

A new approach to assess quality of motion in functional task of upper limb in Duchenne muscular dystrophy

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Supplement S1 – motion protocol to ADL functional motion test

Motion performance were assessing by using following ADL functional tasks:

- 1) abduction-adduction motion in the frontal plane;
- 2) lifting a 50/200/500/1000g weight from the waist height to the shoulder height;
- 3) lifting a 50/200/500/1000g weight from the waist height above the head;
- 4) moving 100/200/500/1000g weight on the table (on the waist height);
- 5) raising an arm with a 50/200g weight from the waist height to the mouth;
- 6) moving, lifting and stacking light/heavy cans on the waist height;
- 7) tracing a path on the waist height;
- 8) supination/pronation of the forearm;
- 9) picking up 6 coins;
- 10) performing a giving grip on the height of the head/chest;
- 11) transferring a given weight from the initial position to the given position;
- 12) raising the arm to the eyes height and tip of the head;
- 13) bringing food/cup to the mouth;
- 14) placing fingers on the diagram and pressing.

Supplement S2 – (Figure S1 – Figure S4)

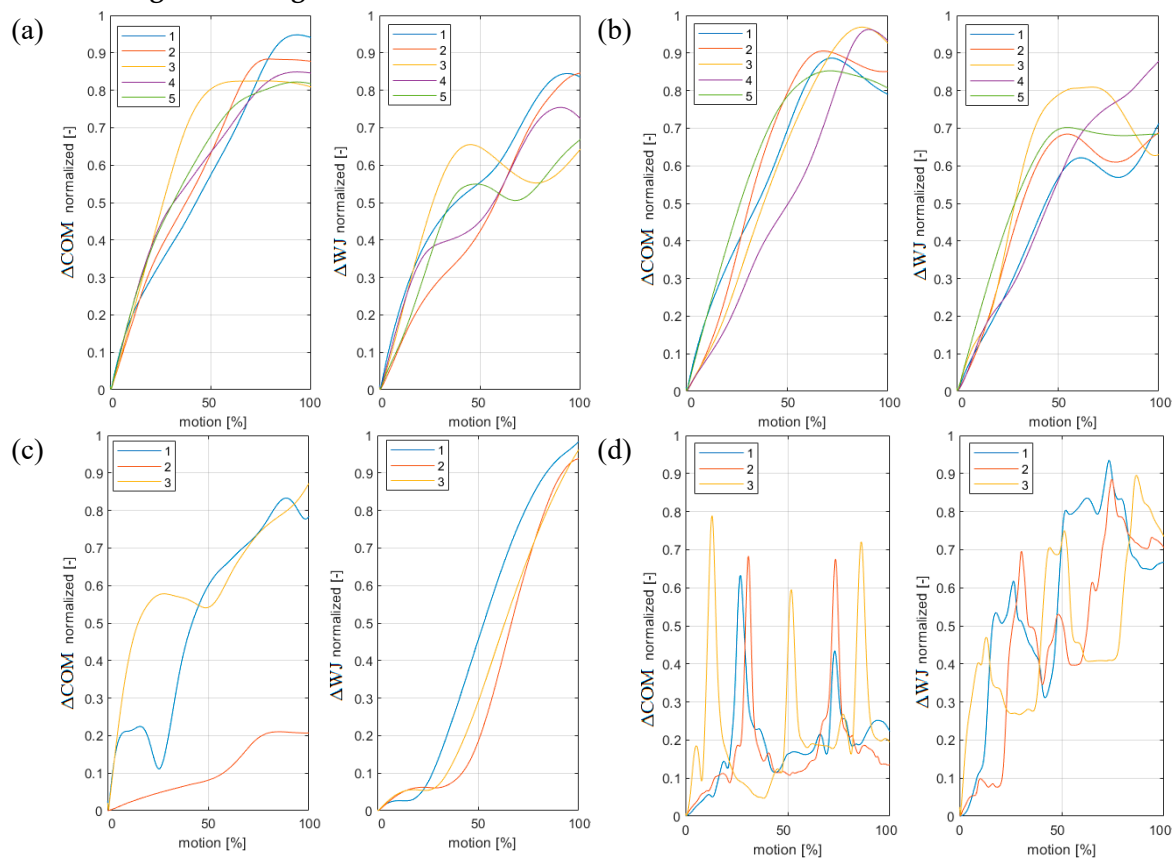


Figure S1. (a) Reference subject in motion 2 in natural conditions; (b) Reference subject in motion 2 in passive manipulator conditions; (c) DMD subject in motion 2 in natural conditions; (d) DMD subject in motion 2 in passive manipulator conditions.

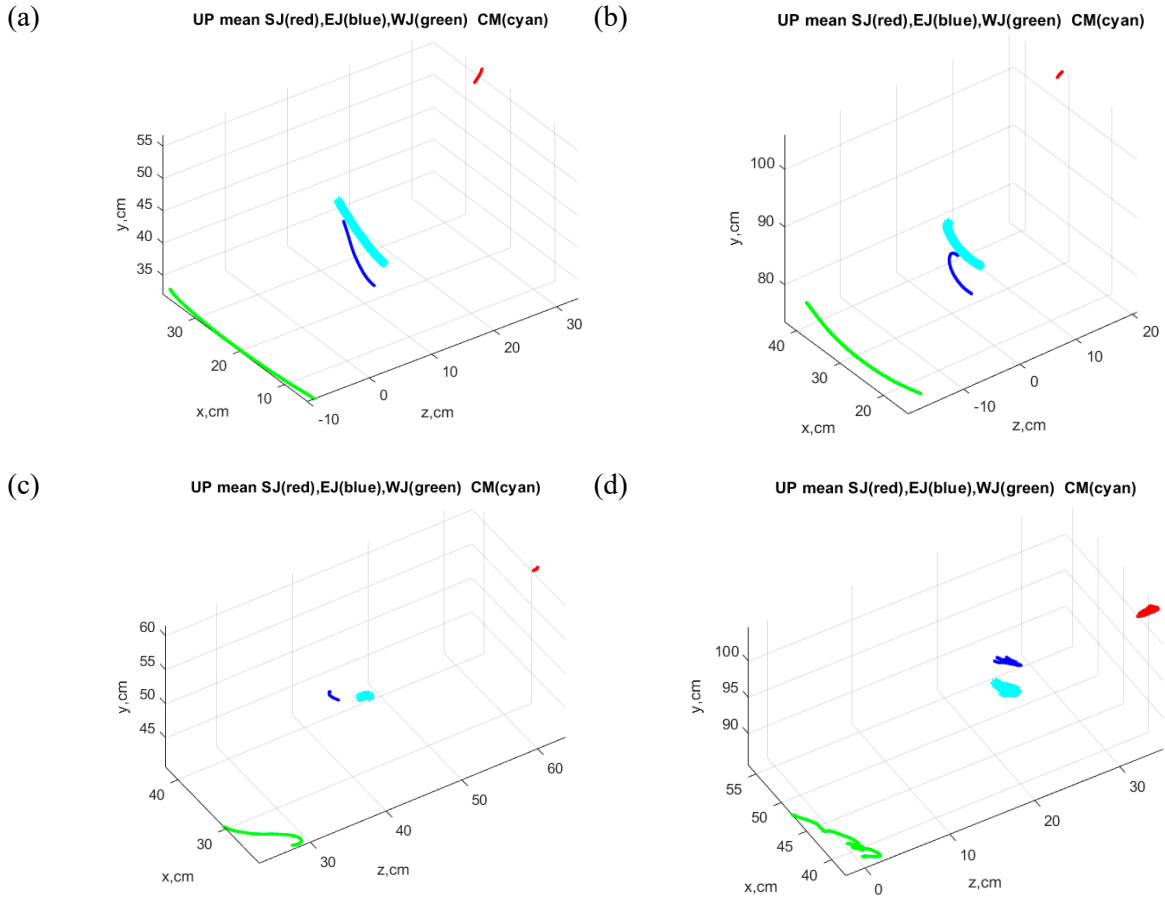


Figure S2. Mean trajectories of Shoulder joint (red), Elbow joint (blue), Wrist joint (green), COM of the upper limb (cyan): (a) Reference subject in motion 1 in natural conditions; (b) Reference subject in motion 1 in passive manipulator conditions; (c) DMD subject in motion 1 in natural conditions; (d) DMD subject in motion 1 in passive manipulator conditions.

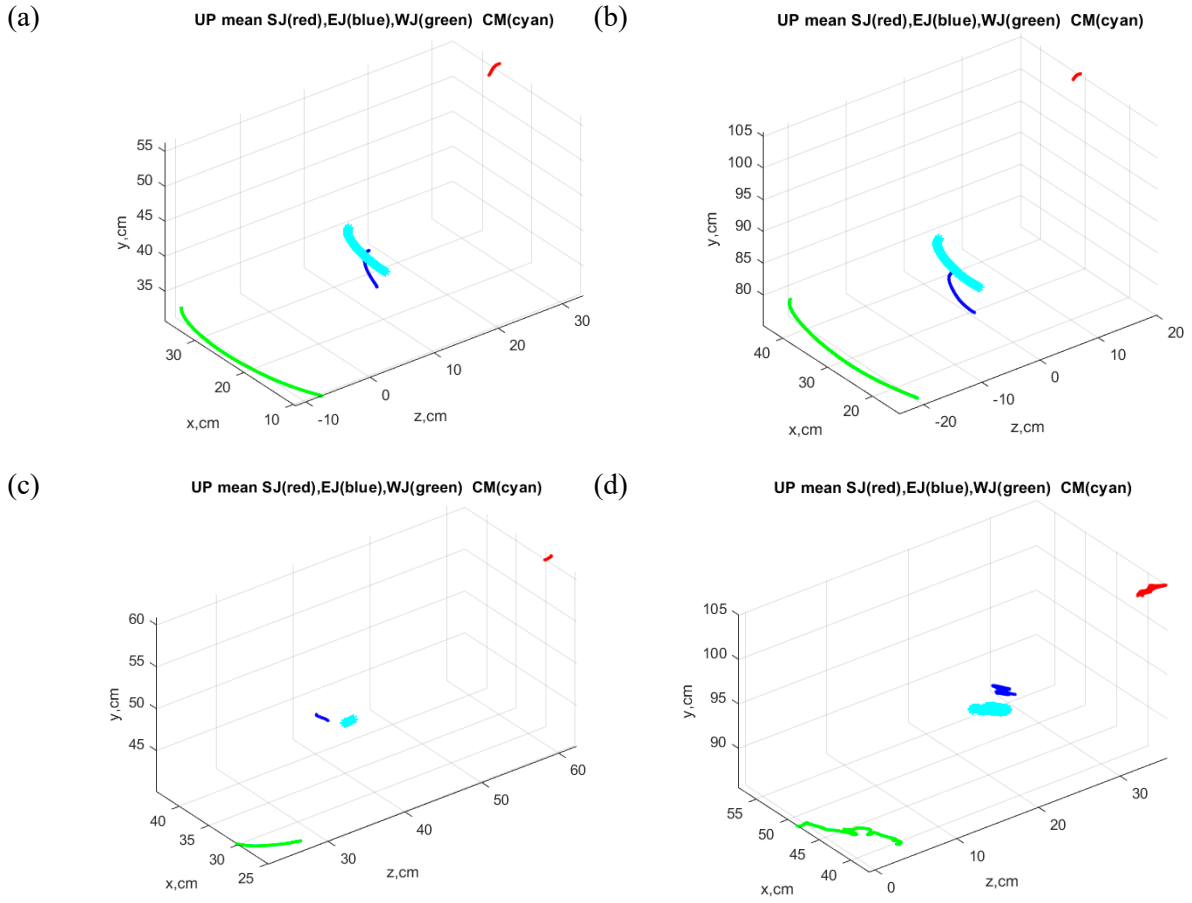


Figure S3. Mean trajectories of Shoulder joint (red), Elbow joint (blue), Wrist joint (green), COM of the upper limb (cyan): (a) Reference subject in motion 2 in natural conditions; (b) Reference subject in motion 2 in passive manipulator conditions; (c) DMD subject in motion 2 in natural conditions; (d) DMD subject in motion 2 in passive manipulator conditions.

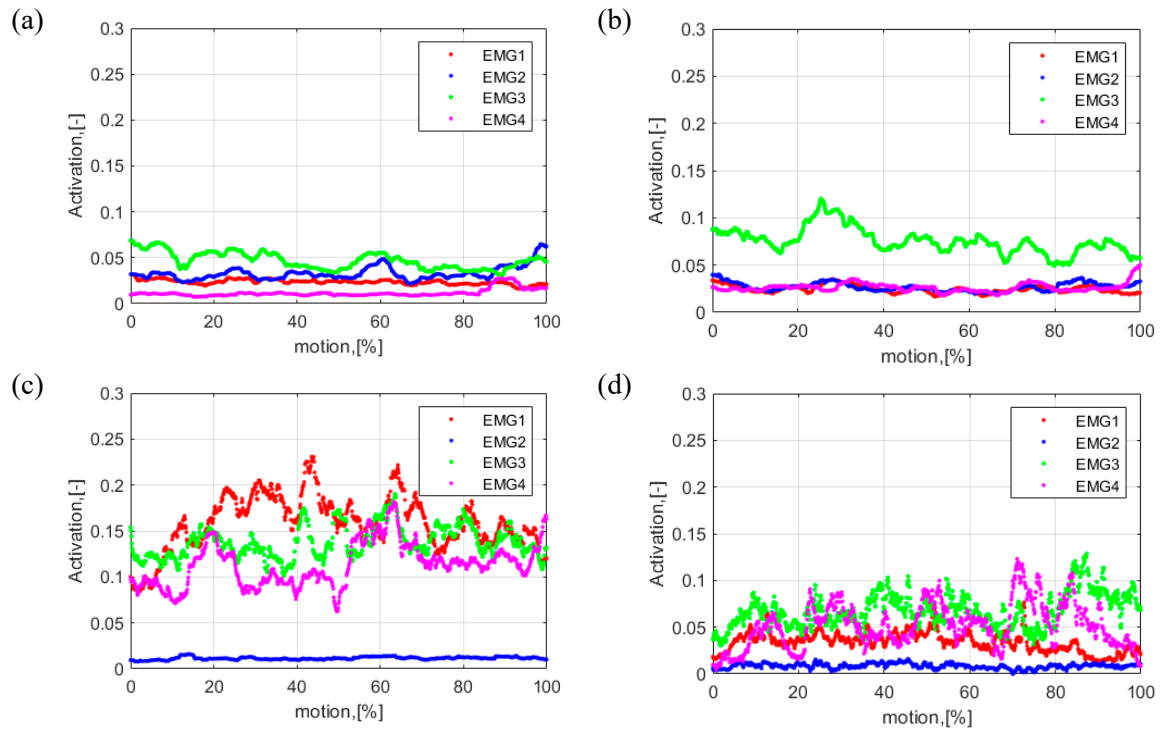


Figure S4. EMG data processed (mean value of the RMS normalized data): BB (EMG₁), TB (EMG₂), AD (EMG₃) and UT (EMG₄): (a) Reference subject in motion2 in natural conditions; (b) Reference subject in motion2 in passive manipulator conditions; (c) DMD subject in motion2 in natural conditions; (d) DMD subject in motion2 in passive manipulator conditions.

Supplement S3 – (Figure S5 – Figure S66)

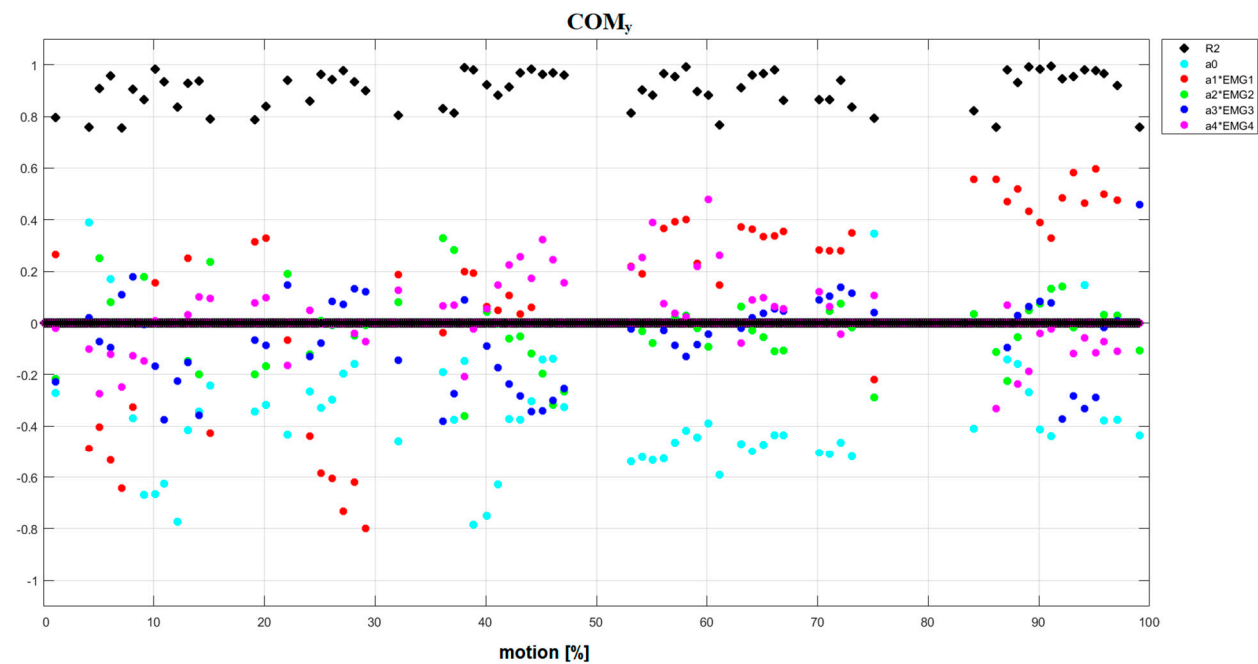


Figure S5. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for reference subject in Motion 1. Natural conditions. COM_y.

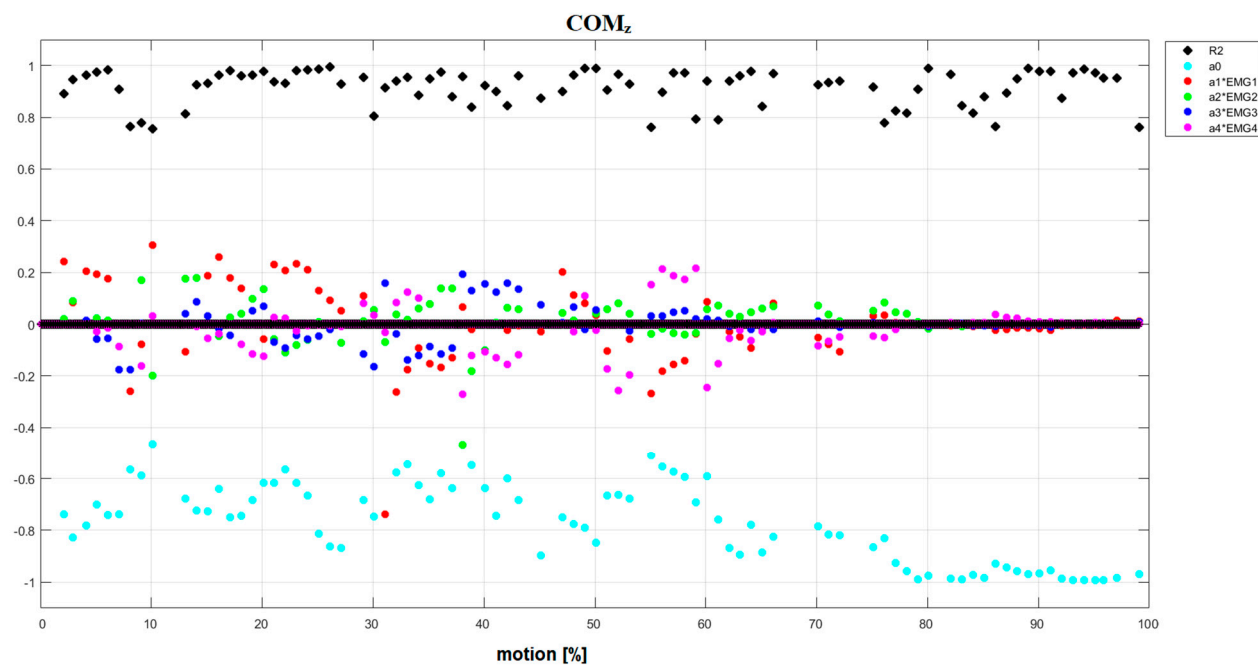


Figure S6. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for reference subject Motion 1. Natural conditions. COM_z.

