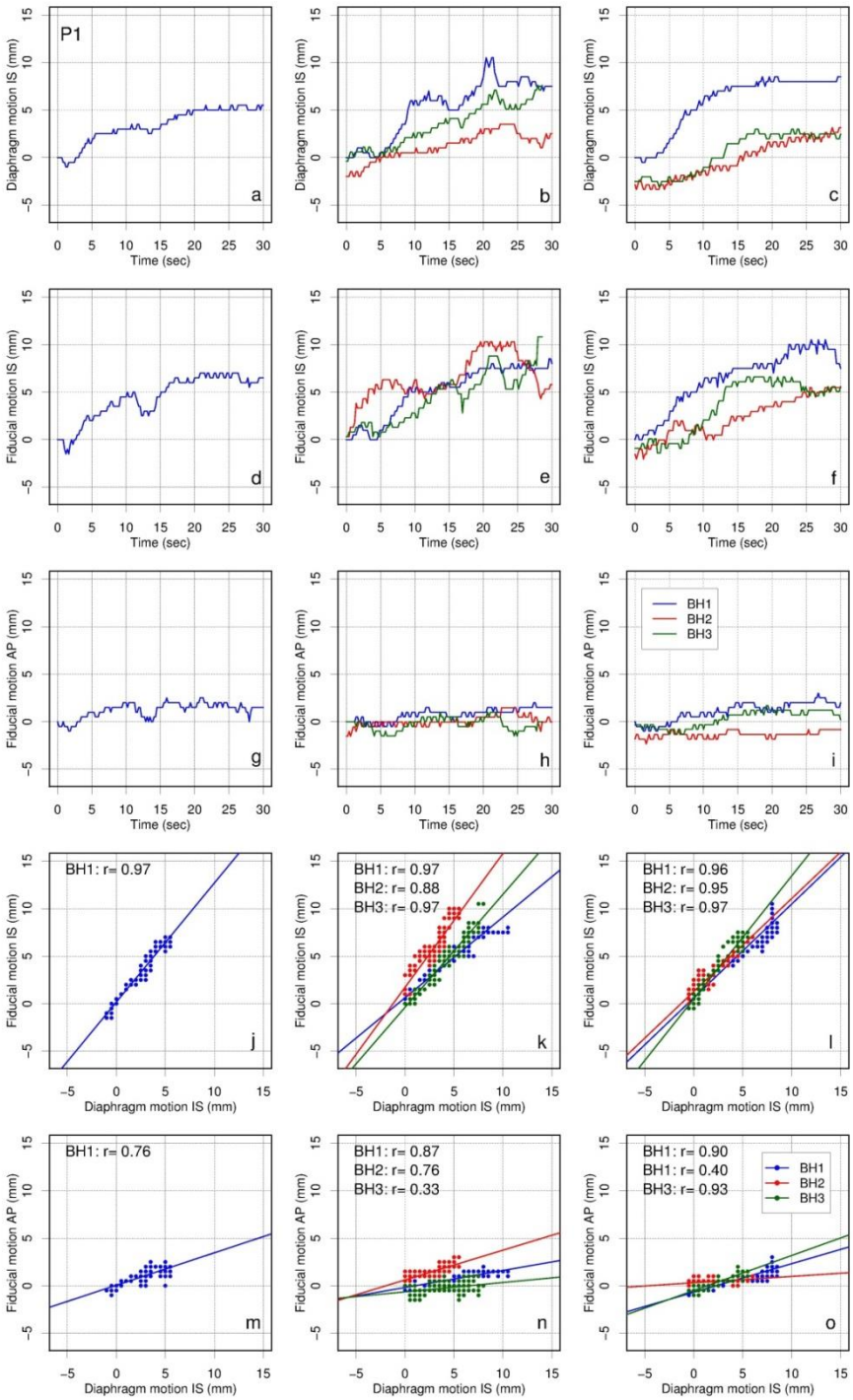


Appendix Figure B5: Histograms for the mean vertebra displacement **during** breath-hold in inferior-superior (a) and anterior-posterior (b) direction. The height of the bar at value x indicates the number of times that the mean displacement was larger than or equal to x–0.25 and smaller than value x+0.25 (*i.e.* [x-0.25,x+0.25)).

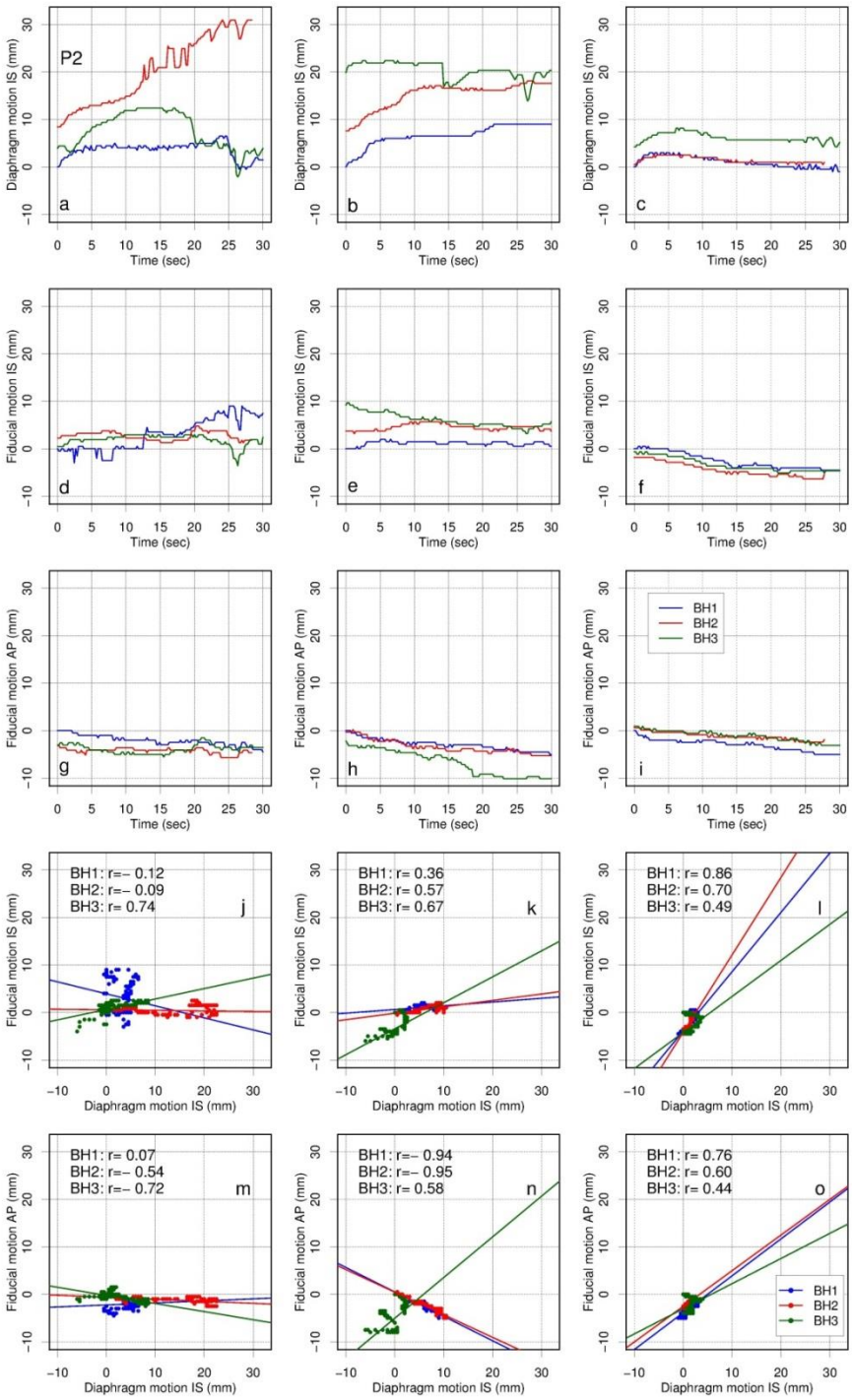
All patient data

The figures on the following pages (Appendix Figures B6--B15) show for each patient the motion during BH in the IS and AP direction of the tumor (i.e. fiducials) and of the diaphragm for all BHs. The difference between the initial position of the different lines indicates the position variation of the tumor or the diaphragm between consecutive BHs. These figures also show the correlation plots between the motion of the tumor and the motion of the diaphragm (j--o).

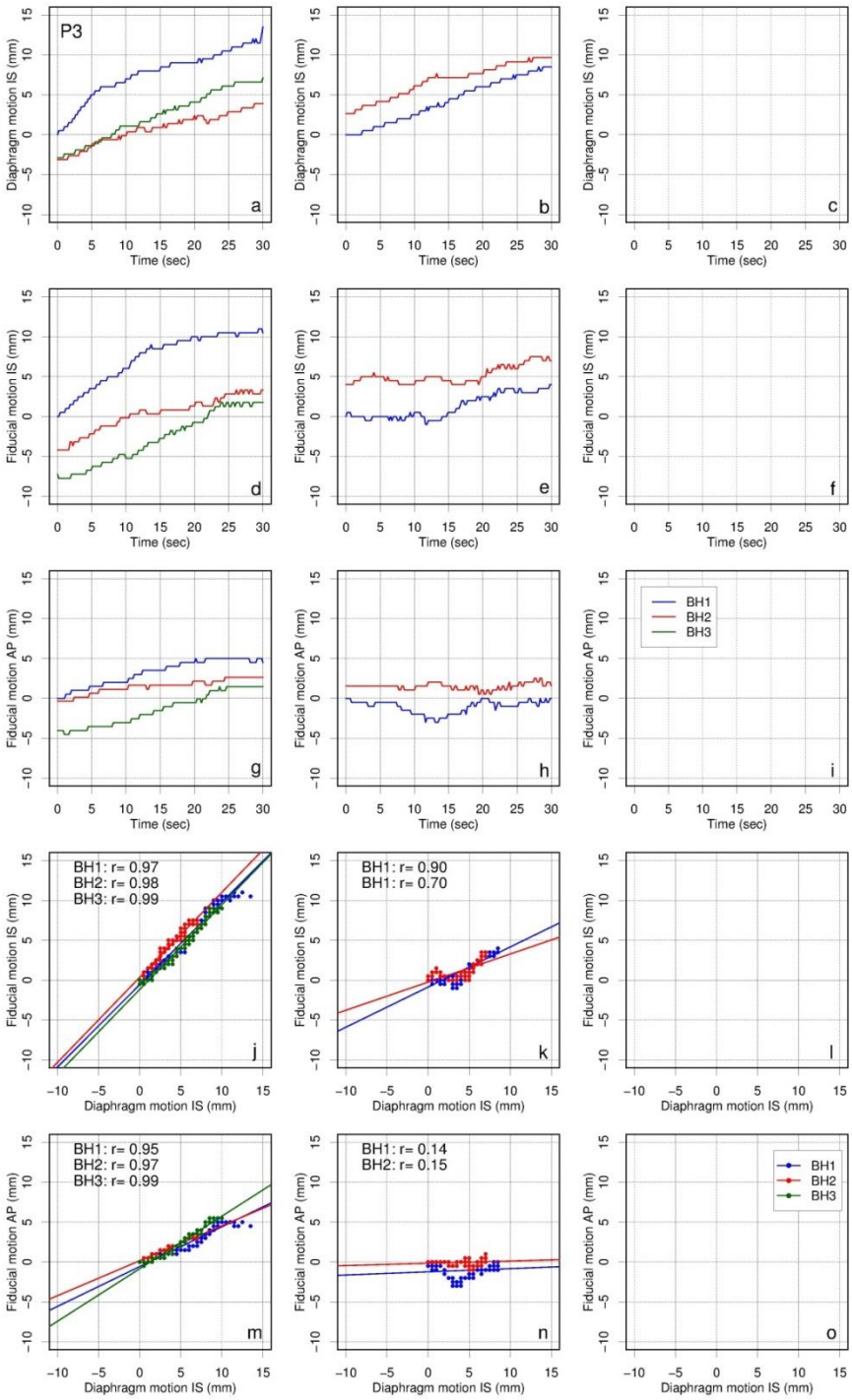
No data is shown for patient 7 and 12 since these patients were unable to successfully perform a single BH.