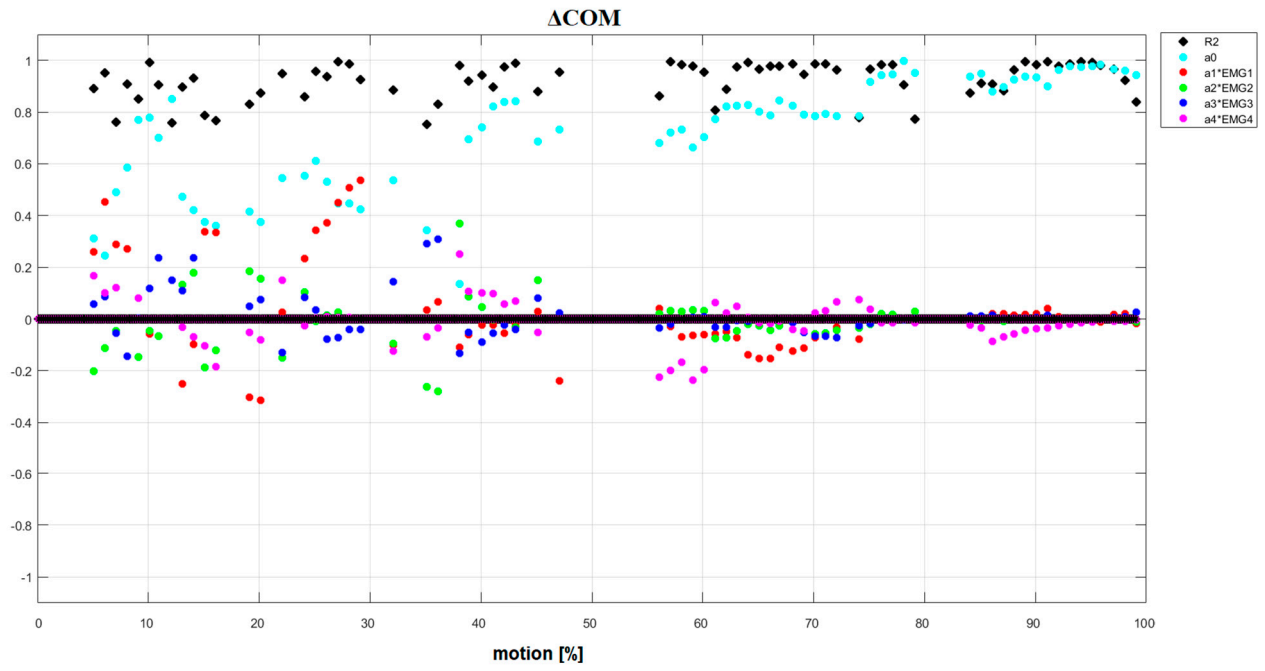


Figure S7. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for reference subject in Motion 1. Natural conditions. ΔCOM .

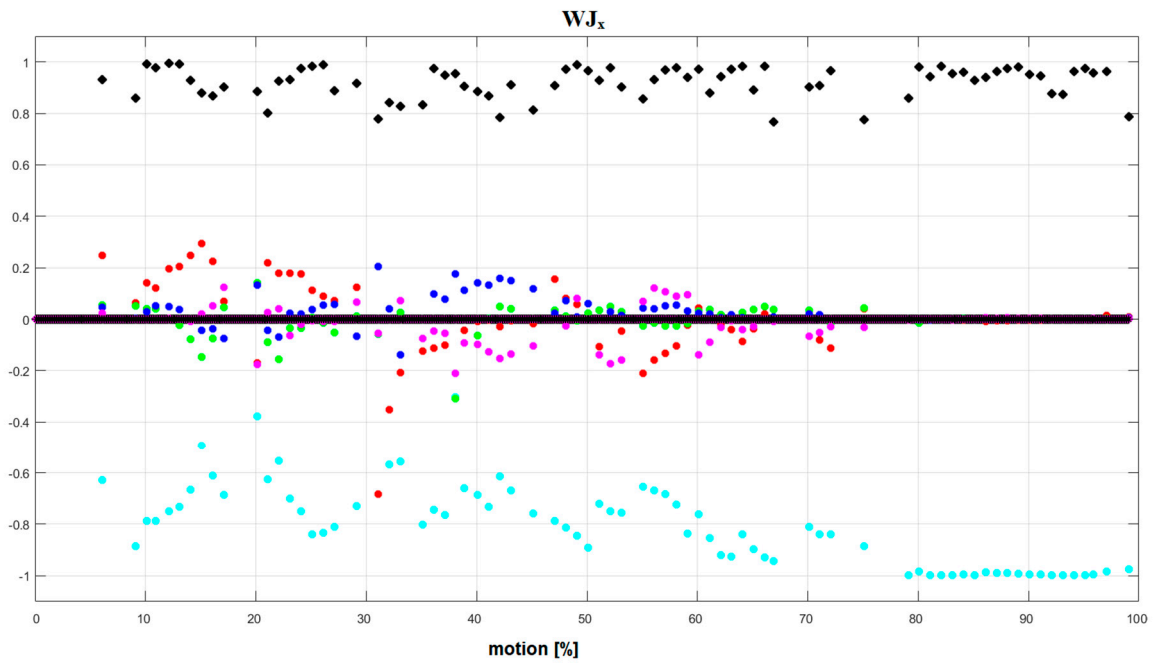


Figure S8. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for reference subject in Motion 1. Natural conditions. WJ_x .

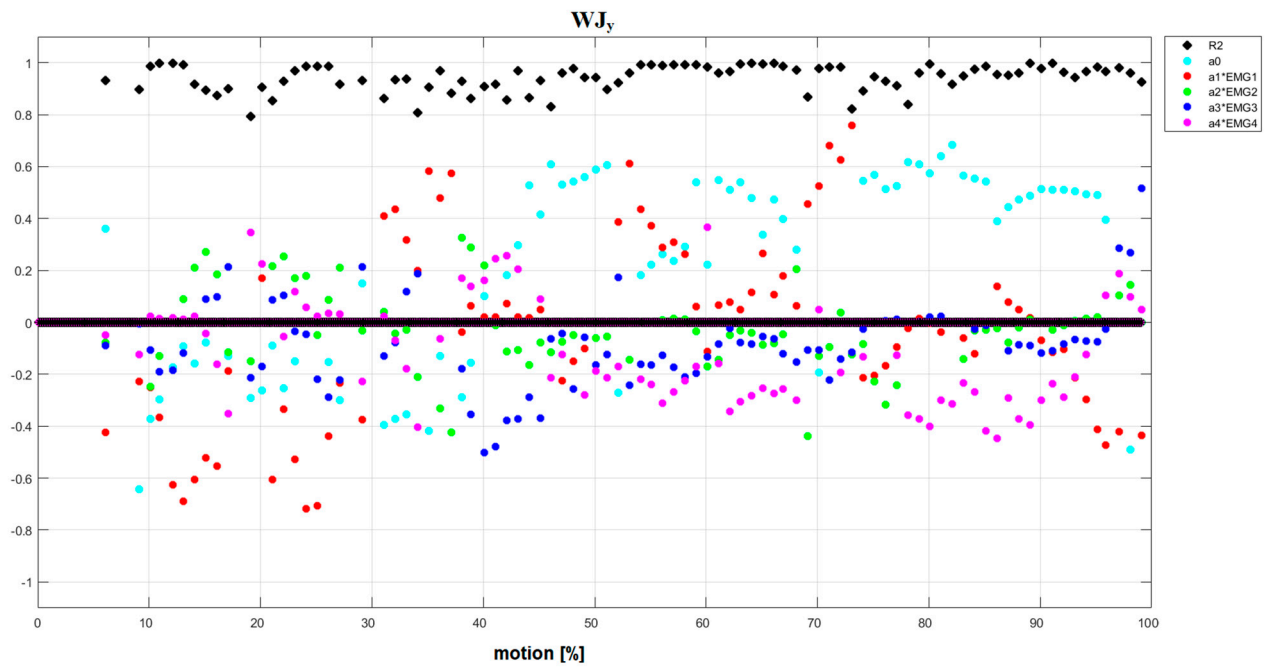


Figure S9. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for reference subject in Motion 1. Natural conditions. WJ_y .

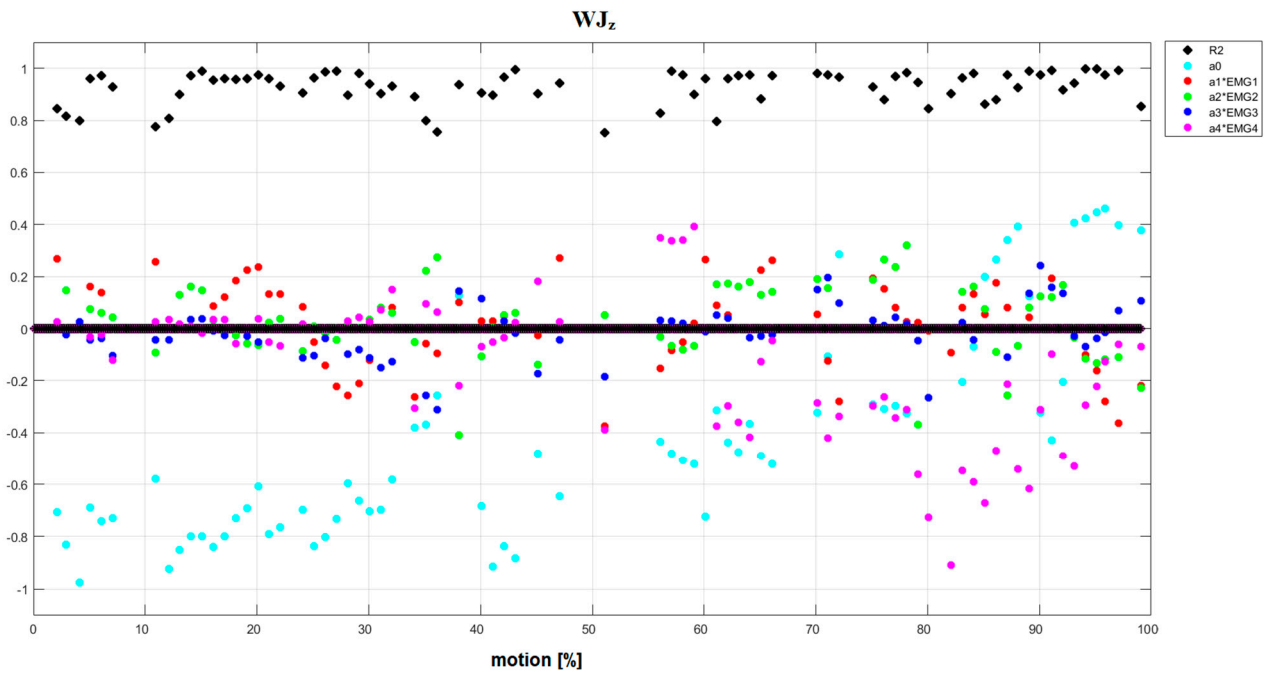


Figure S10. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for reference subject in Motion 1. Natural conditions. WJ_z .

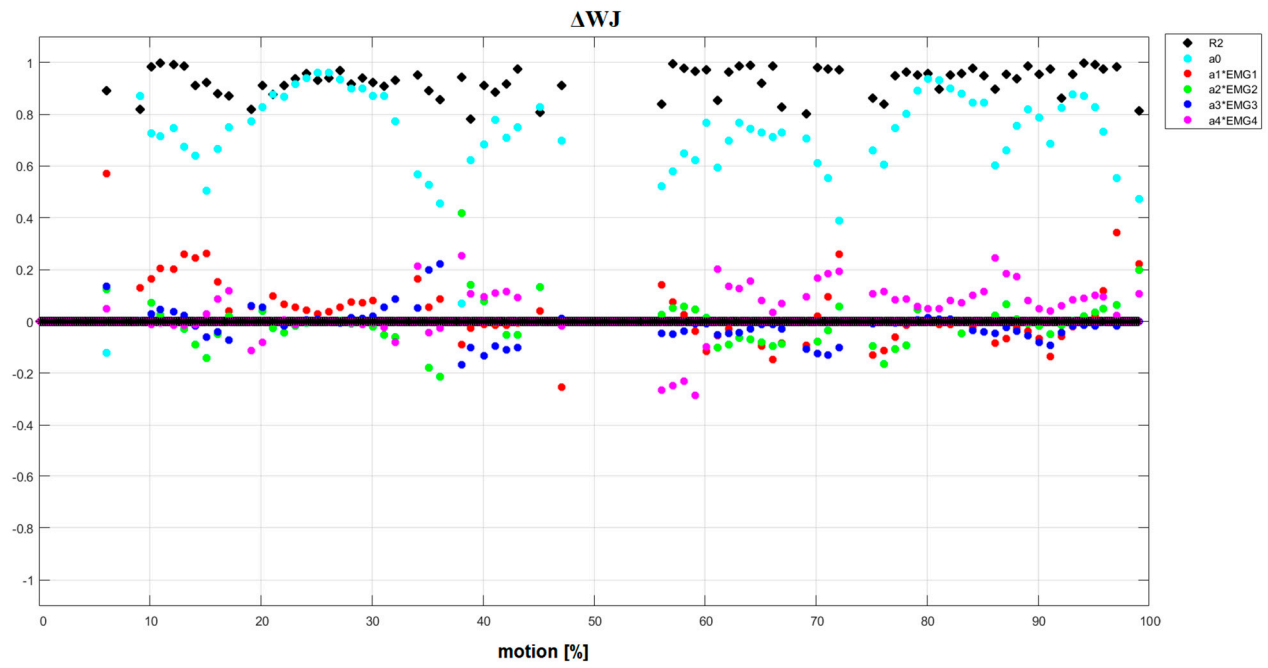


Figure S11. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for reference subject in Motion 1. Natural conditions. ΔW .

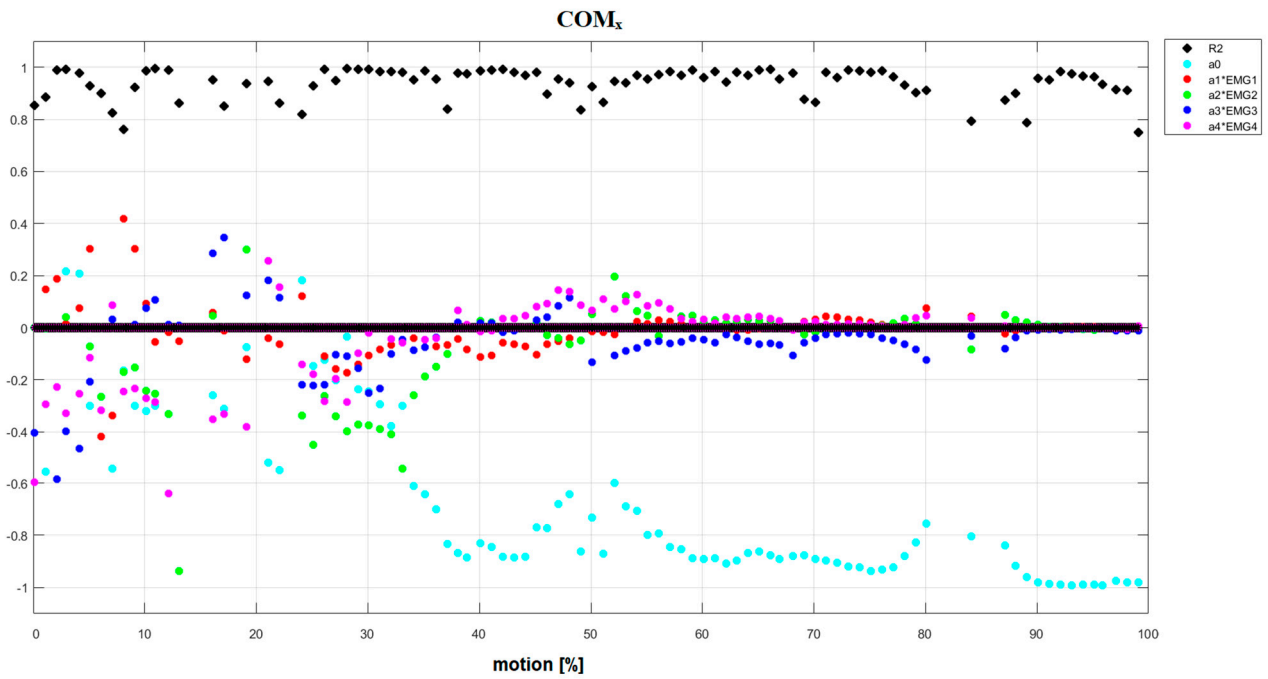


Figure S12. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for reference subject in Motion 1. Passive manipulator conditions. COM_x .

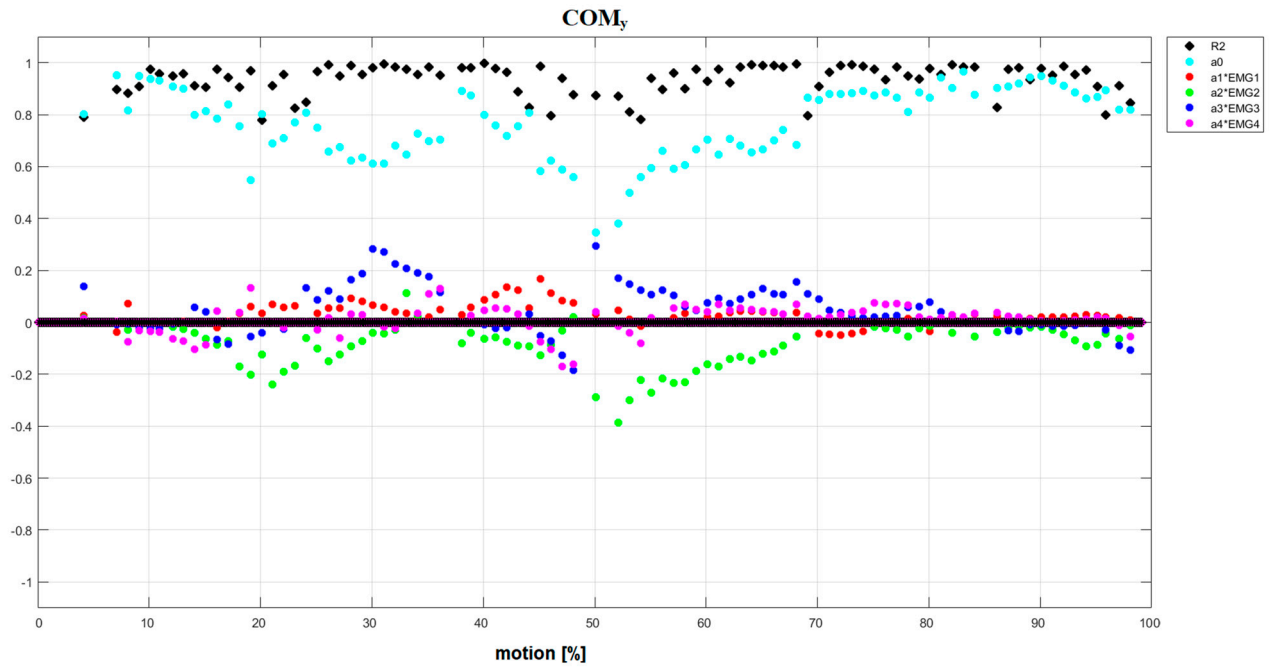


Figure S13. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for reference subject in Motion 1. Passive manipulator conditions. COM_y .

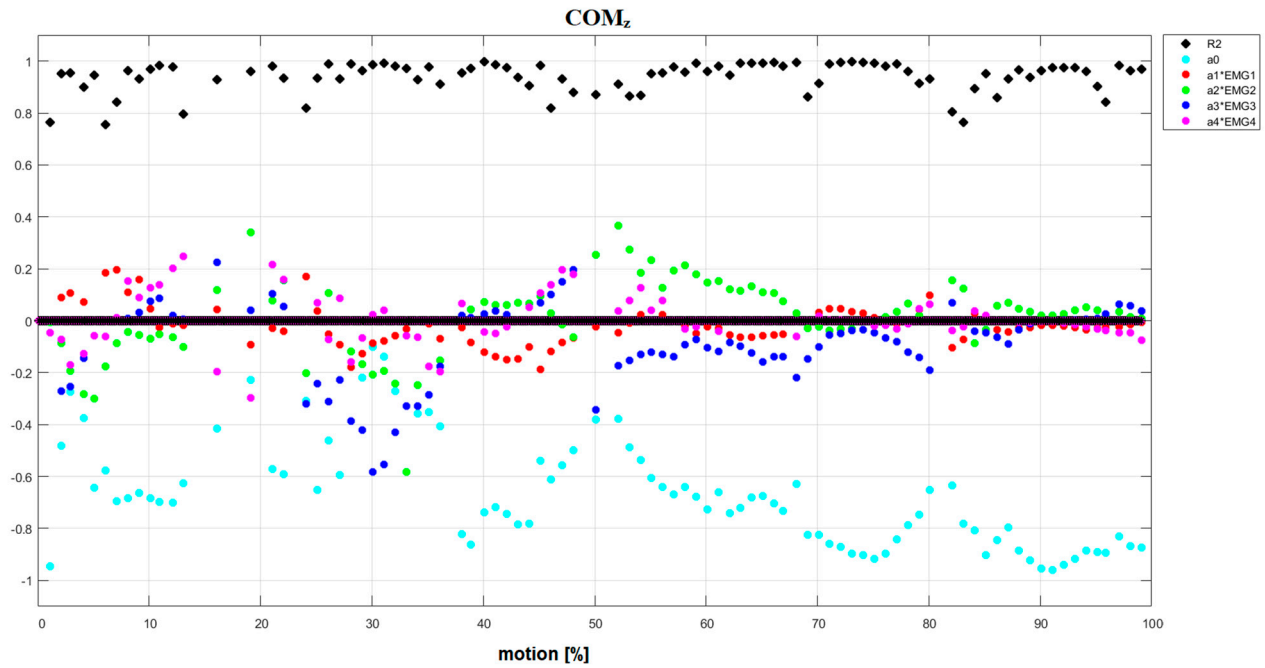


Figure S14. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for reference subject in Motion 1. Passive manipulator conditions. COM_z .

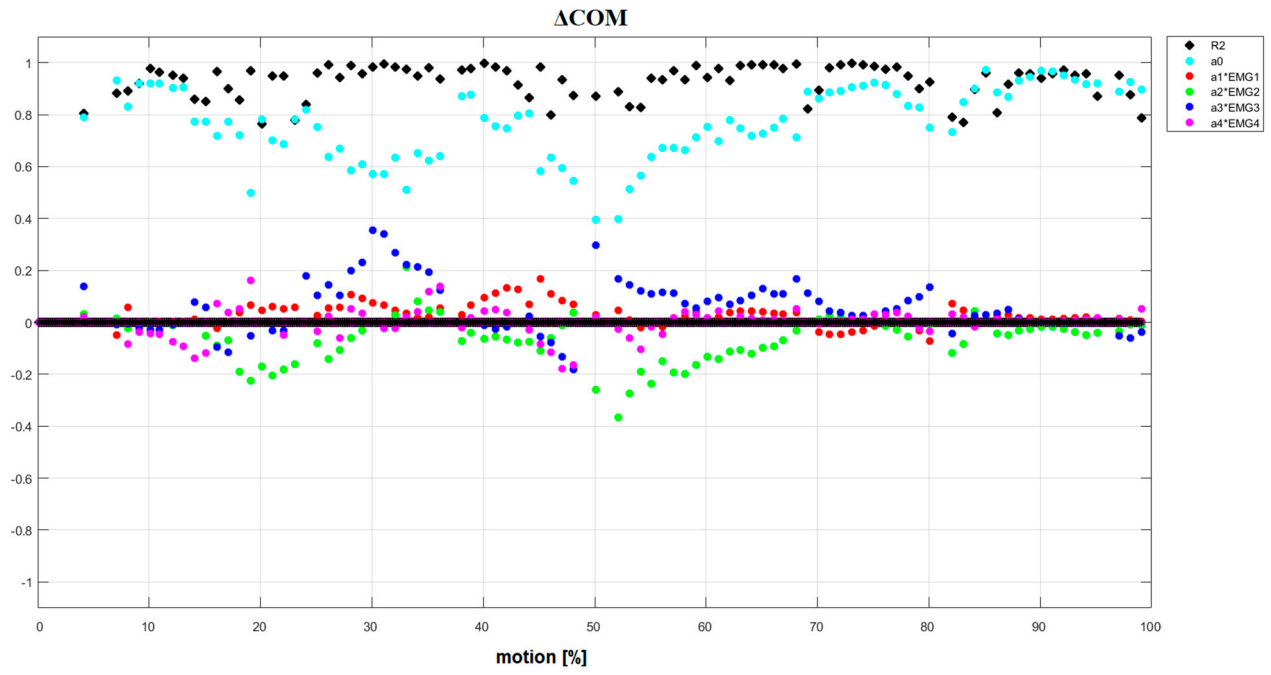


Figure S15. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for reference subject in Motion 1. Passive manipulator conditions. ΔCOM .

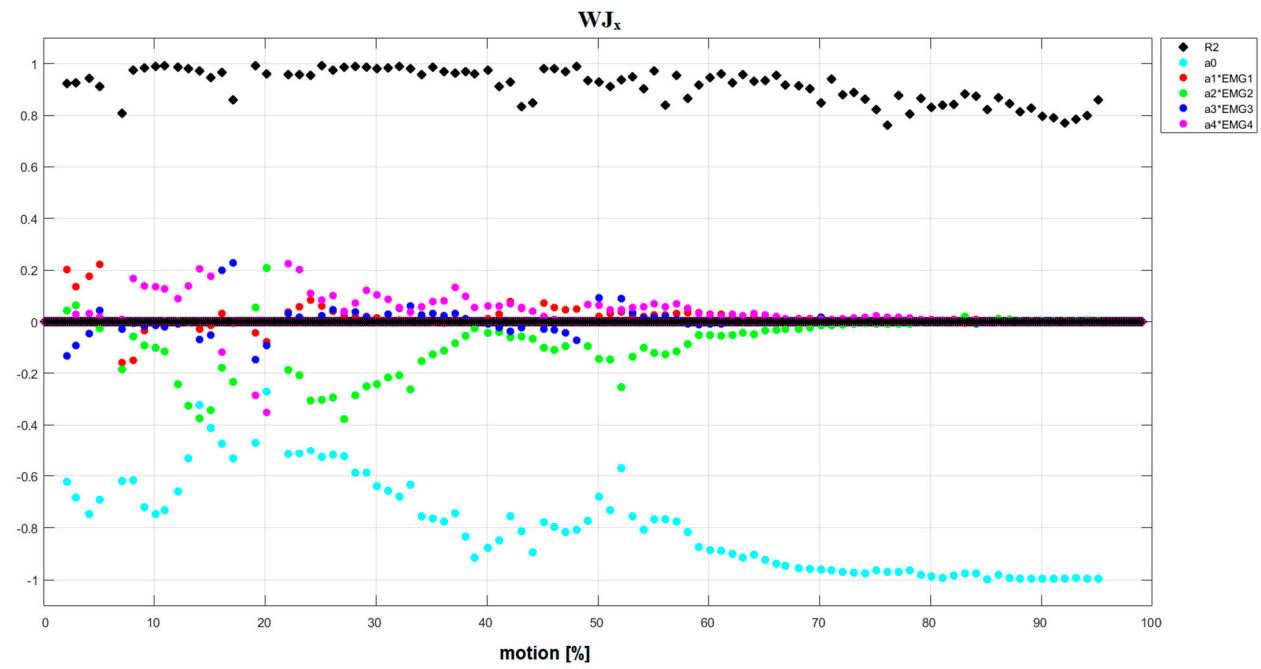


Figure S16. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for reference subject in Motion 1. Passive manipulator conditions. WJ_x .

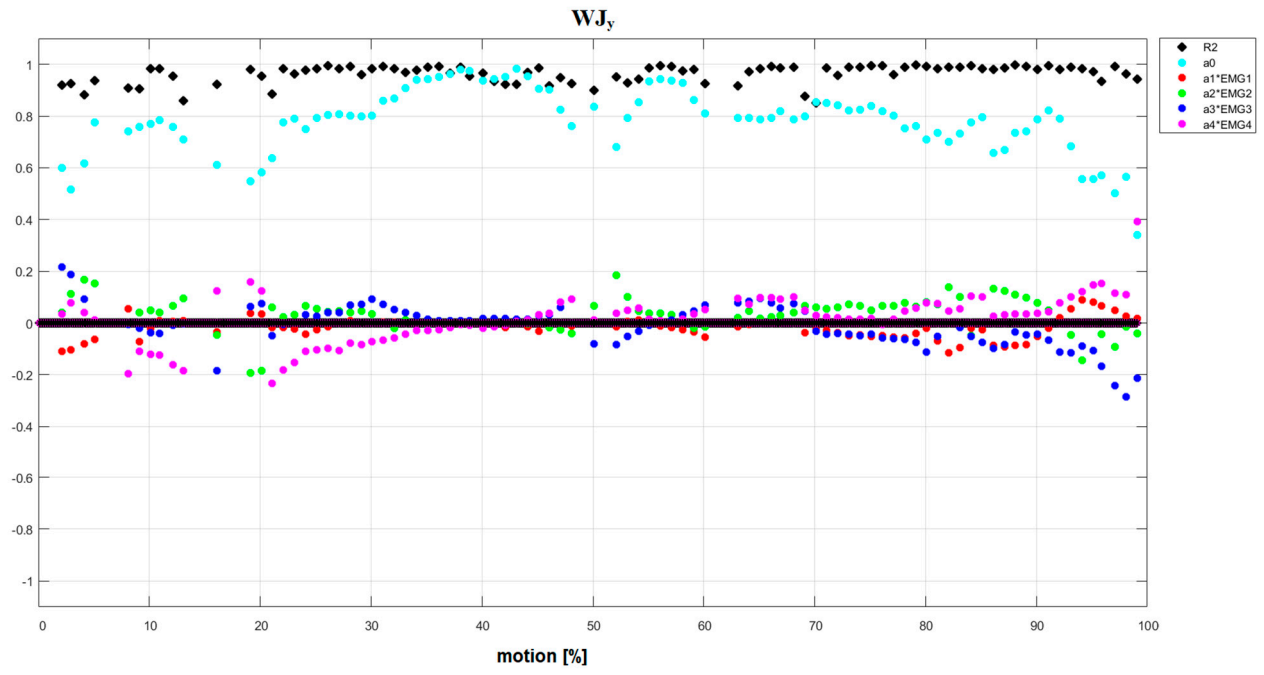


Figure S17. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for reference subject in Motion 1. Passive manipulator conditions. WJ_y .

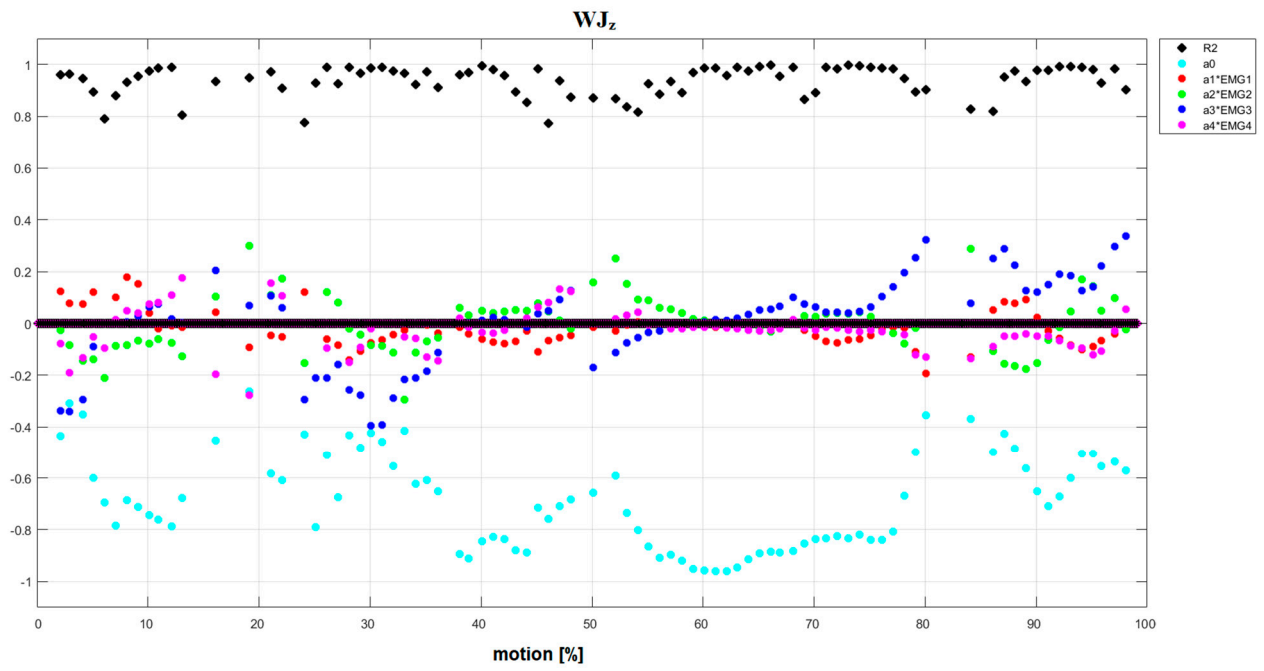


Figure S18. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for reference subject in Motion 1. Passive manipulator conditions. WJ_z .

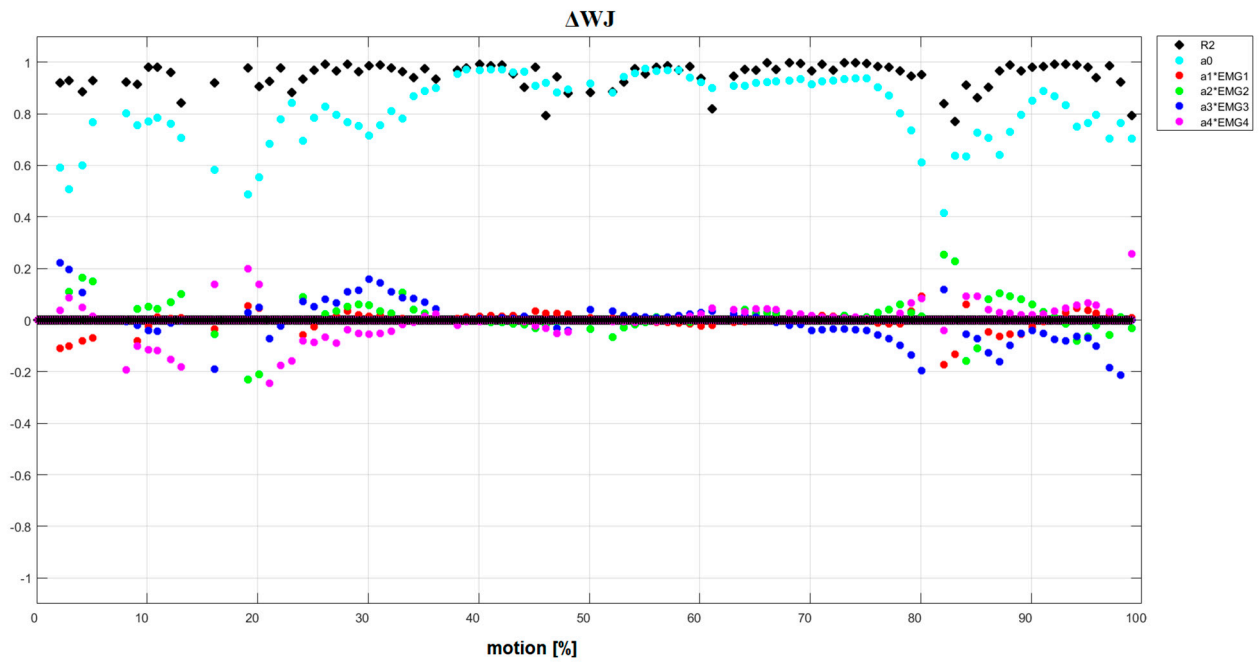


Figure S19. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for reference subject in Motion 1. Passive manipulator conditions. ΔW .

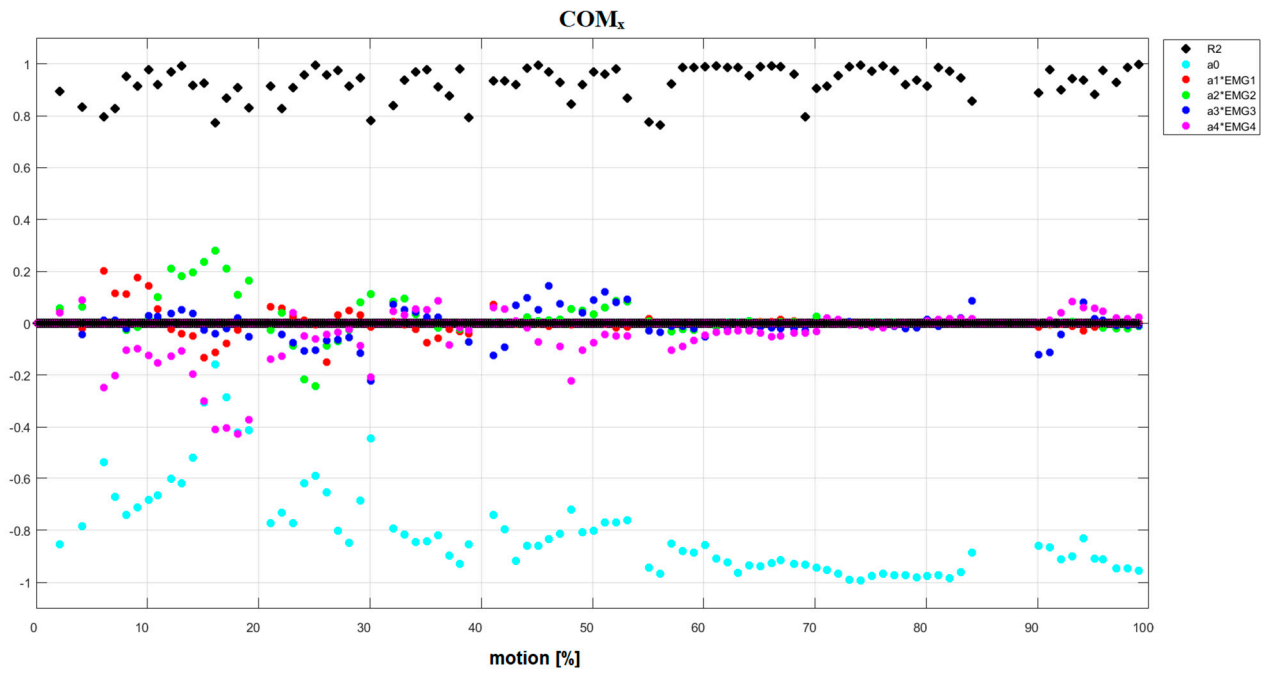


Figure S20. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for reference subject in Motion 2. Natural conditions. COM_x .

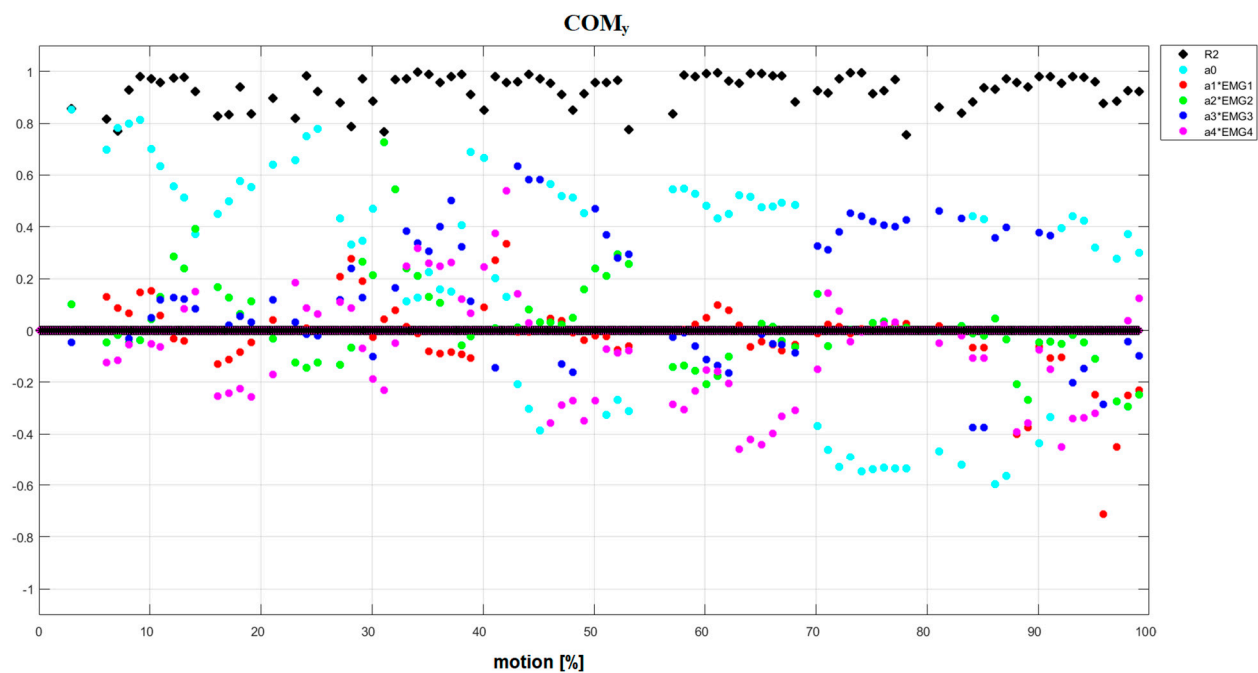


Figure S21. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for reference subject in Motion 2. Natural conditions. COM_y .