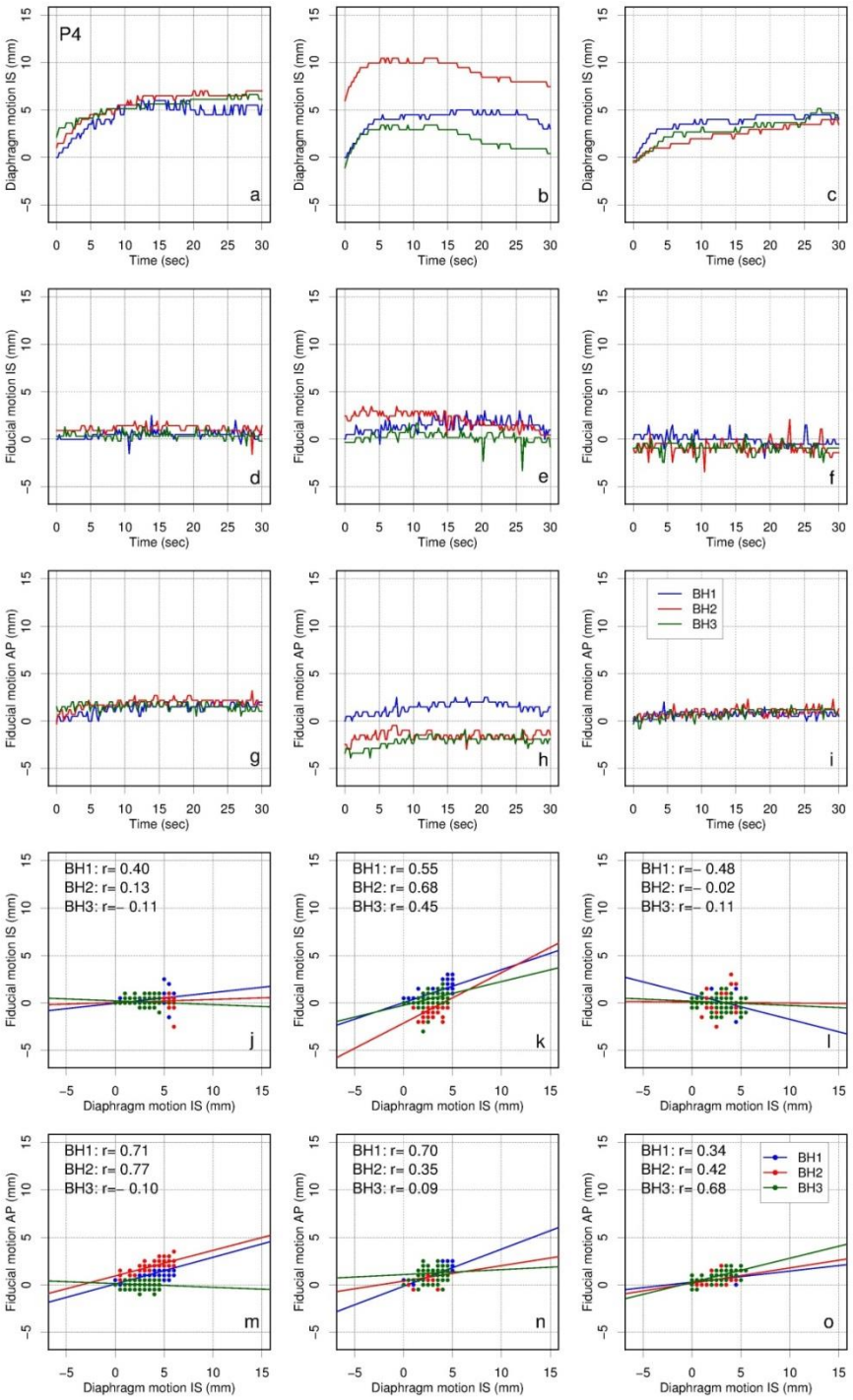
Appendix Figure B6: Intra-breath-hold motion of diaphragm in IS (a--c) and of the fiducials in IS (d--f) and in AP (g--i) during three consecutive breath-holds on three measurement days for **patient 1**. Correlation plots for displacement of diaphragm and fiducials in IS (j--l) and for the displacement of the diaphragm in IS and the fiducials in AP (m--o), with *r* the Pearson correlation coefficient.



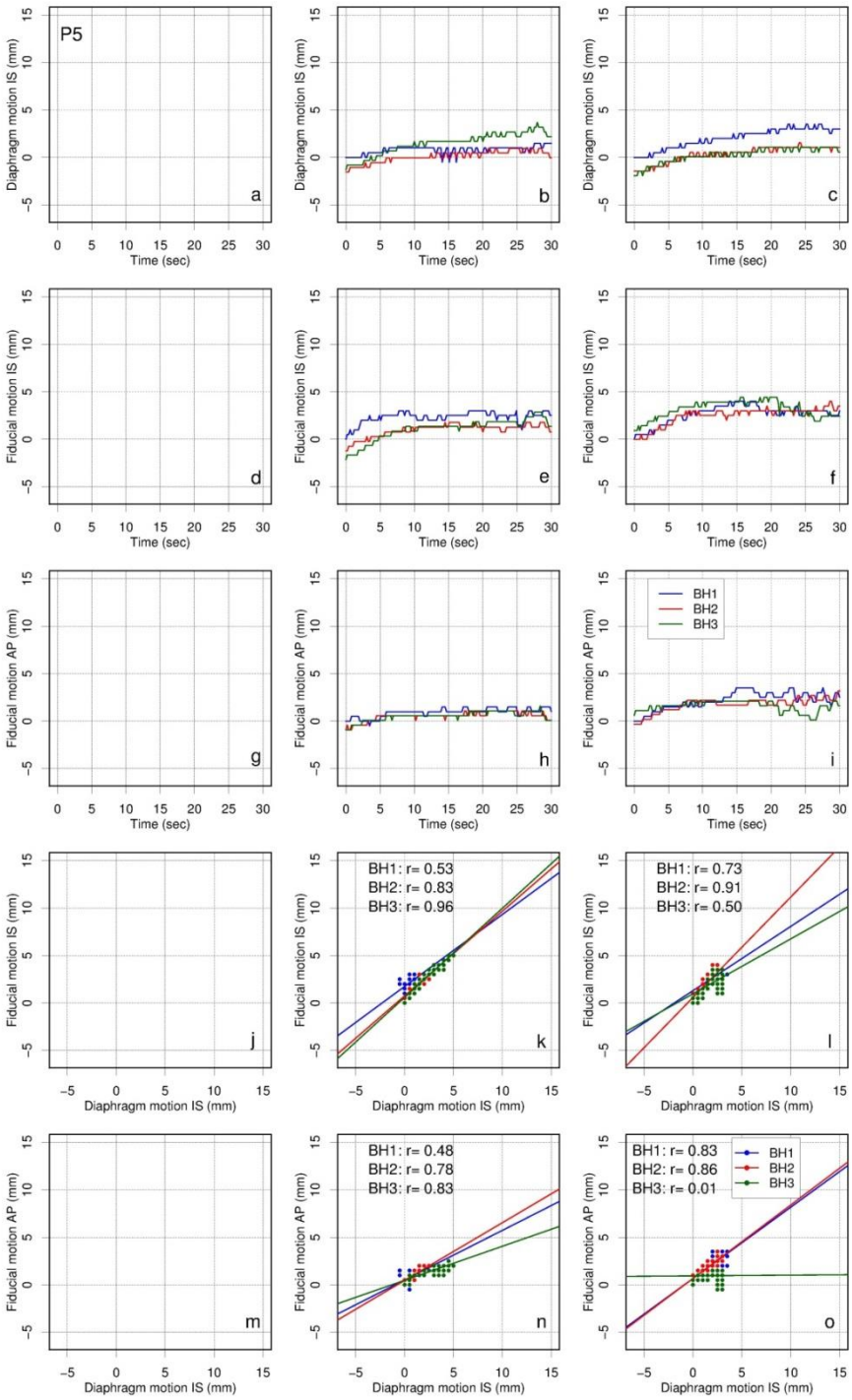
Appendix Figure B7: Intra-breath-hold motion of diaphragm in IS (a--c) and of the fiducials in IS (d--f) and in AP (g--i) during three consecutive breath-holds on three measurement days for **patient 2**. Correlation plots for displacement of diaphragm and fiducials in IS (j--l) and for the displacement of the diaphragm in IS and the fiducials in AP (m--o), with *r* the Pearson correlation coefficient. Note, length of axes in correlation plots differ from other patients.