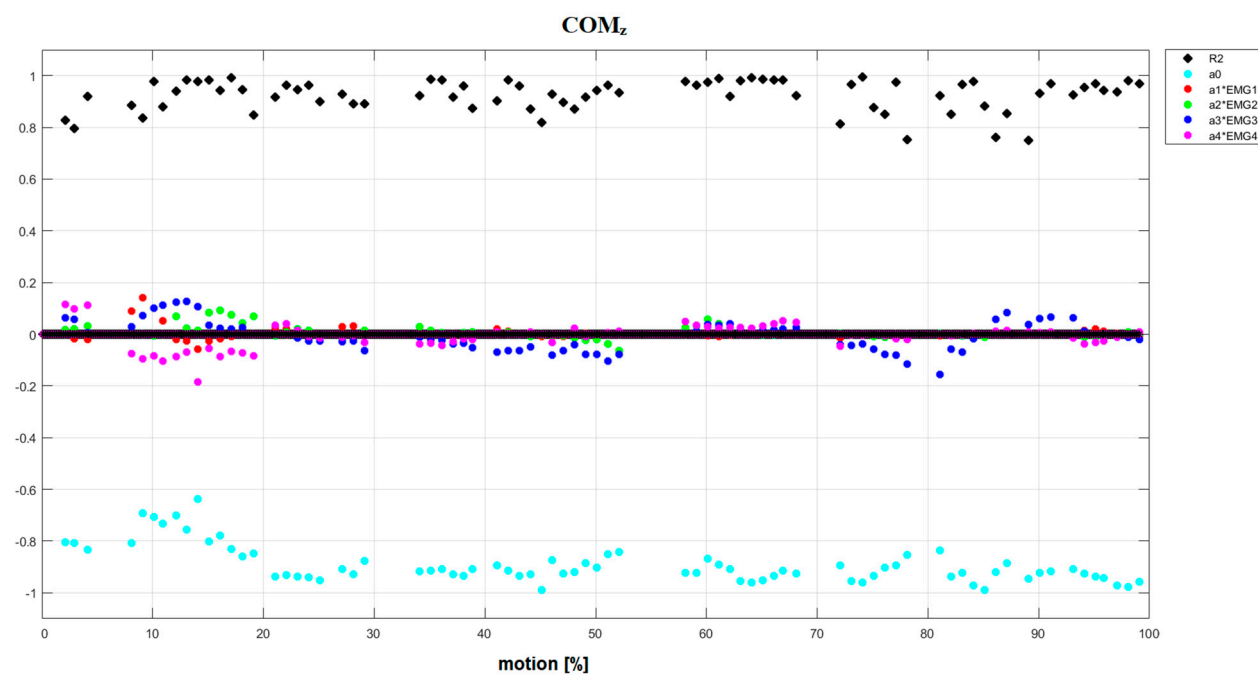


Figure S22. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for reference subject in Motion 2. Natural conditions. COM_z .

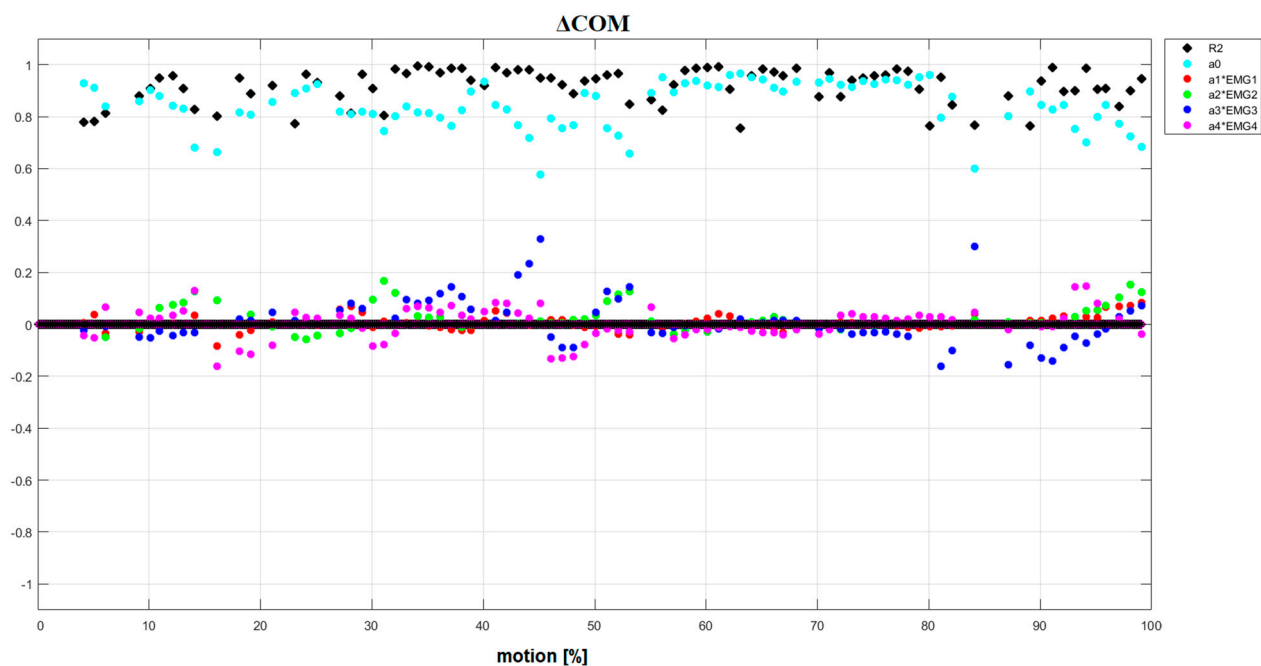


Figure S23. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for reference subject in Motion 2. Natural conditions. ΔCOM .

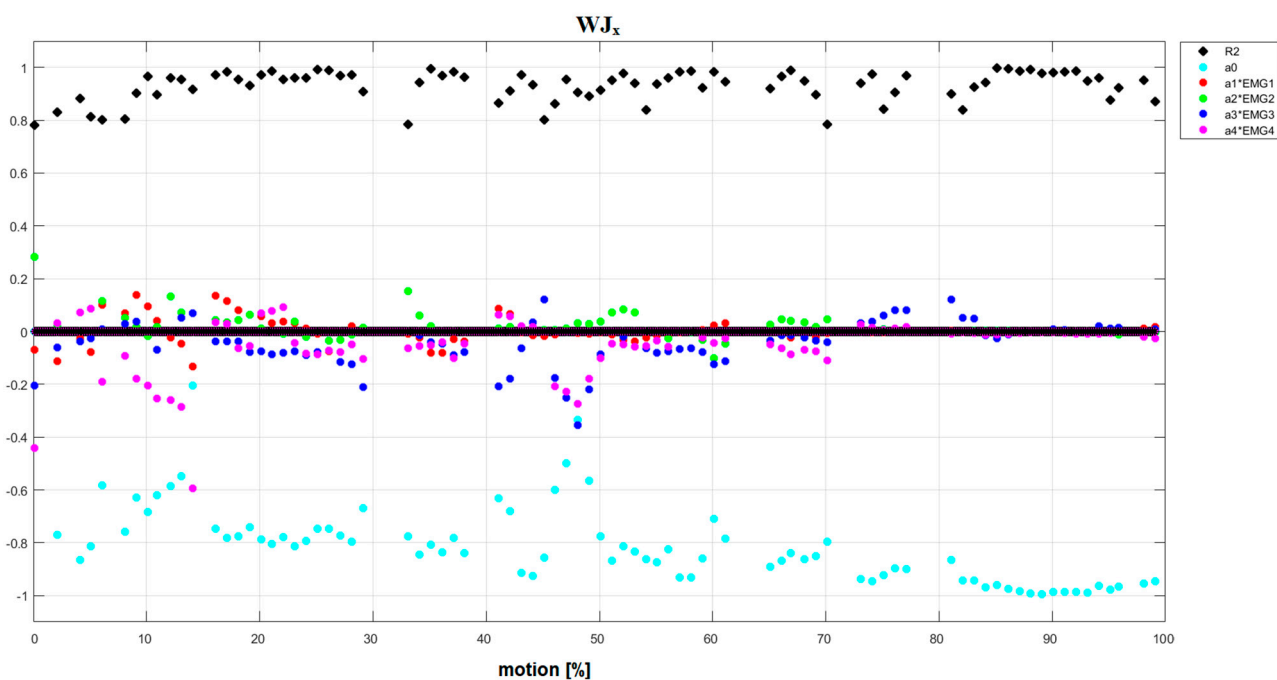


Figure S24. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for reference subject in Motion 2. Natural conditions. WJ_x .

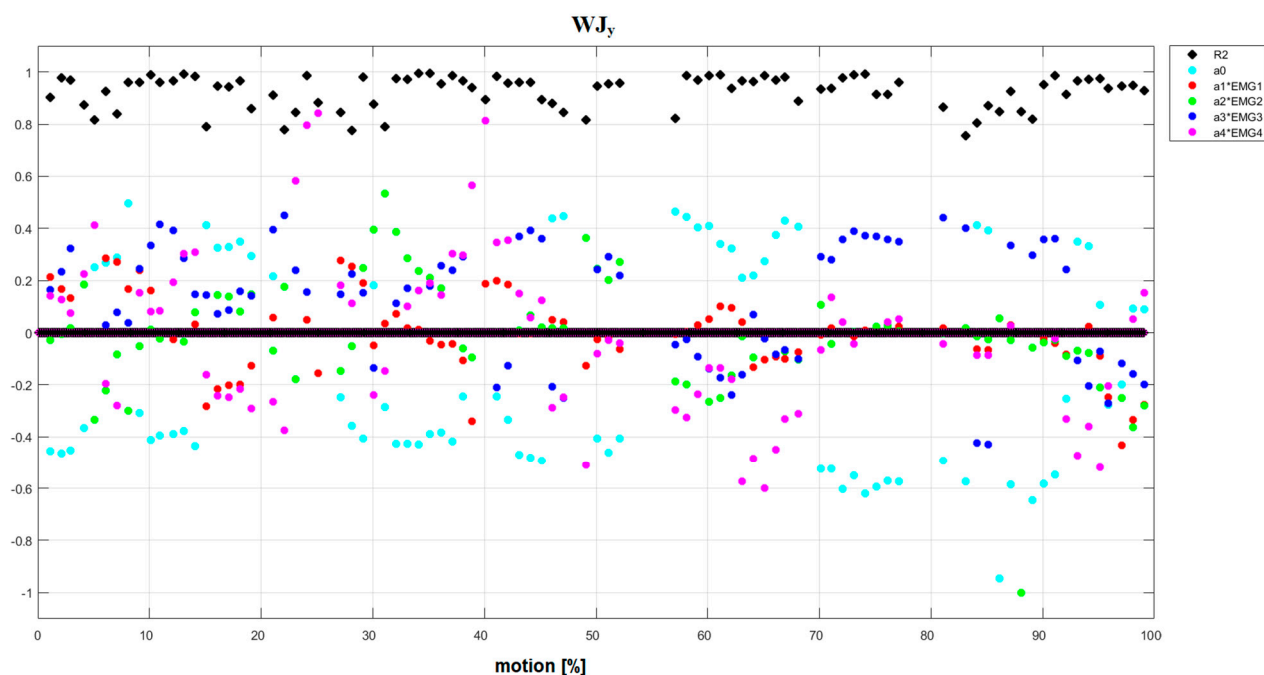


Figure S25. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for reference subject in Motion 2. Natural conditions. WJ_y .

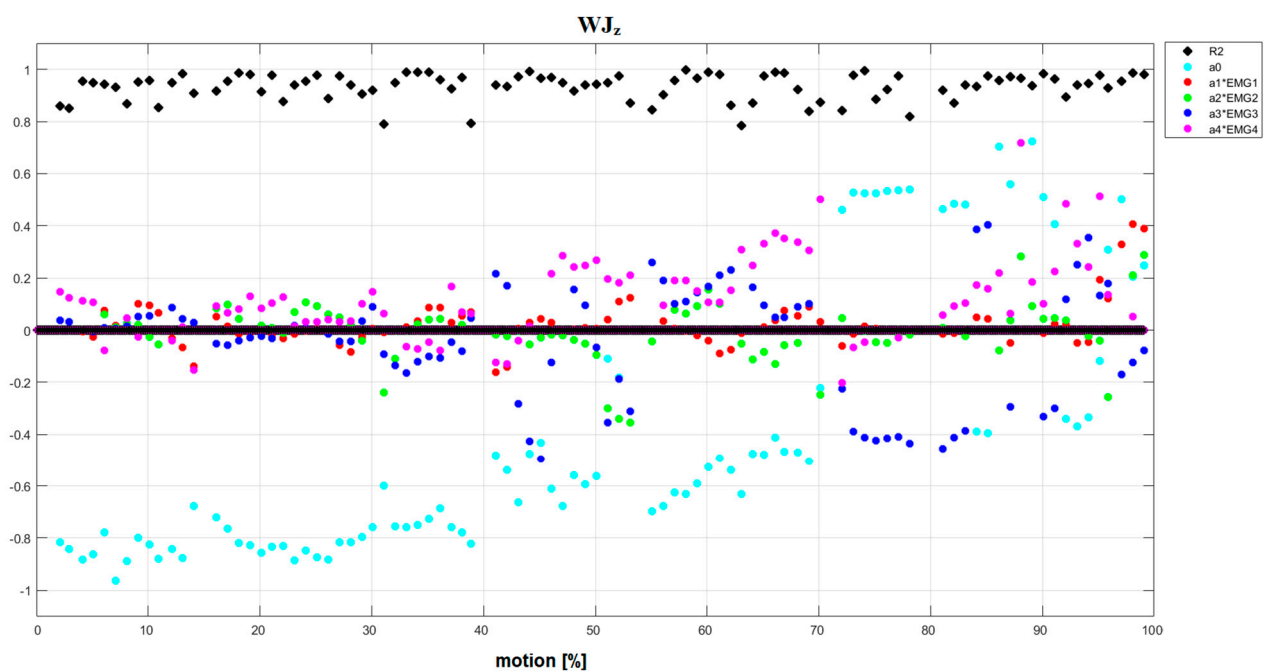


Figure S26. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for reference subject in Motion 2. Natural conditions. WJ_z .

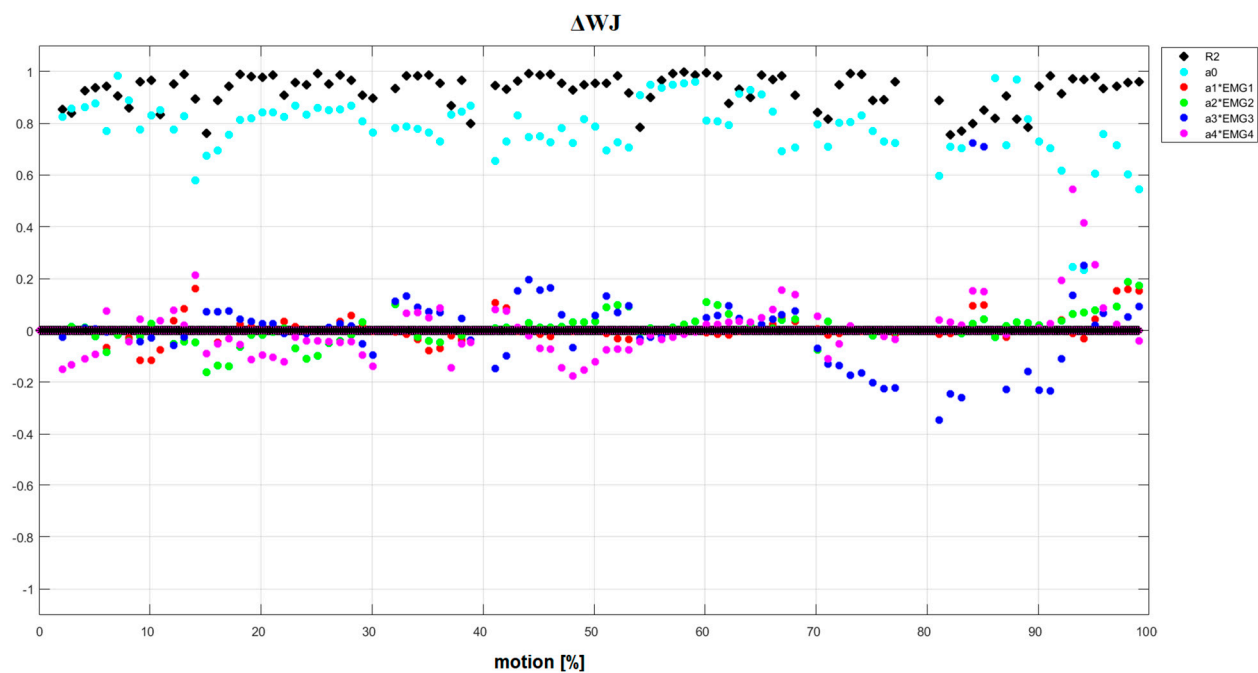


Figure S27. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for reference subject in Motion 2. Natural conditions. ΔW .

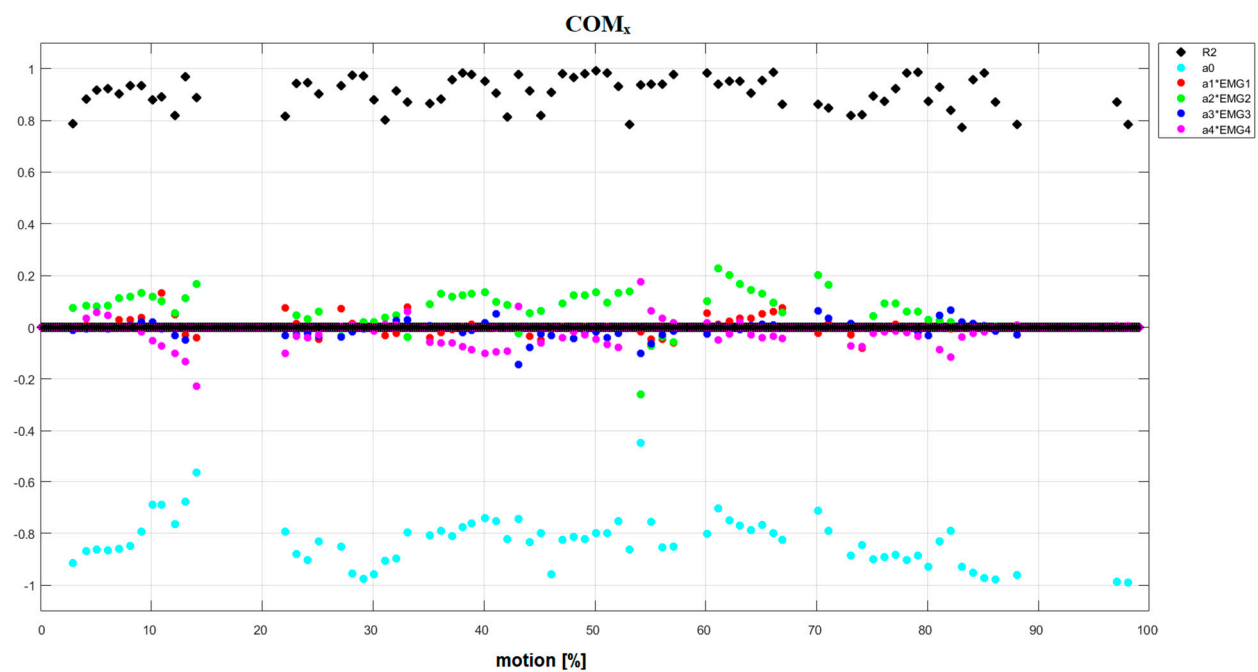


Figure S28. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for reference subject in Motion 2. Passive manipulator conditions. COM_x .