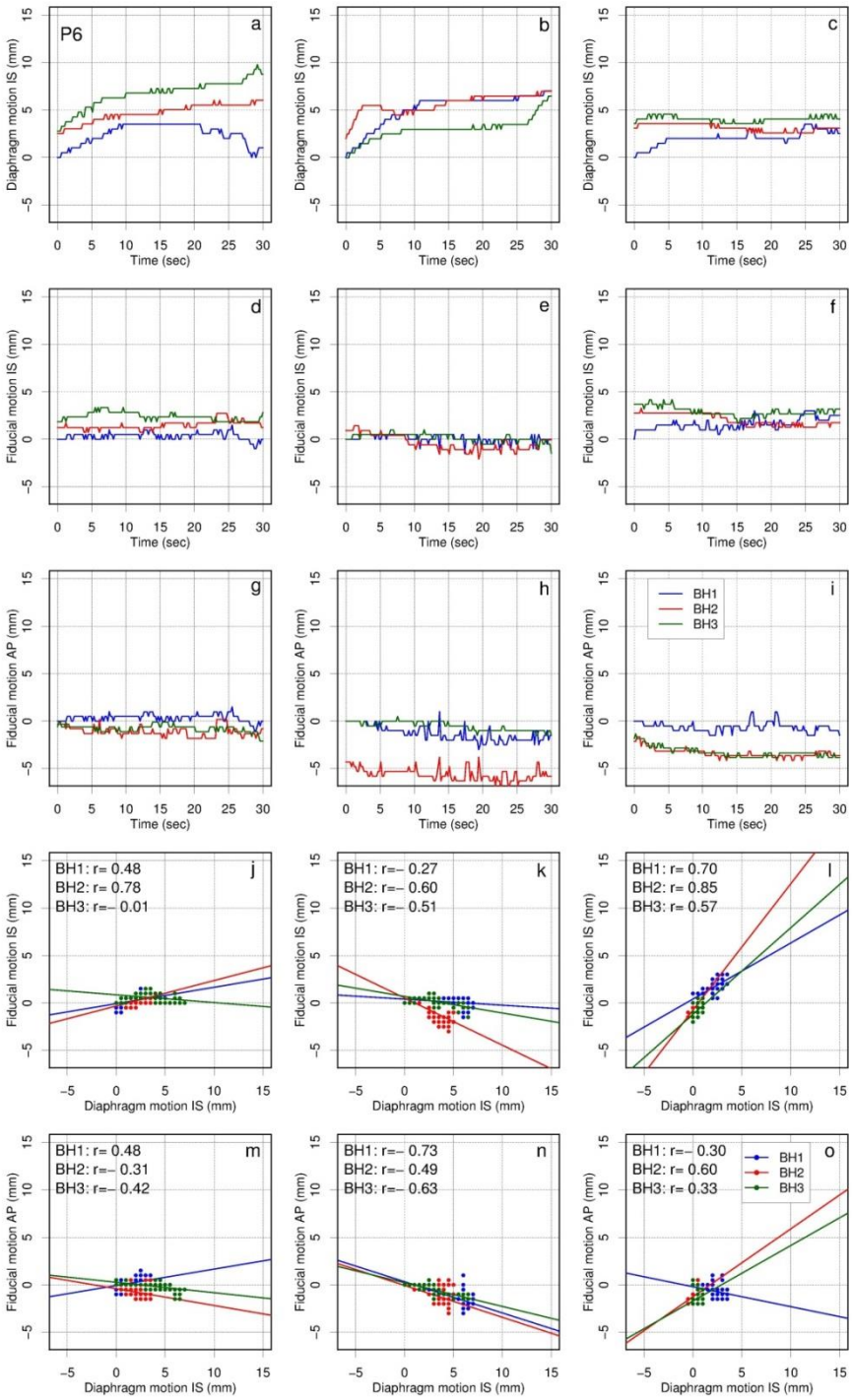
Appendix Figure B8: Intra-breath-hold motion of diaphragm in IS (a--c) and of the fiducials in IS (d--f) and in AP (g--i) during three consecutive breath-holds on three measurement days for **patient 3**. Correlation plots for displacement of diaphragm and fiducials in IS (j--l) and for the displacement of the diaphragm in IS and the fiducials in AP (m--o), with *r* the Pearson correlation coefficient. Note, length of axes in correlation plots differ from other patients.



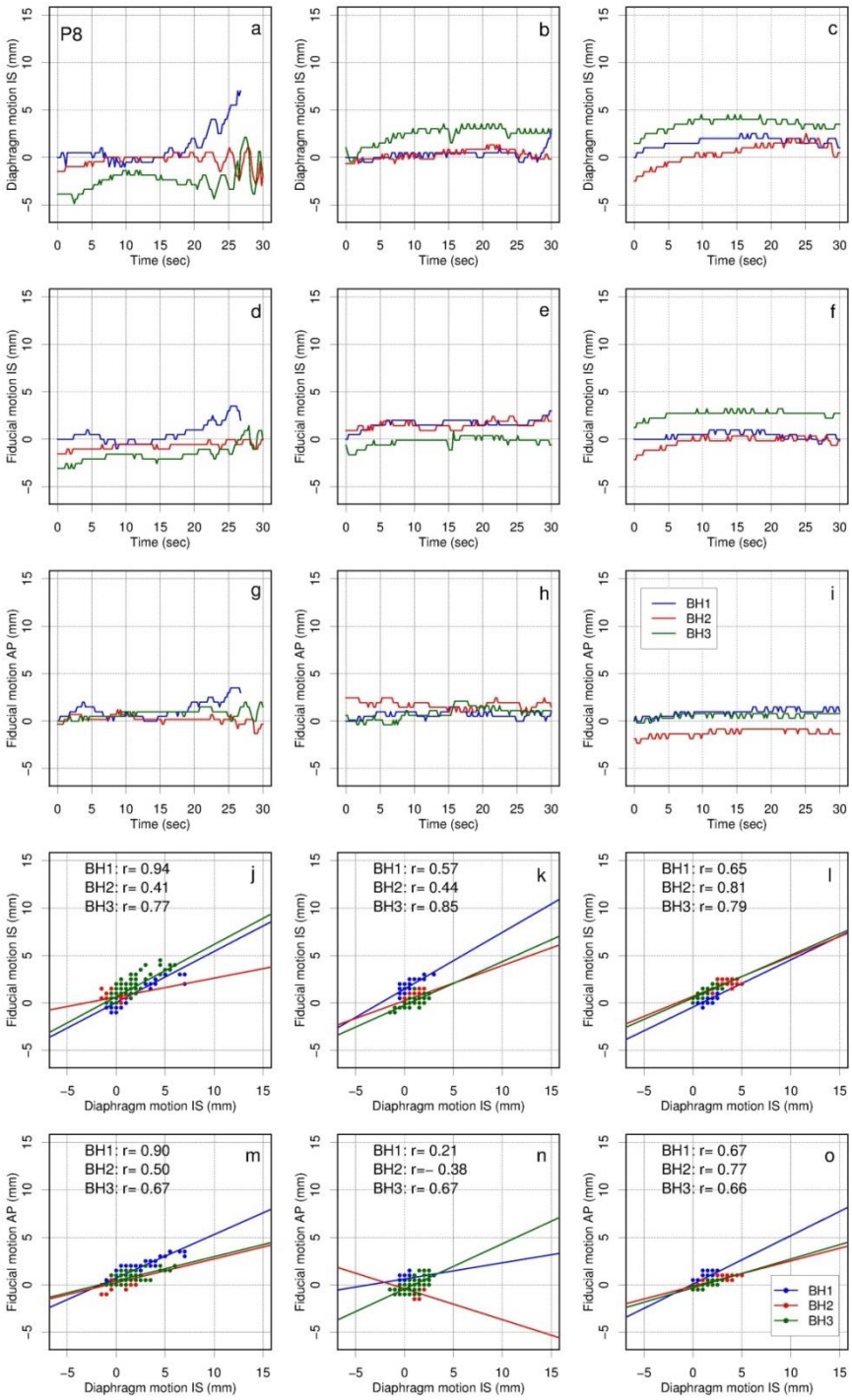
Appendix Figure B9: Intra-breath-hold motion of diaphragm in IS (a--c) and of the fiducials in IS (d--f) and in AP (g--i) during three consecutive breath-holds on three measurement days for **patient 4**. Correlation plots for displacement of diaphragm and fiducials in IS (j--l) and for the displacement of the diaphragm in IS and the fiducials in AP (m--o), with *r* the Pearson correlation coefficient.



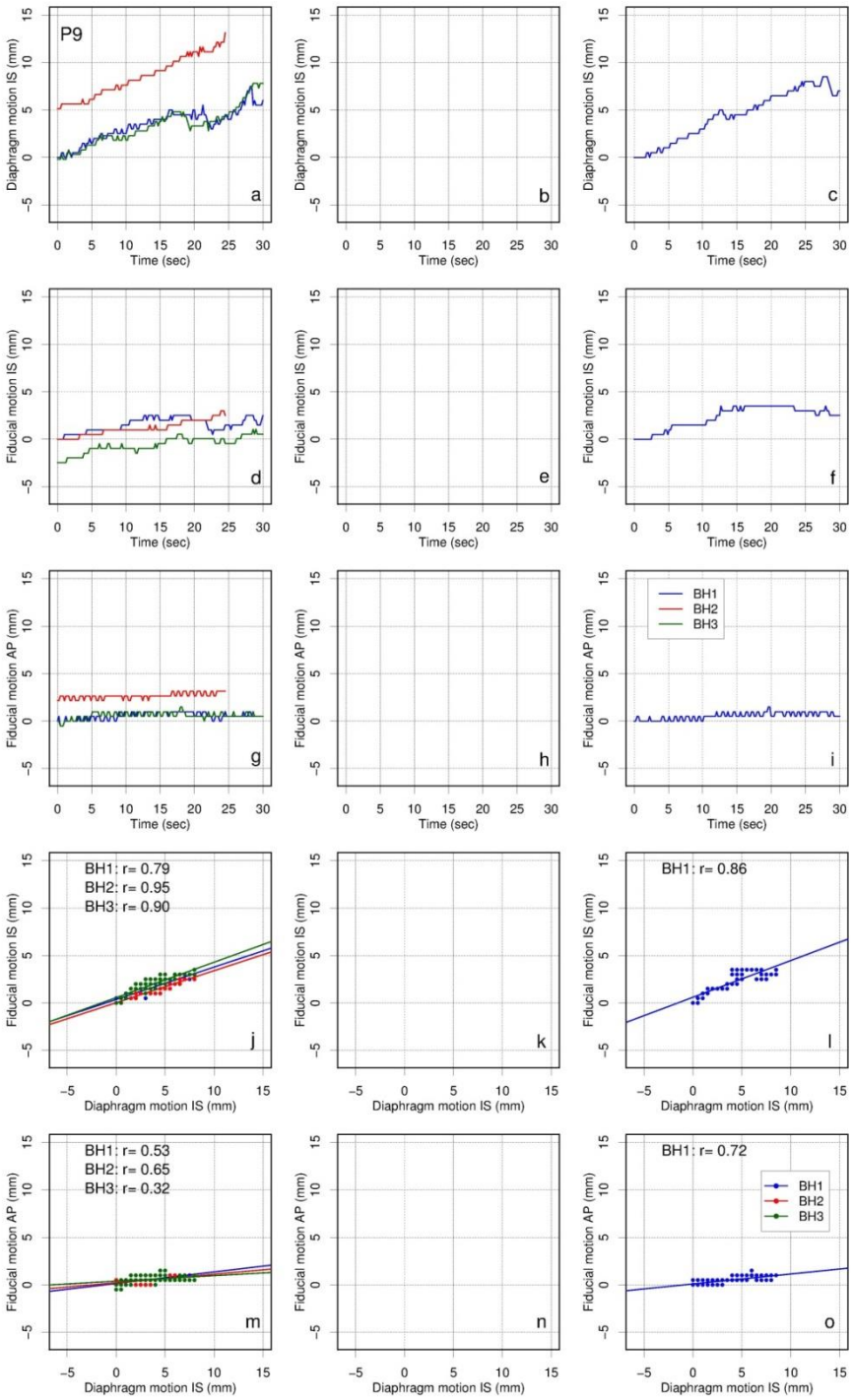
Appendix Figure B10: Intra-breath-hold motion of diaphragm in IS (a--c) and of the fiducials in IS (d--f) and in AP (g--i) during three consecutive breath-holds on three measurement days for **patient 5**. Correlation plots for displacement of diaphragm and fiducials in IS (j--l) and for the displacement of the diaphragm in IS and the fiducials in AP (m--o), with *r* the Pearson correlation coefficient.