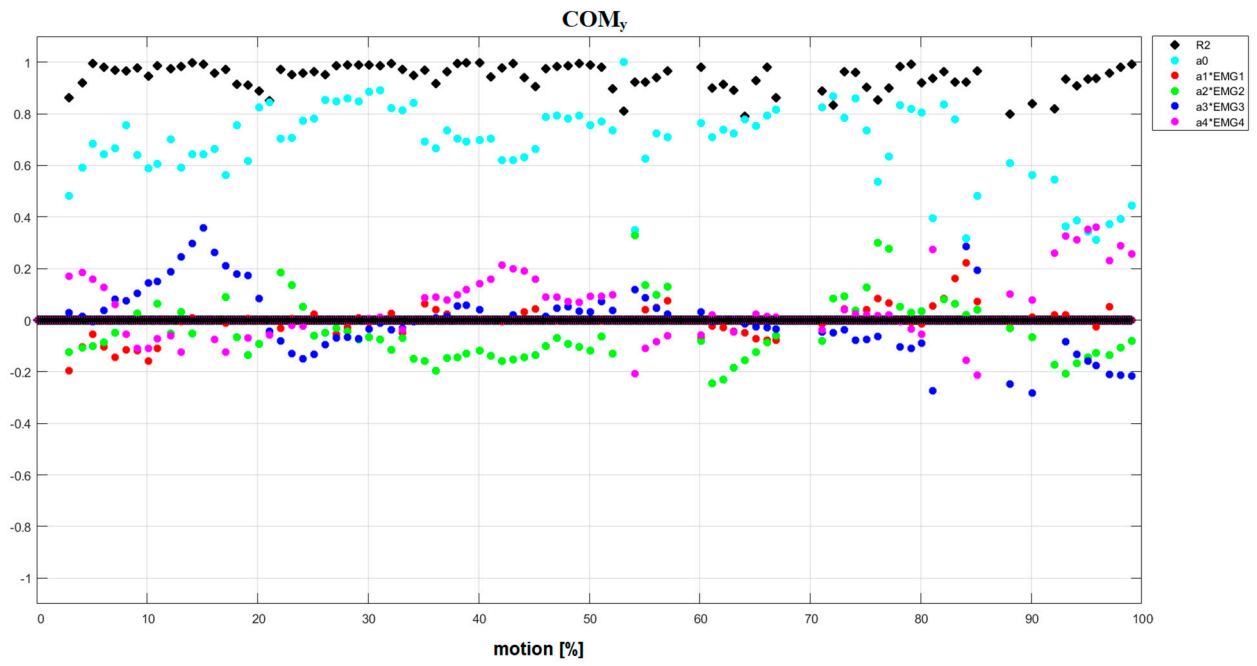


Figure S29. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for reference subject in Motion 2. Passive manipulator conditions. COM_y .

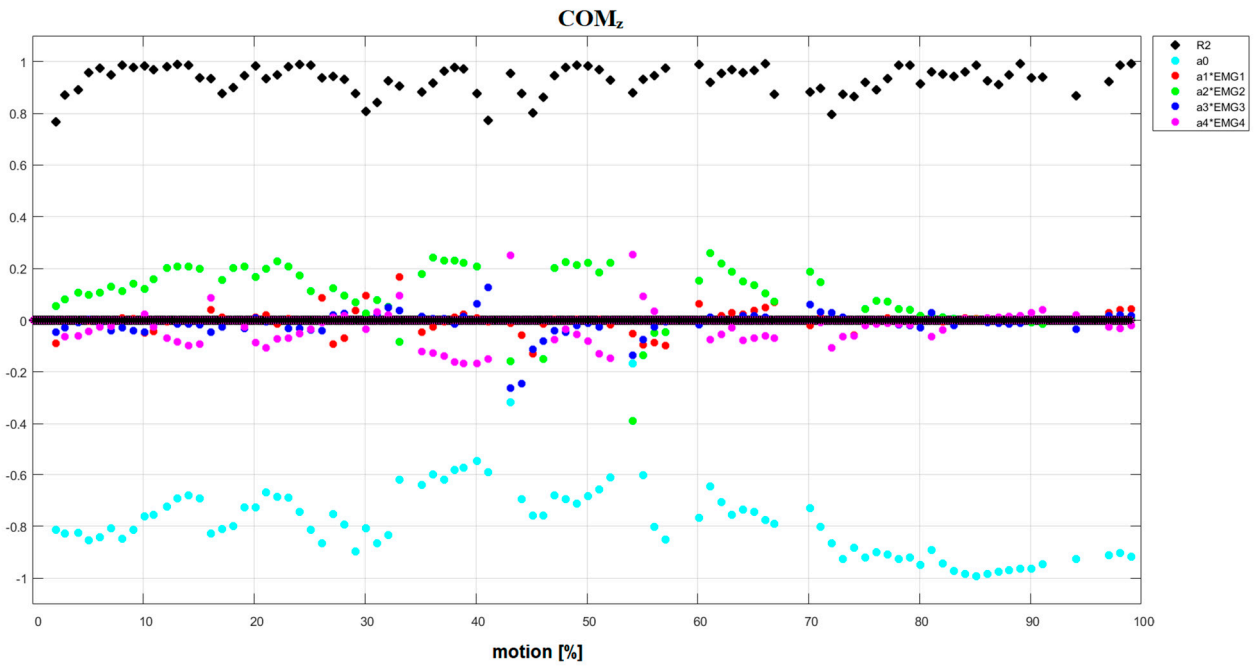


Figure S30. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for reference subject in Motion 2. Passive manipulator conditions. COM_z .

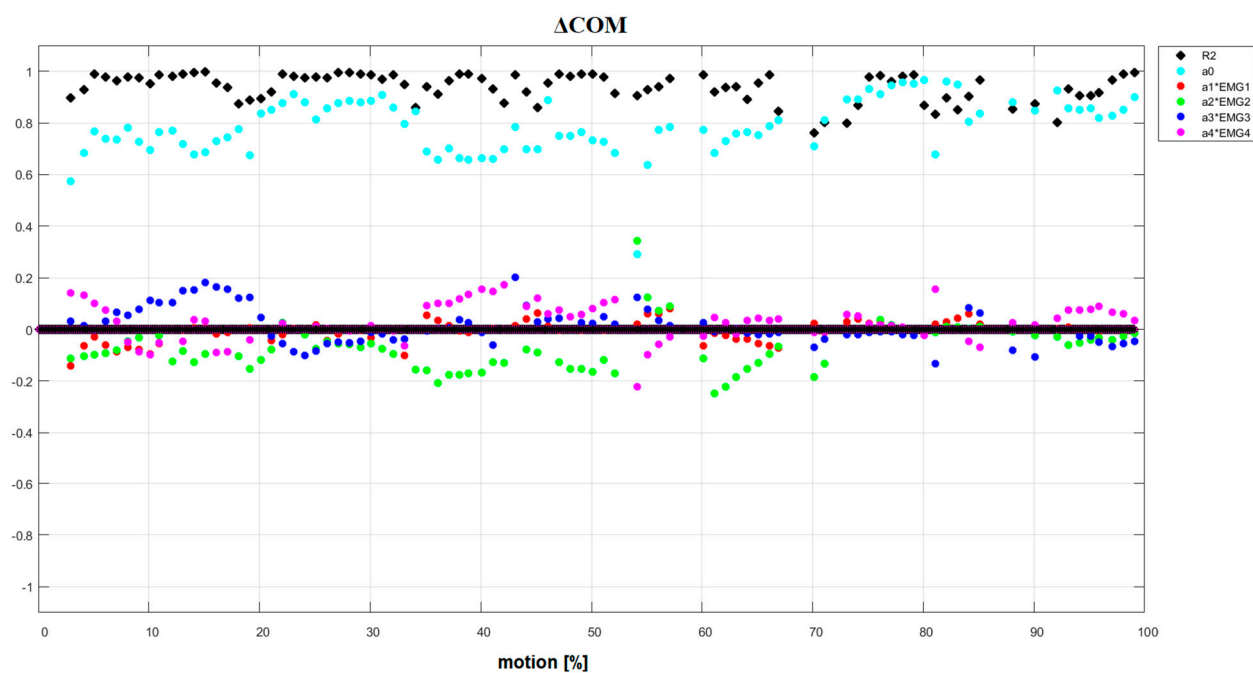


Figure S31. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for reference subject in Motion 2. Passive manipulator conditions. ΔCOM .

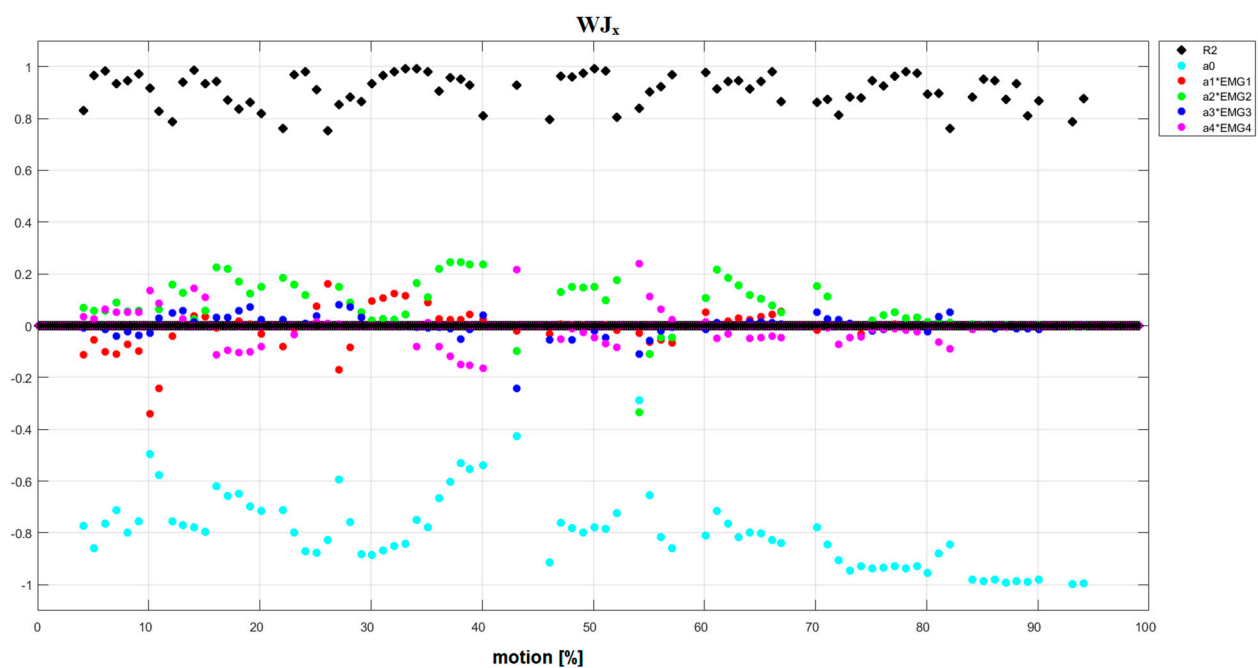


Figure S32. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for reference subject in Motion 2. Passive manipulator conditions. WJ_x .

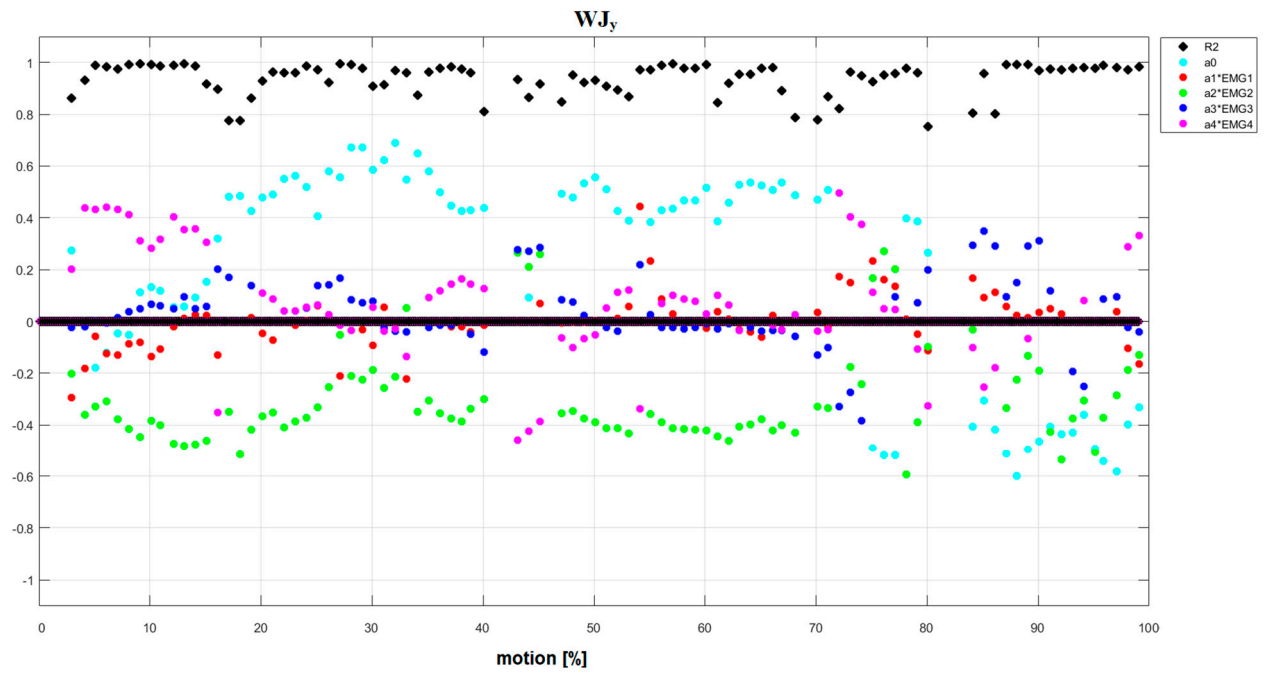


Figure S33. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for reference subject in Motion 2. Passive manipulator conditions. WJ_y .

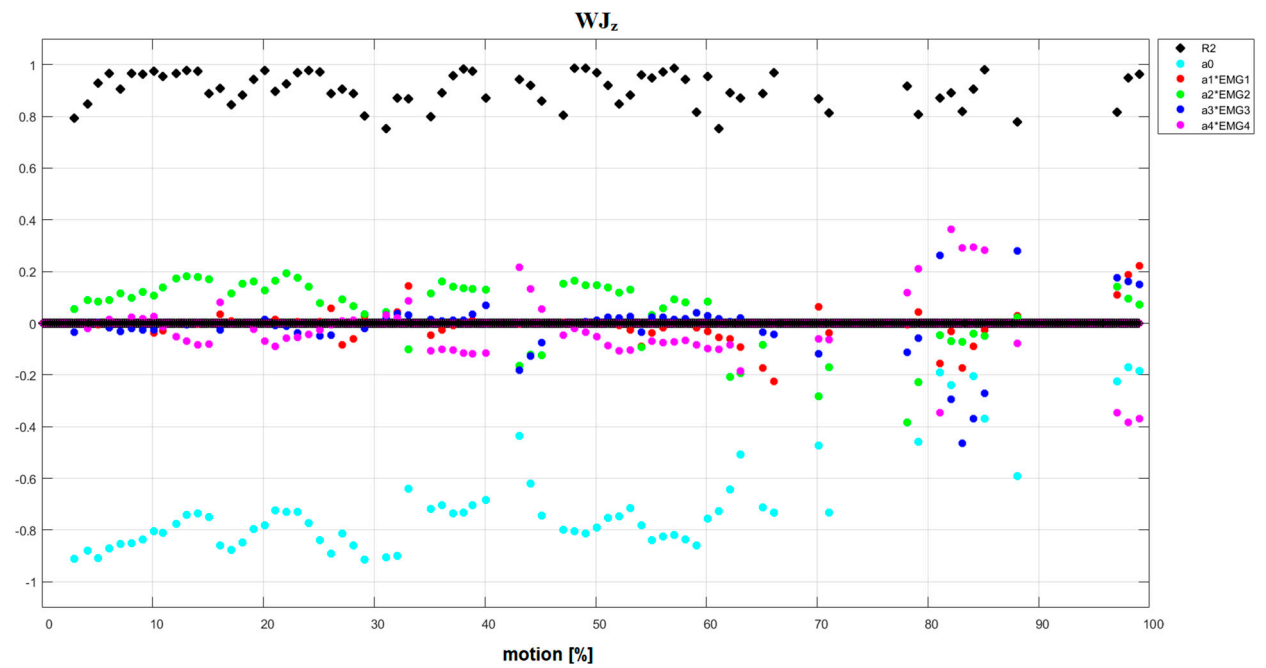


Figure S34. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for reference subject in Motion 2. Passive manipulator conditions. WJ_z .

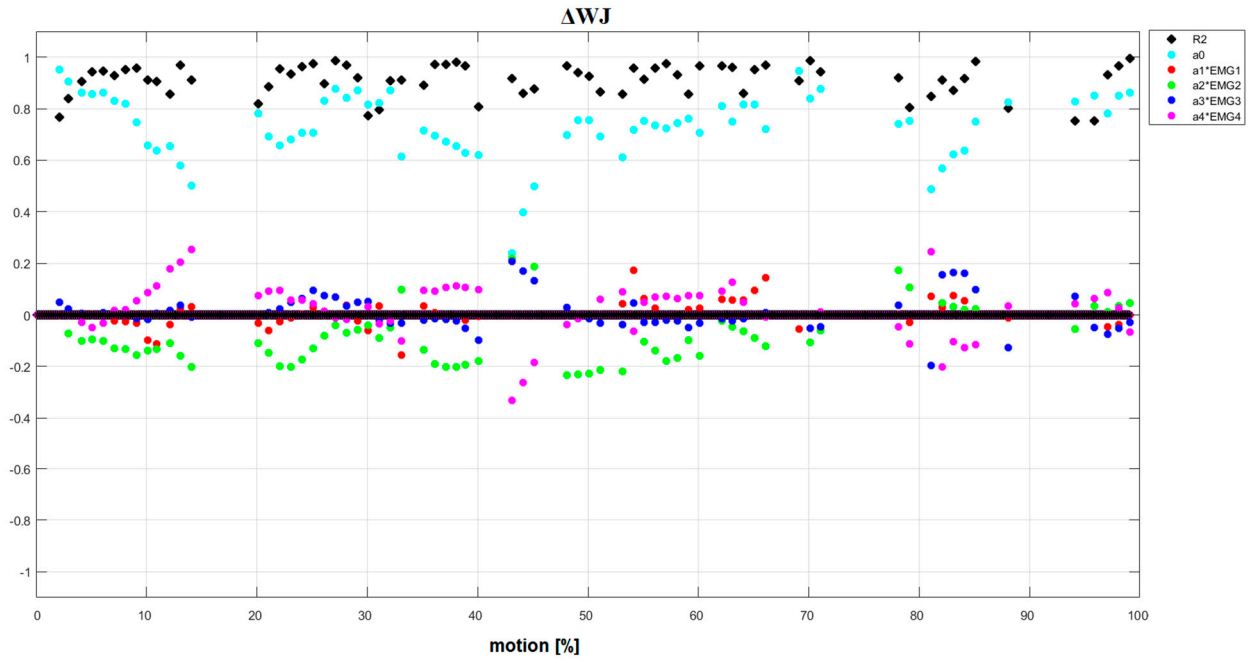


Figure S35. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for reference subject in Motion 2. Passive manipulator conditions. ΔW .

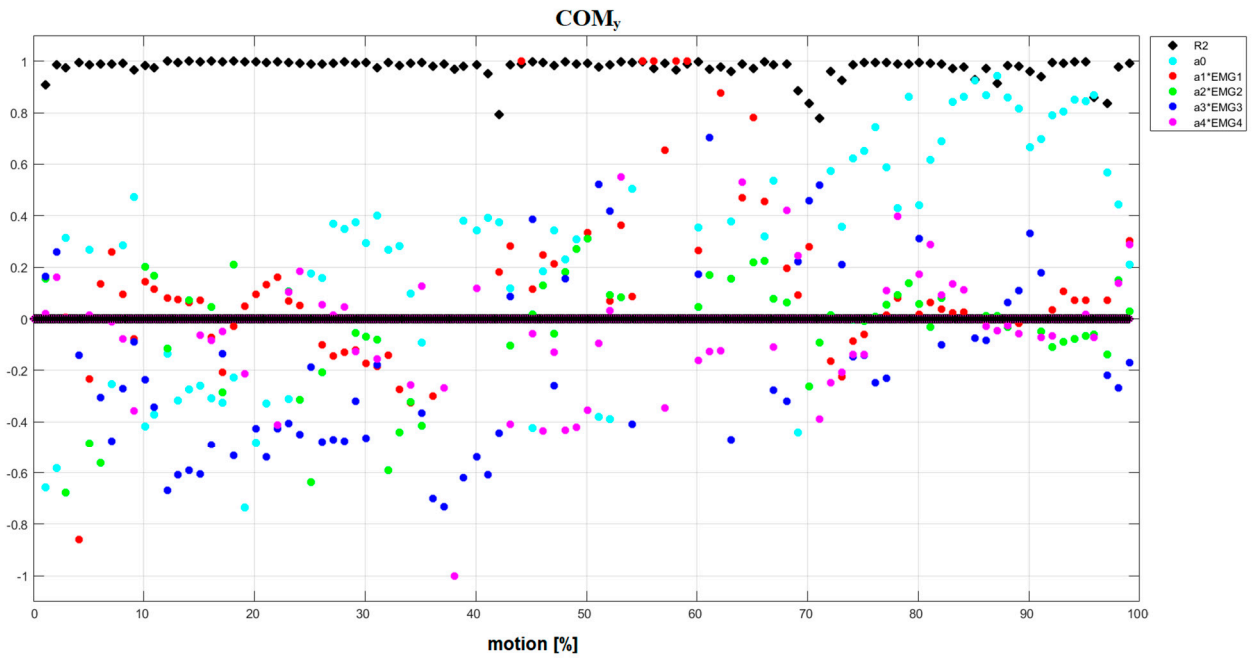


Figure S36. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for DMD patient in Motion 1. Natural conditions. COM_y .