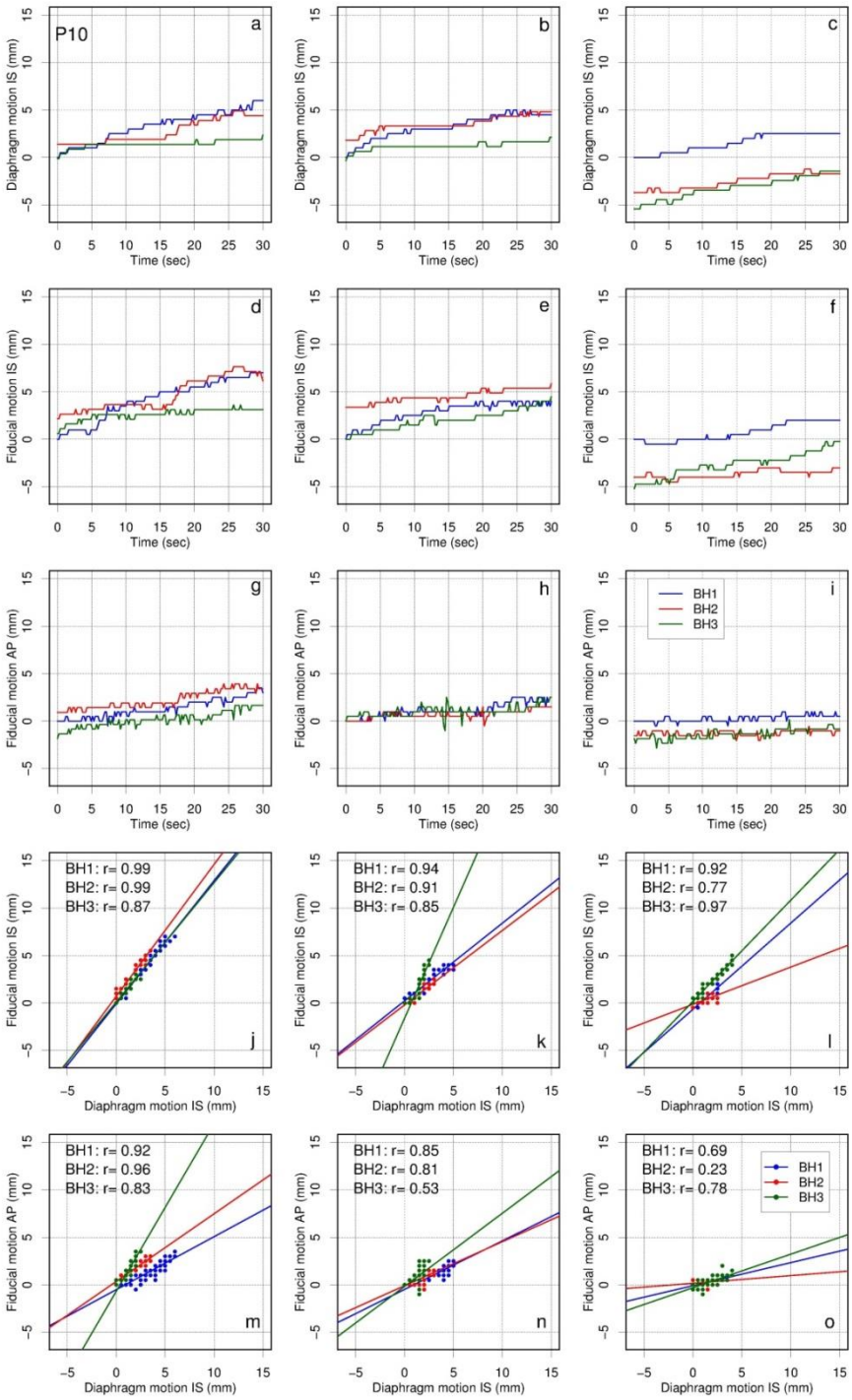
Appendix Figure B11: Intra-breath-hold motion of diaphragm in IS (a--c) and of the fiducials in IS (d--f) and in AP (g--i) during three consecutive breath-holds on three measurement days for **patient 6**. Correlation plots for displacement of diaphragm and fiducials in IS (j--l) and for the displacement of the diaphragm in IS and the fiducials in AP (m--o), with *r* the Pearson correlation coefficient.