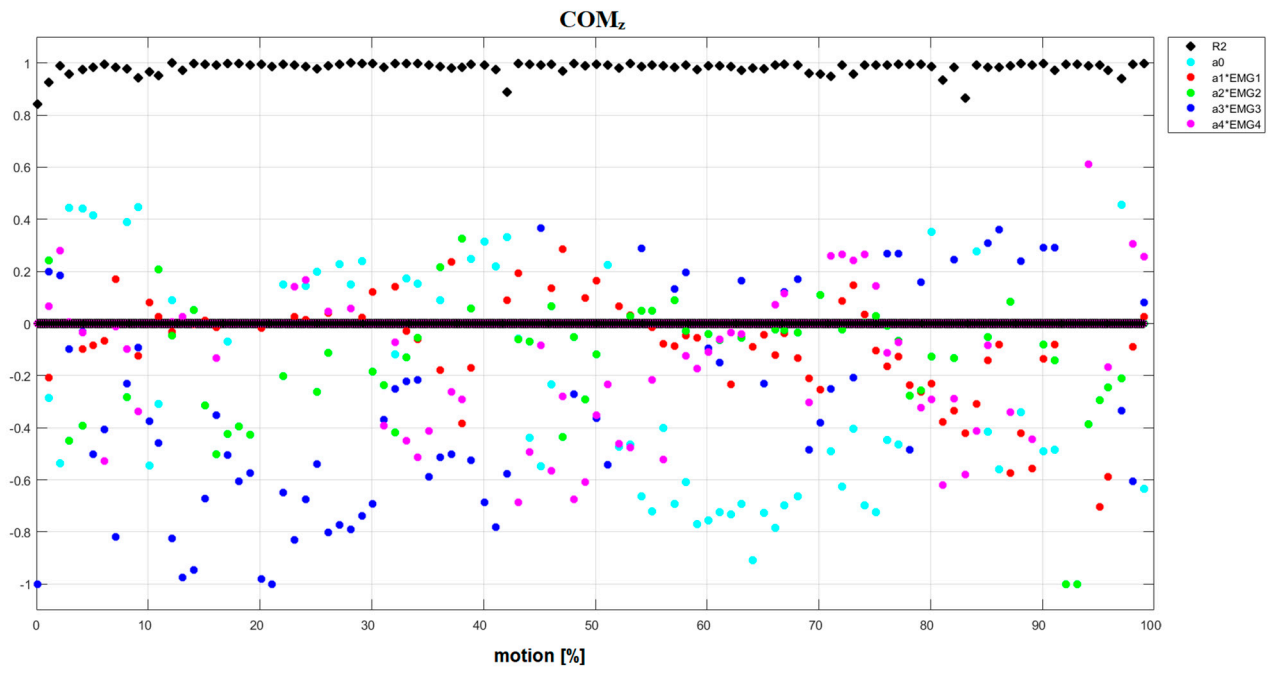


Figure S37. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for DMD patient in Motion 1. Natural conditions. COM_z.

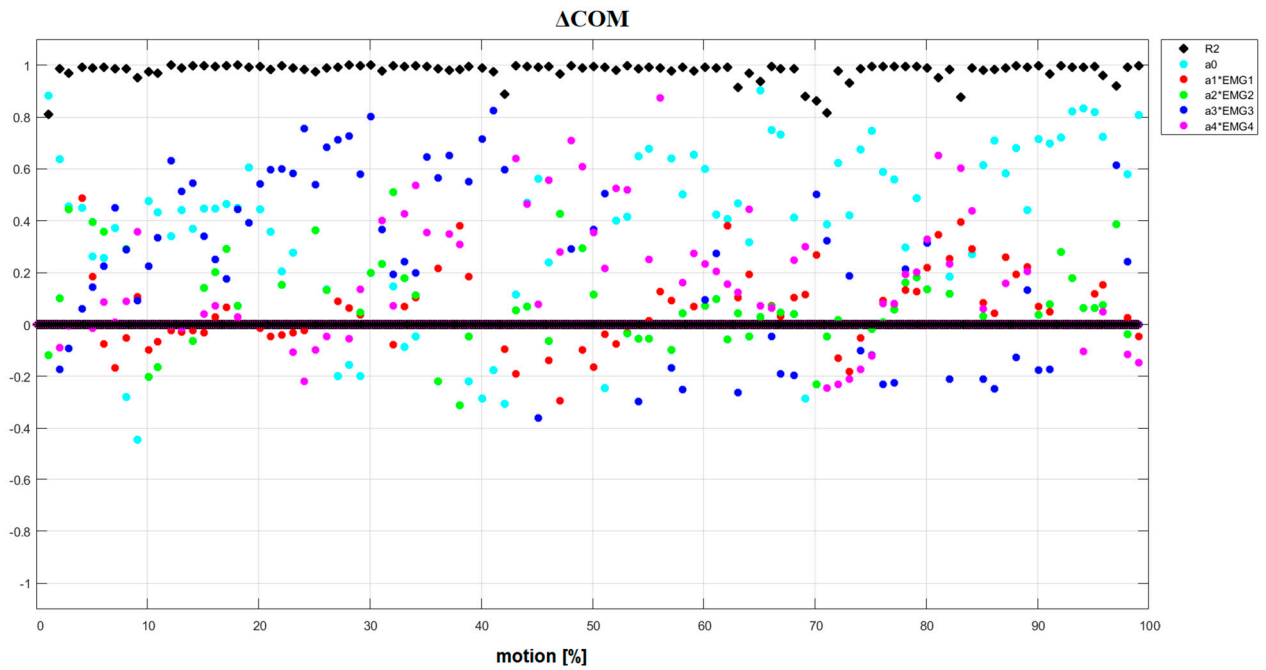


Figure S38. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for DMD patient in Motion 1. Natural conditions. ΔCOM.

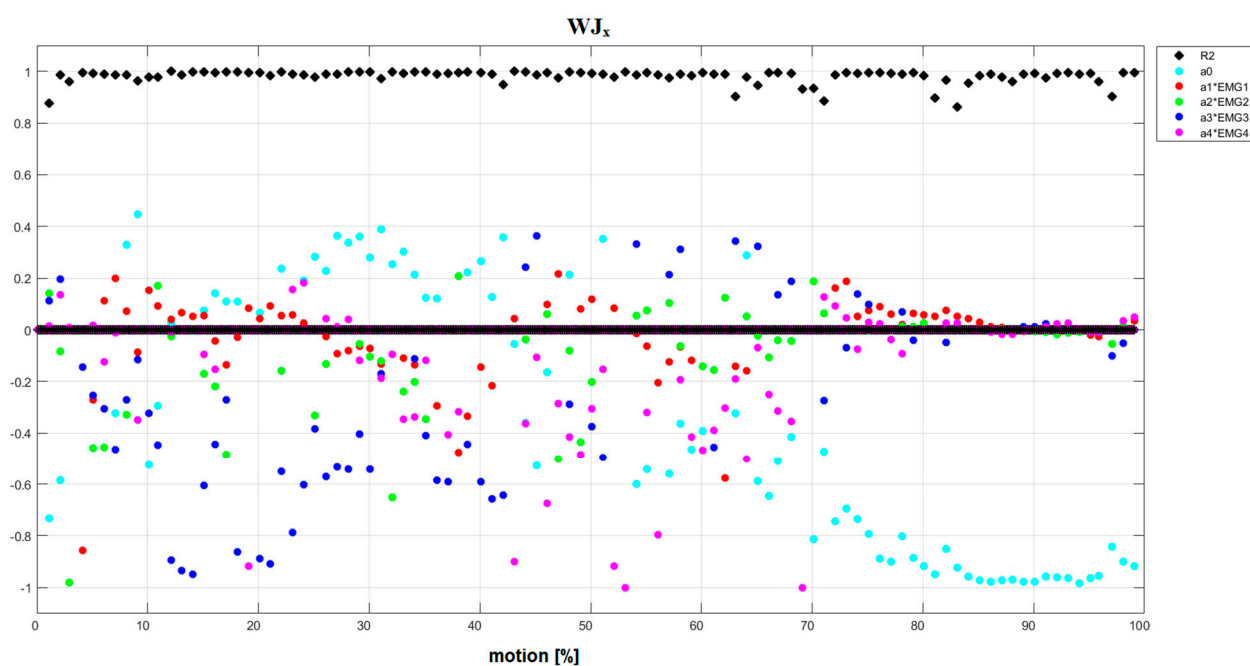


Figure S39. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for DMD patient in Motion 1. Natural conditions. WJ_x .

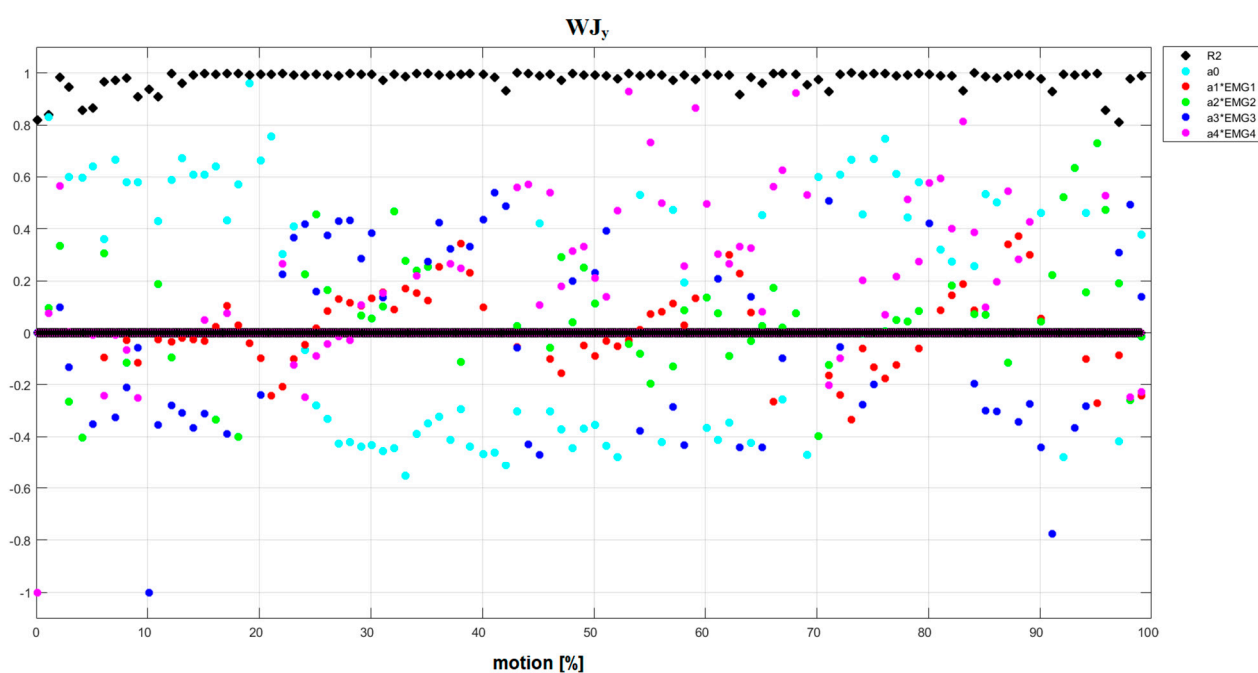


Figure S40. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for DMD patient in Motion 1. Natural conditions. WJ_y .

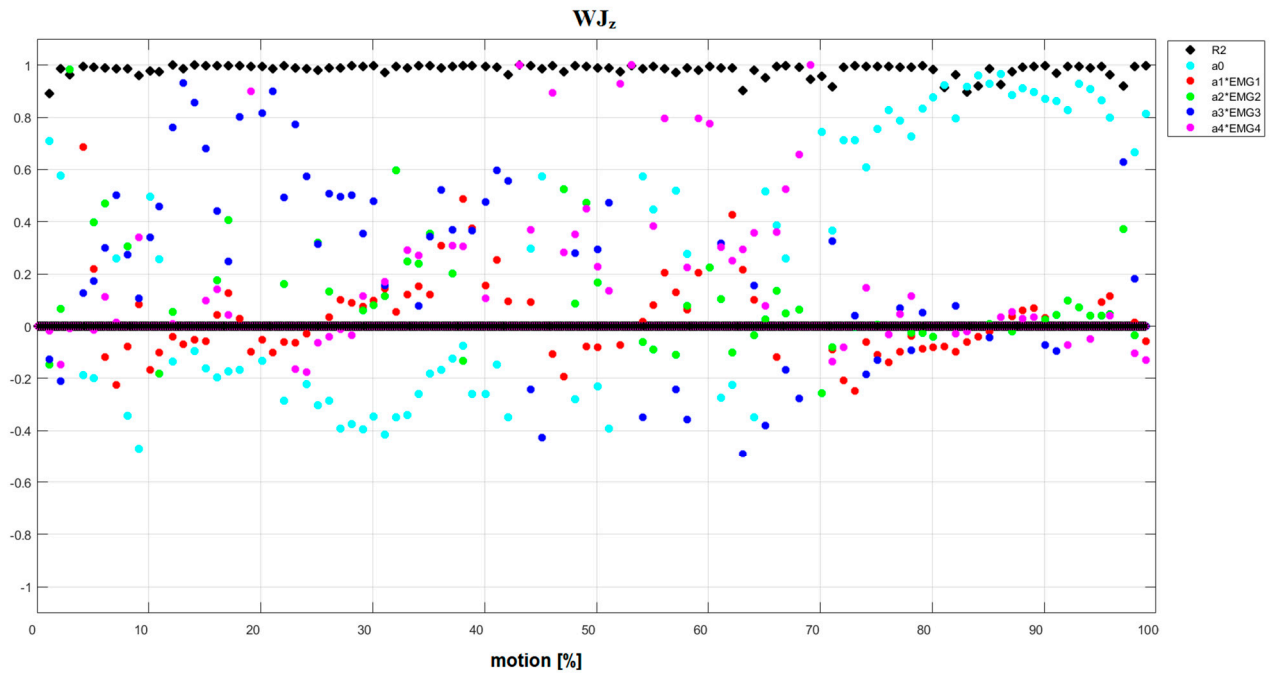


Figure S41. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for DMD patient in Motion 1. Natural conditions. WJ_z .

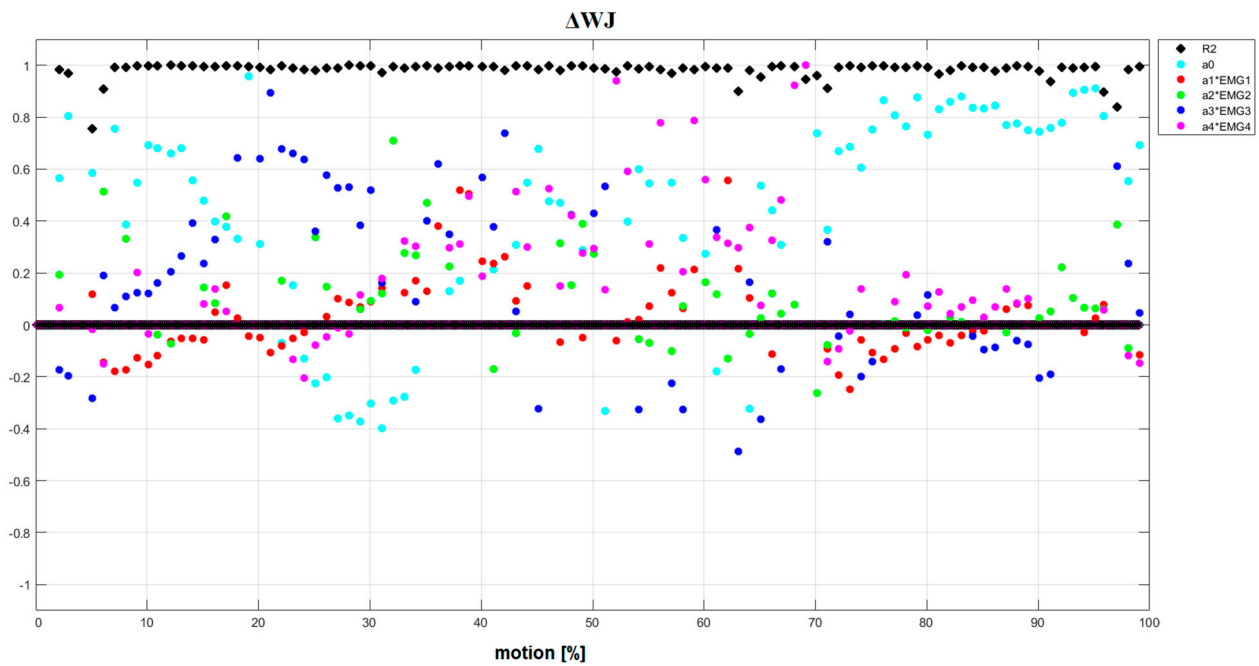


Figure S42. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for DMD patient in Motion 1. Natural conditions. ΔWJ .

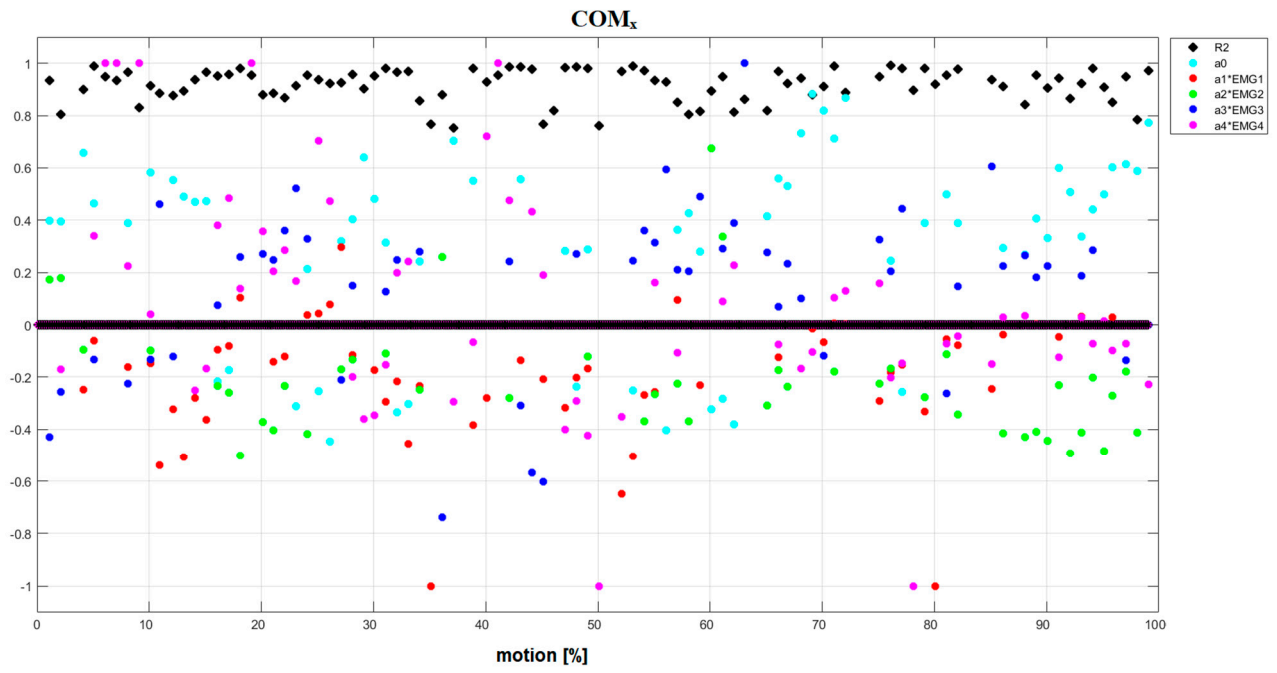


Figure S43. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for DMD patient in Motion 1. Passive manipulator conditions. COM_x .

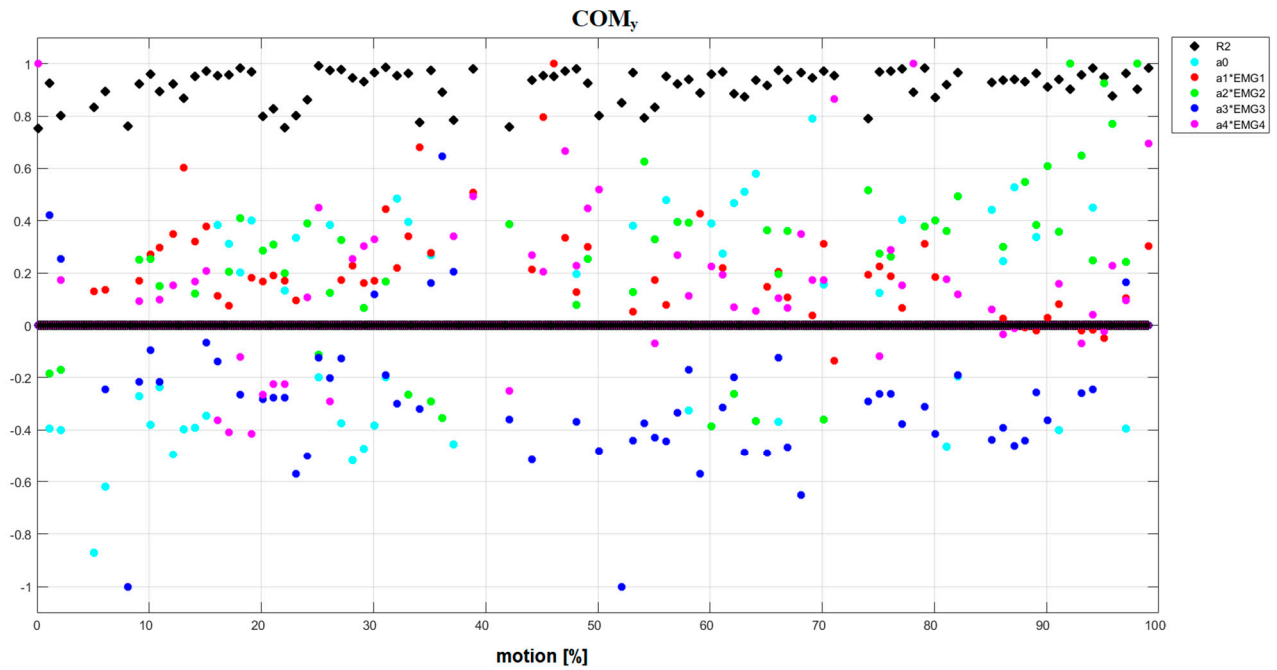


Figure S44. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for DMD patient in Motion 1. Passive manipulator conditions. COM_y .

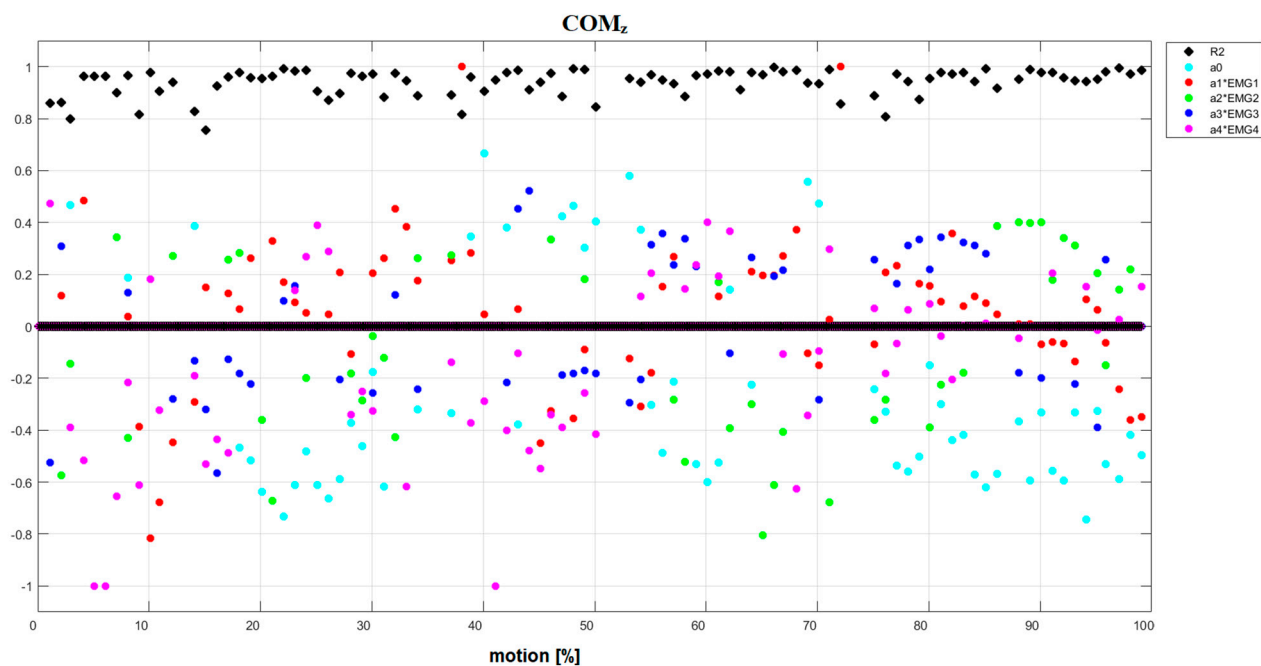


Figure S45. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for DMD patient in Motion 1. Passive manipulator conditions. COM_z .

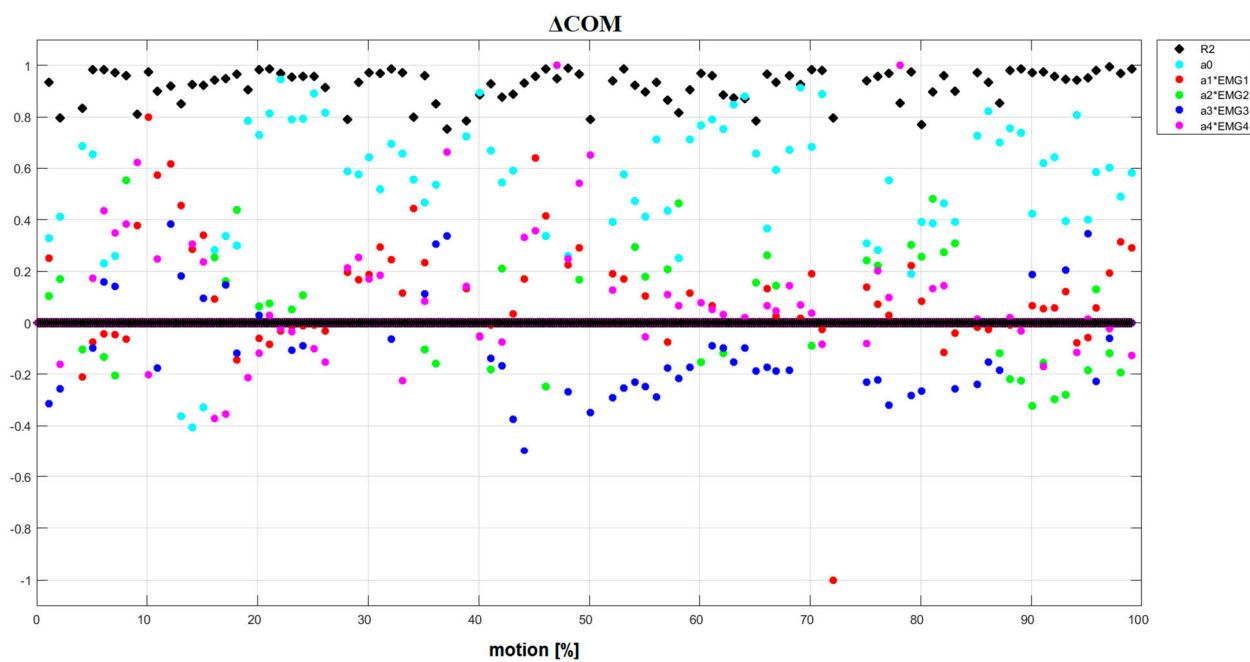


Figure S46. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for DMD patient in Motion 1. Passive manipulator conditions. ΔCOM .

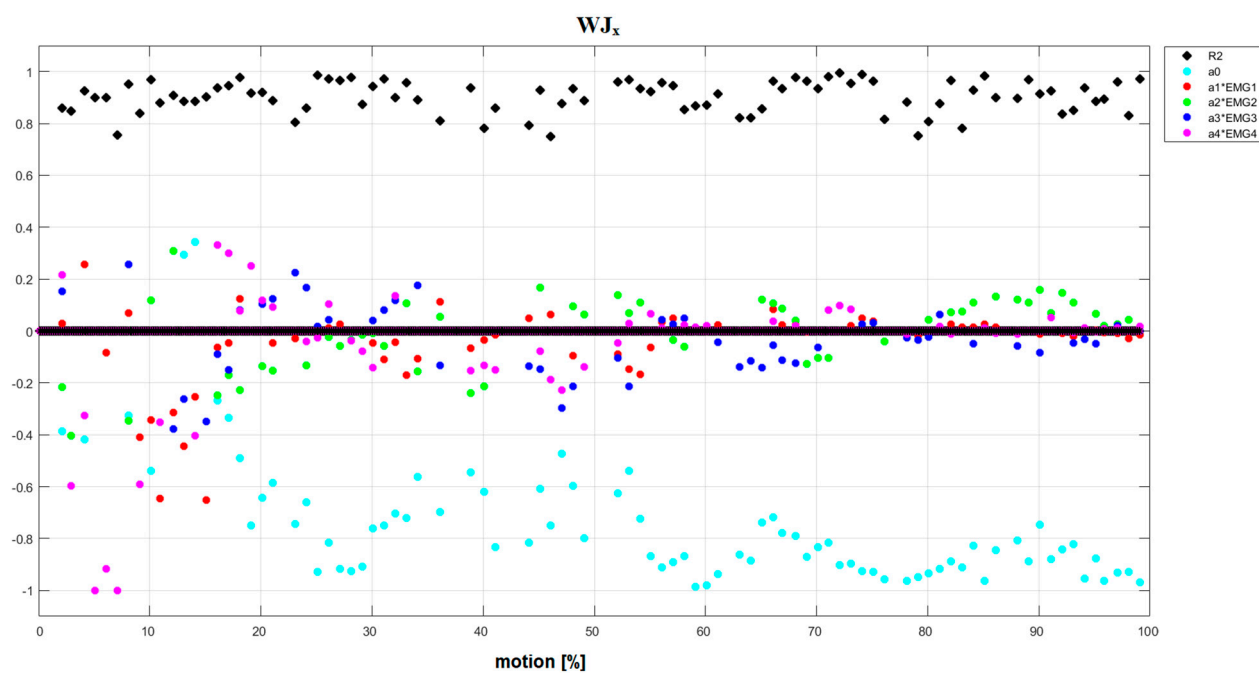


Figure S47. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for DMD patient in Motion 1. Passive manipulator conditions. WJ_x .

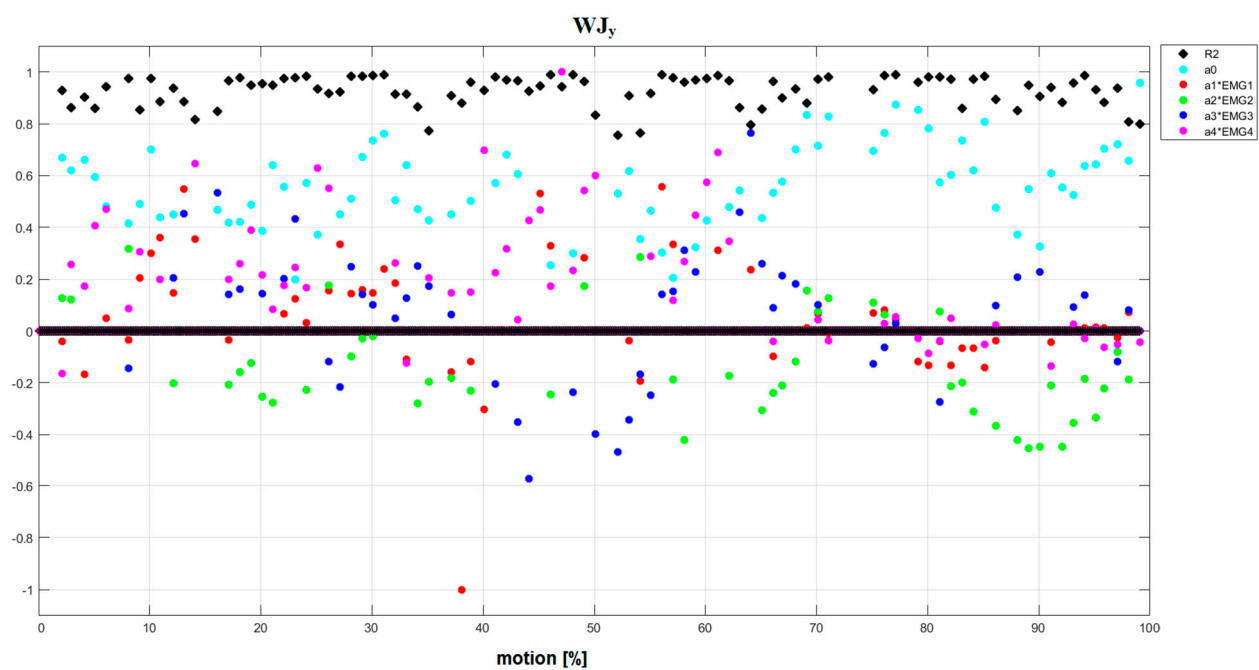


Figure S48. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for DMD patient in Motion 1. Passive manipulator conditions. WJ_y .

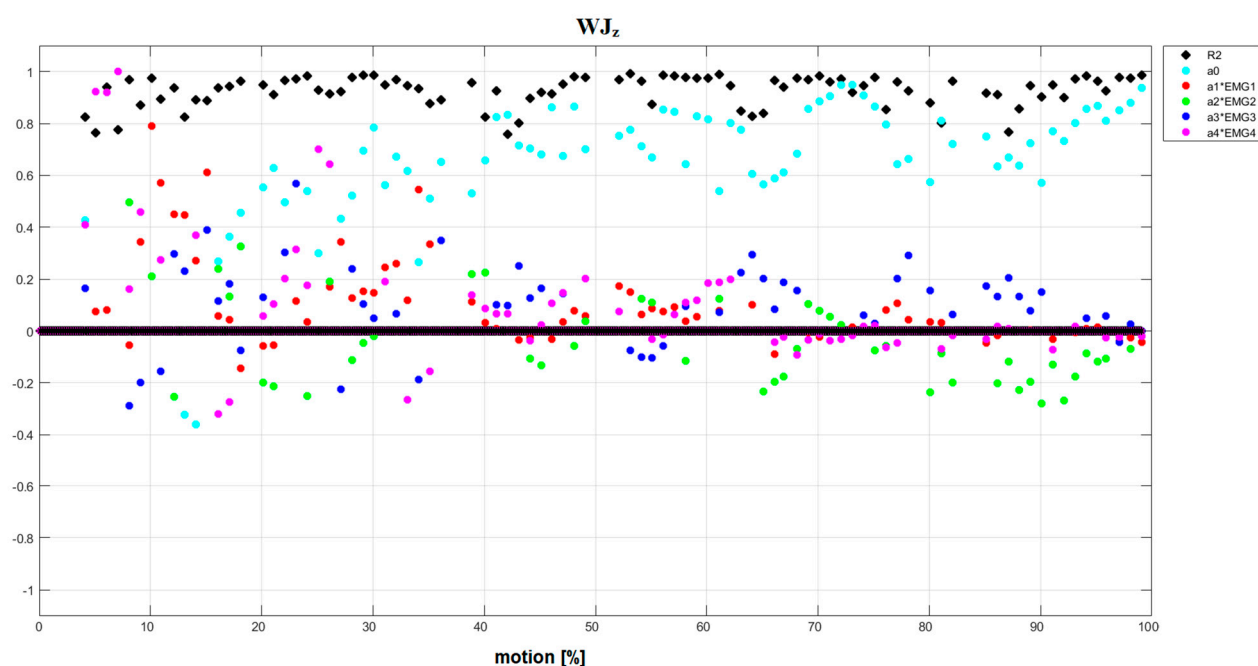


Figure S49. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for DMD patient in Motion 1. Passive manipulator conditions. WJ_z .

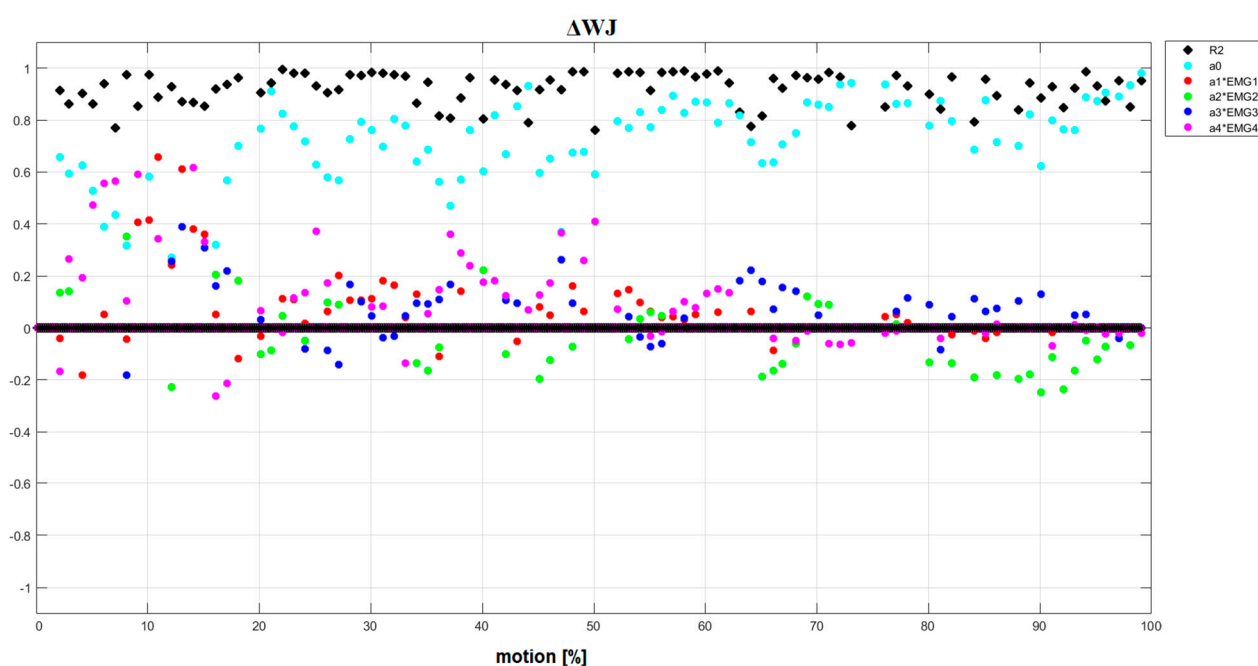


Figure S50. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for DMD patient in Motion 1. Passive manipulator conditions. ΔW .

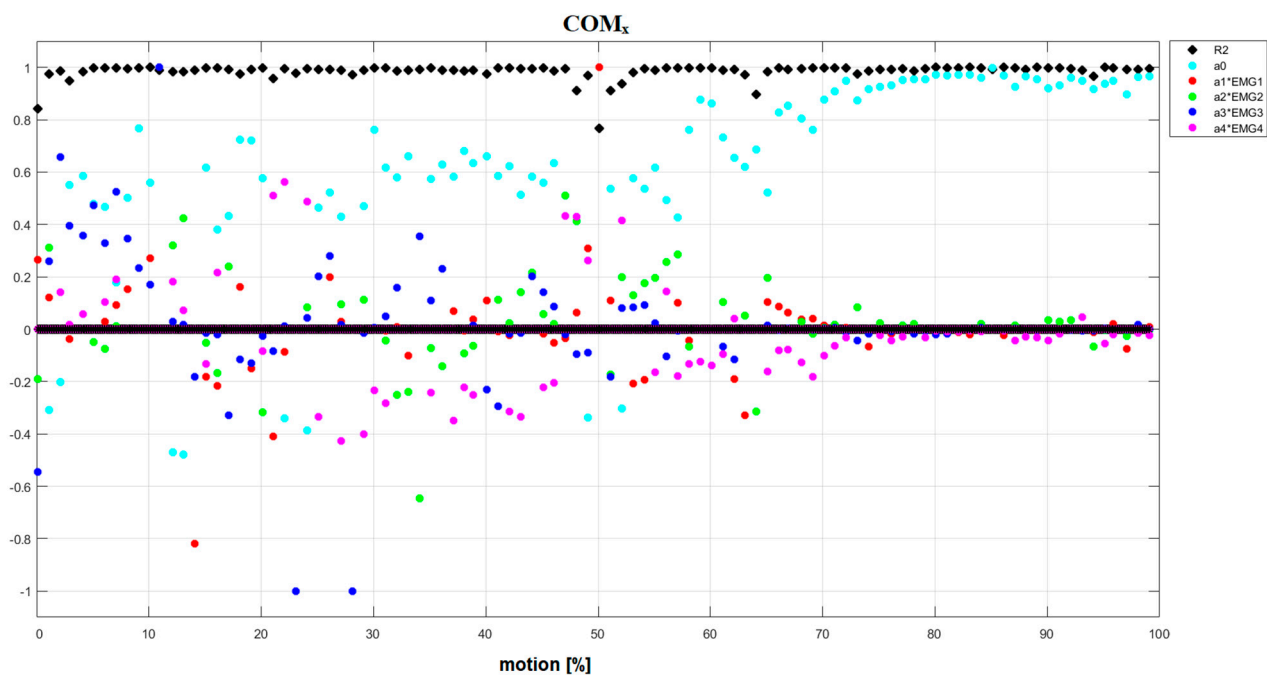


Figure S51. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for DMD patient in Motion 2. Natural conditions. COM_x.