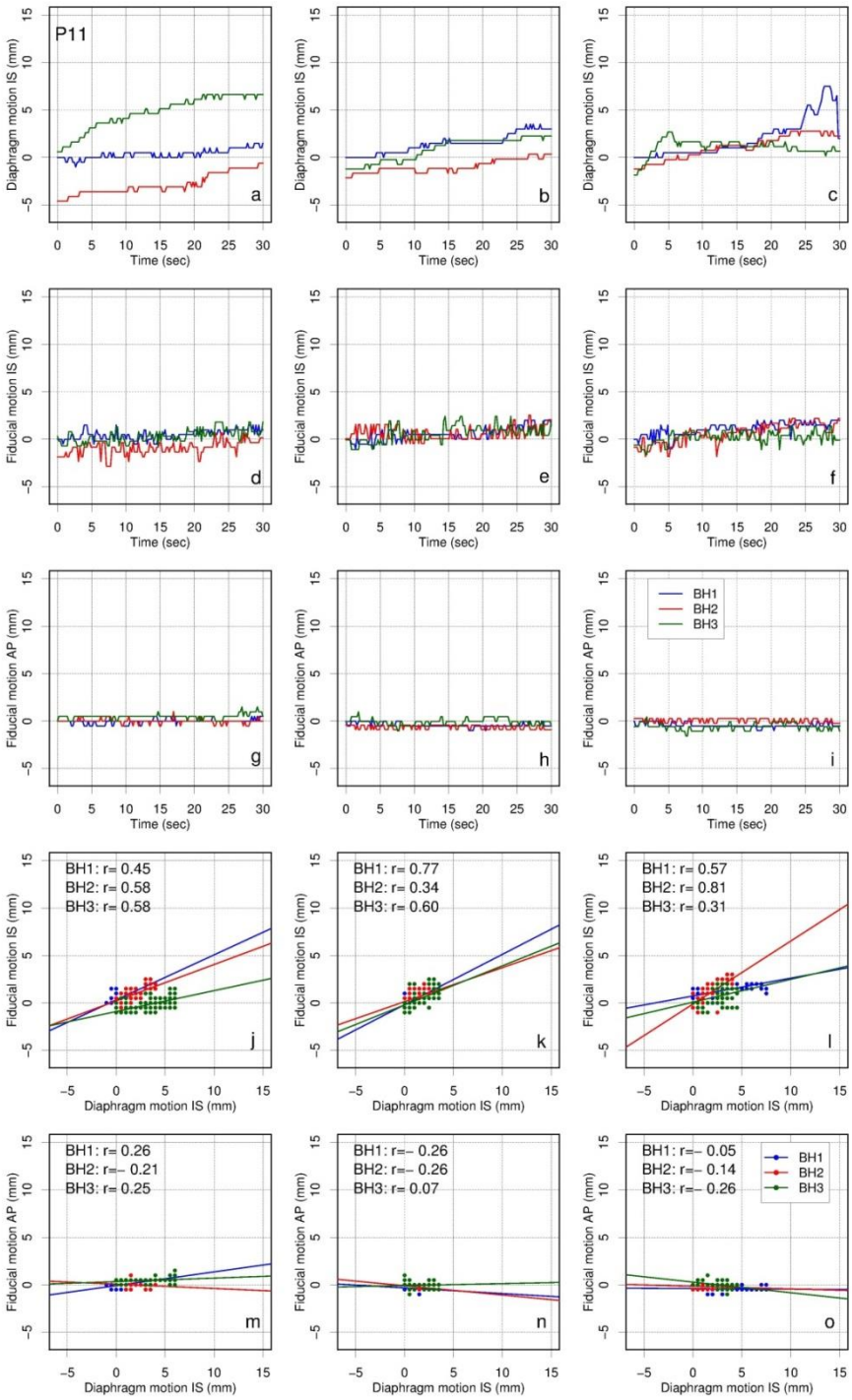
Appendix Figure B12: Intra-breath-hold motion of diaphragm in IS (a--c) and of the fiducials in IS (d--f) and in AP (g--i) during three consecutive breath-holds on three measurement days for **patient 8**. Correlation plots for displacement of diaphragm and fiducials in IS (j--l) and for the displacement of the diaphragm in IS and the fiducials in AP (m--o), with *r* the Pearson correlation coefficient.



Appendix Figure B13: Intra-breath-hold motion of diaphragm in IS (a--c) and of the fiducials in IS (d--f) and in AP (g--i) during three consecutive breath-holds on three measurement days for **patient 9**. Correlation plots for displacement of diaphragm and fiducials in IS (j--l) and for the displacement of the diaphragm in IS and the fiducials in AP (m--o), with *r* the Pearson correlation coefficient.



Appendix Figure B14: Intra-breath-hold motion of diaphragm in IS (a--c) and of the fiducials in IS (d--f) and in AP (g--i) during three consecutive breath-holds on three measurement days for **patient 10**. Correlation plots for displacement of diaphragm and fiducials in IS (j--l) and for the displacement of the diaphragm in IS and the fiducials in AP (m--o), with *r* the Pearson correlation coefficient.



Appendix Figure B15: Intra-breath-hold motion of diaphragm in IS (a--c) and of the fiducials in IS (d--f) and in AP (g--i) during three consecutive breath-holds on three measurement days for **patient 11**. Correlation plots for displacement of diaphragm and fiducials in IS (j--l) and for the displacement of the diaphragm in IS and the fiducials in AP (m--o), with *r* the Pearson correlation coefficient.