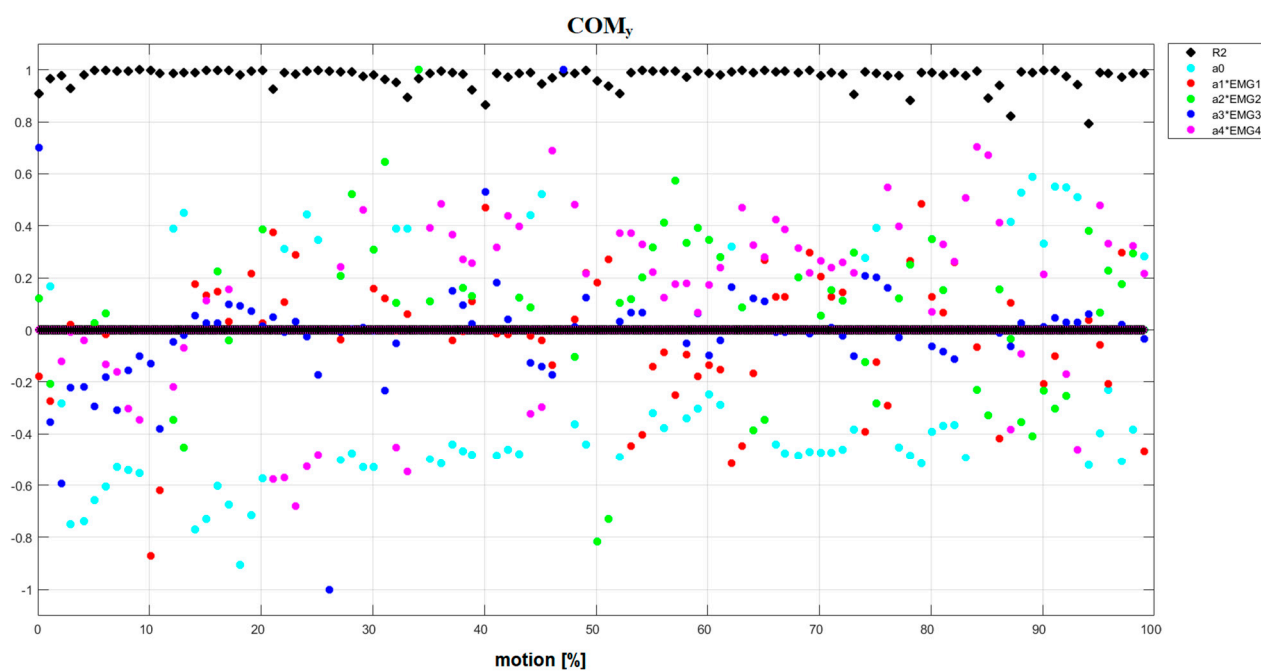


Figure S52. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for DMD patient in Motion 2. Natural conditions. COM_y.

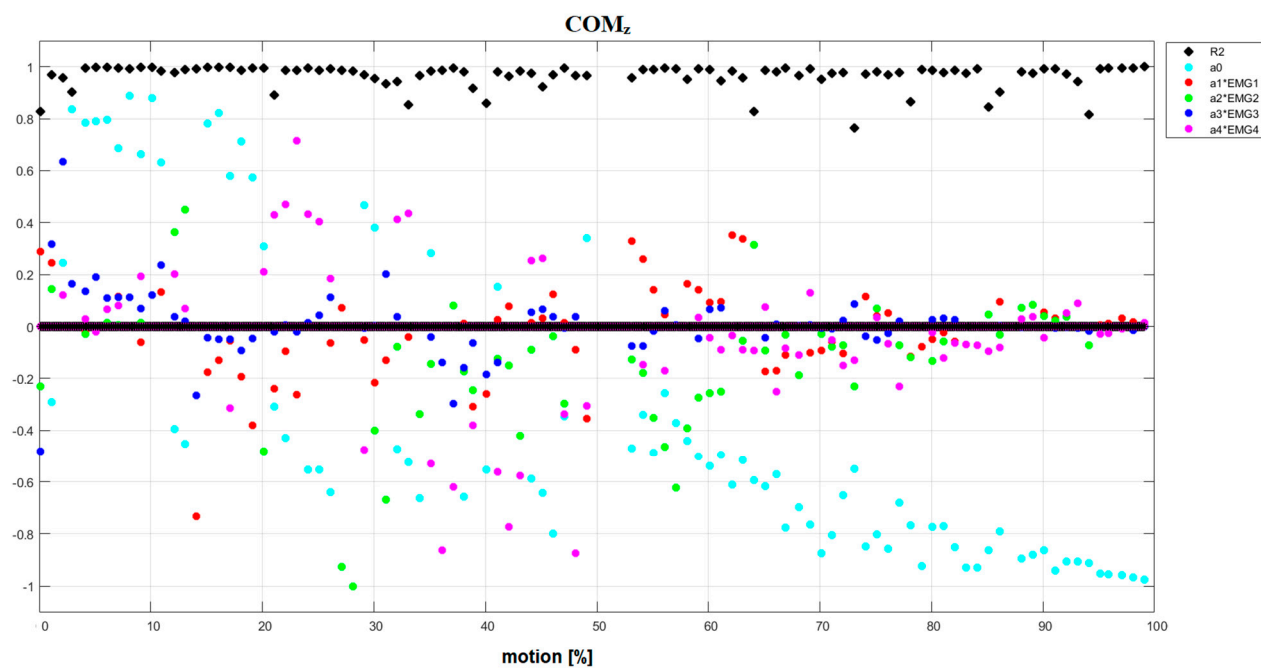


Figure S53. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for DMD patient in Motion 2. Natural conditions. COM_z .

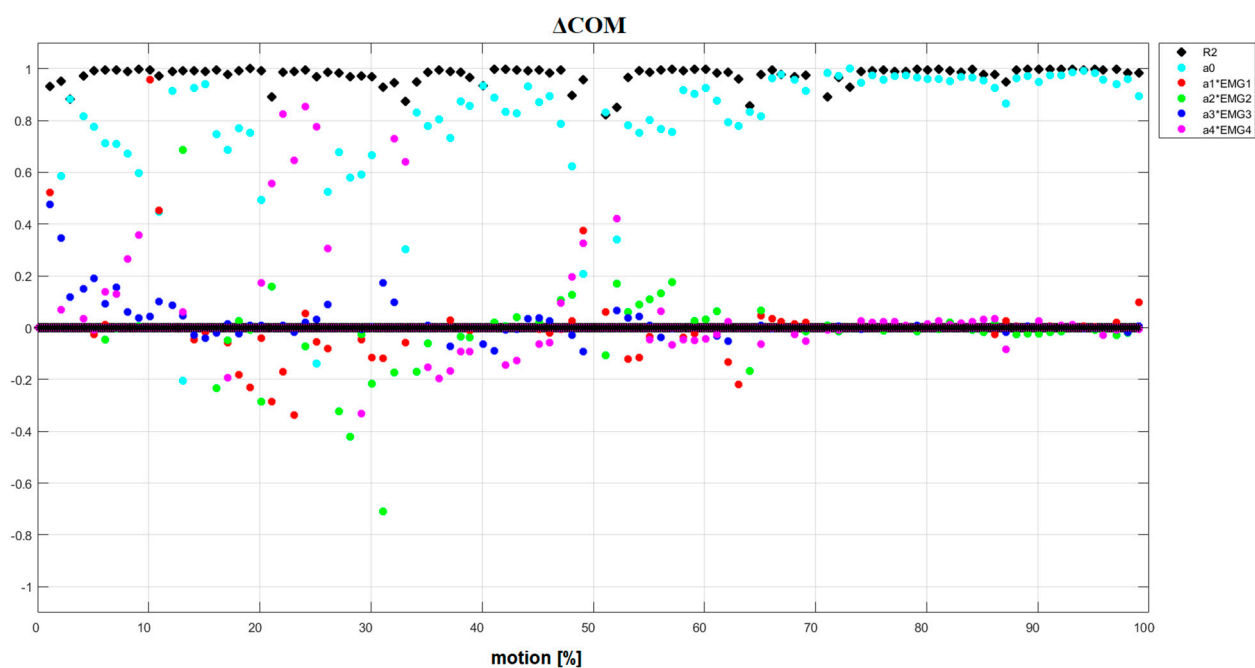


Figure S54. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for DMD patient in Motion 2. Natural conditions. ΔCOM .

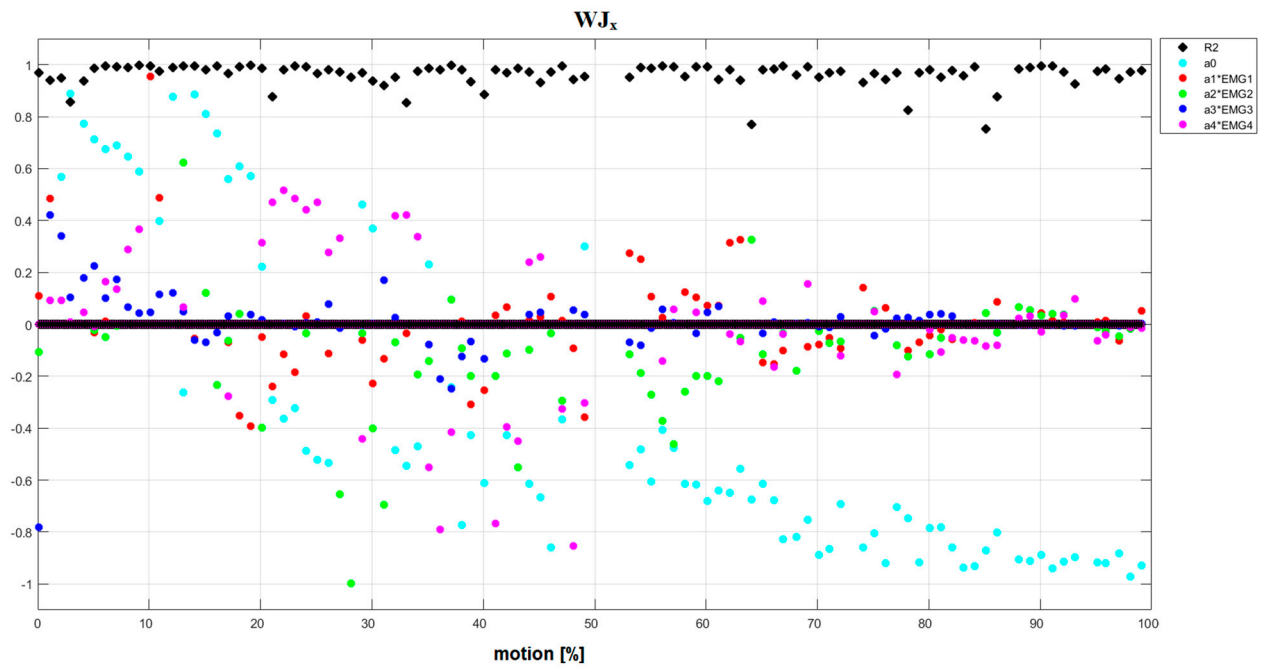


Figure S55. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for DMD patient in Motion 2. Natural conditions. WJ_x .

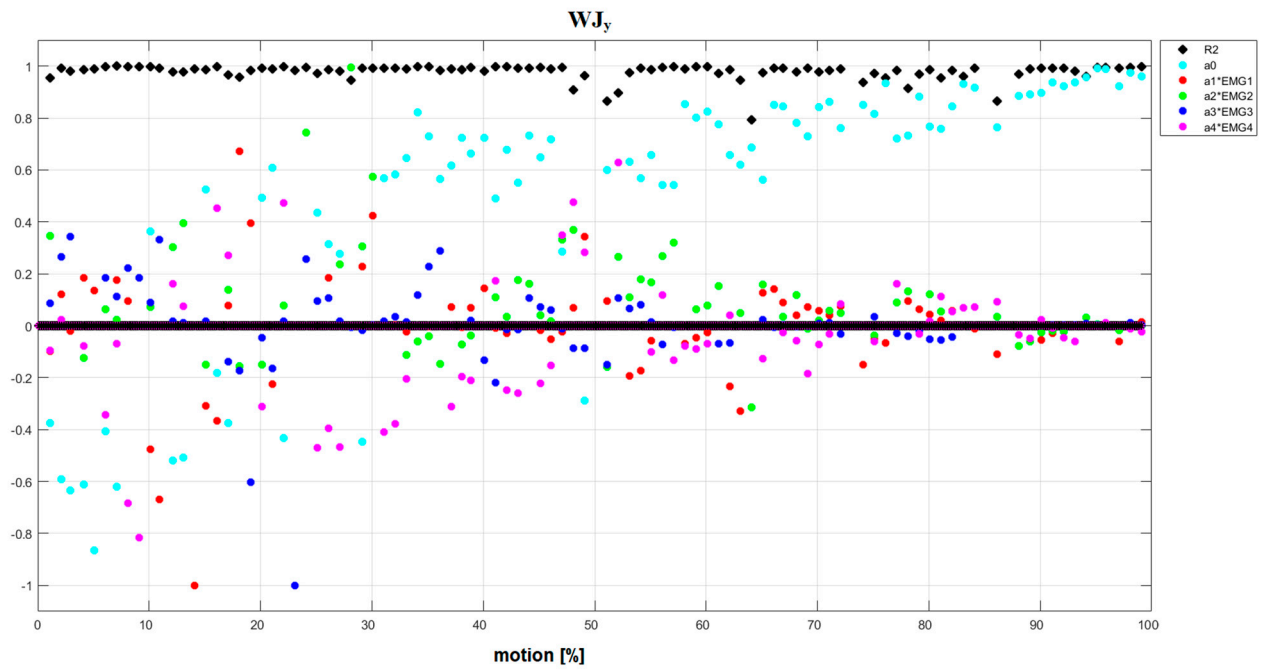


Figure S56. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for DMD patient in Motion 2. Natural conditions. WJ_y .

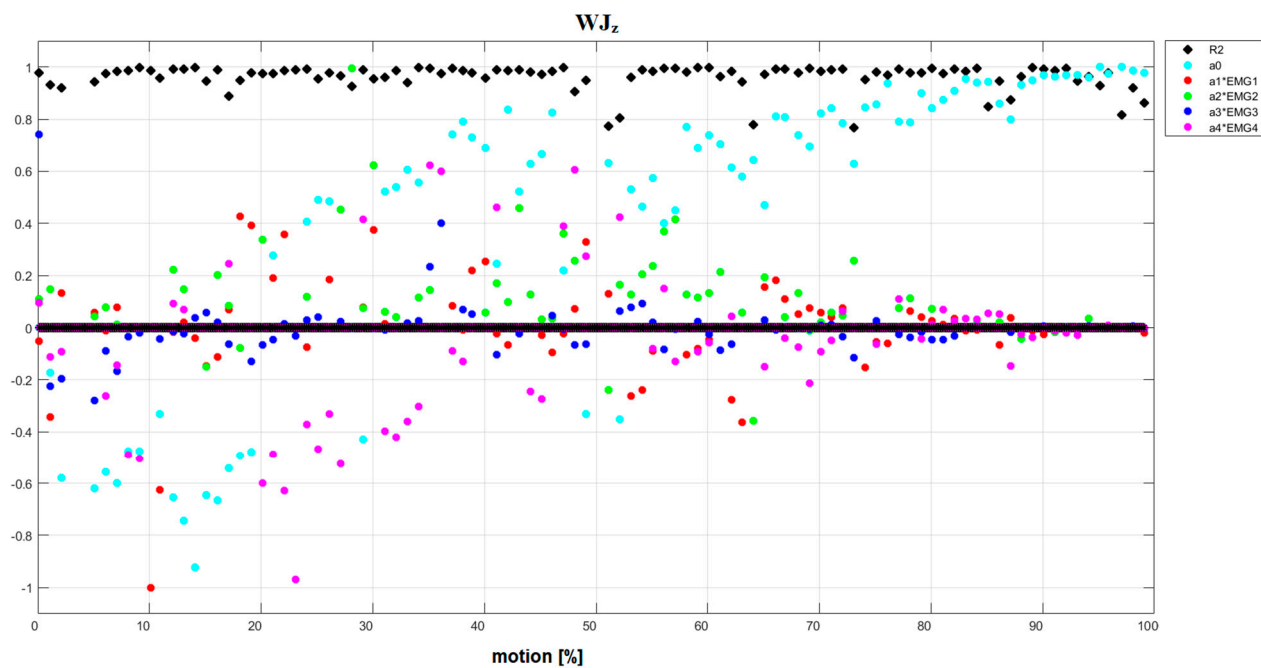


Figure S57. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for DMD patient in Motion 2. Natural conditions. WJ_z .

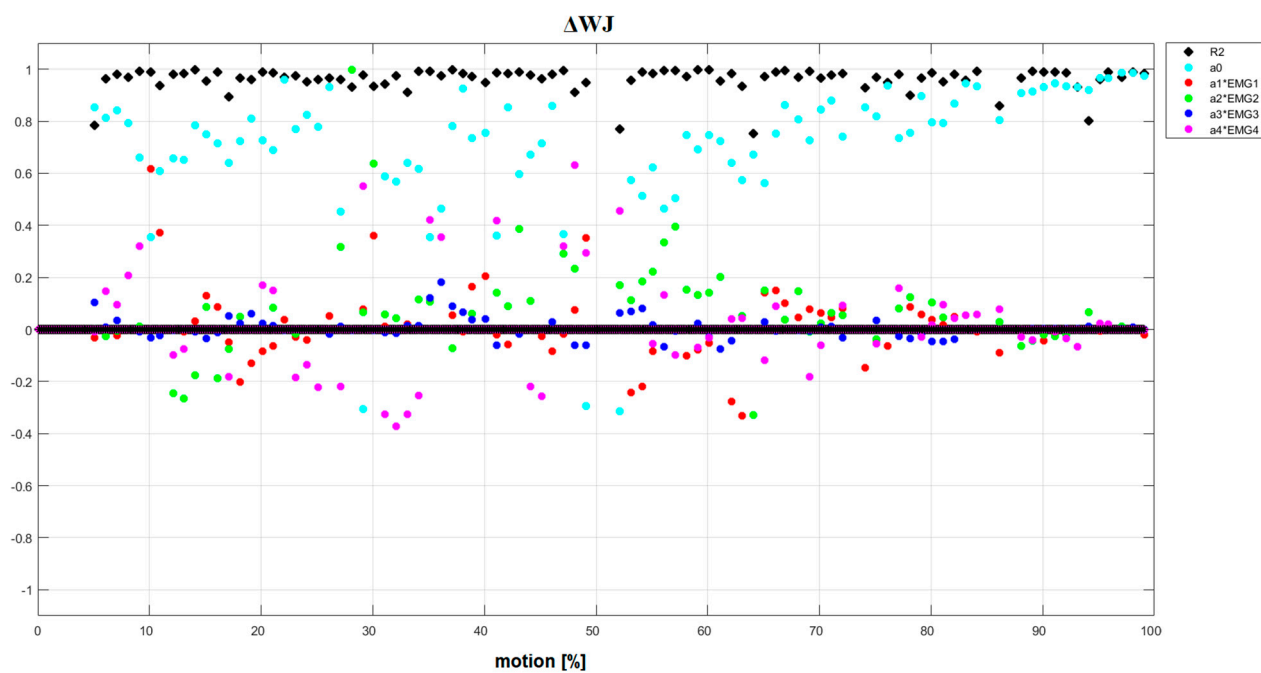


Figure S58. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for DMD patient in Motion 2. Natural conditions. ΔW .

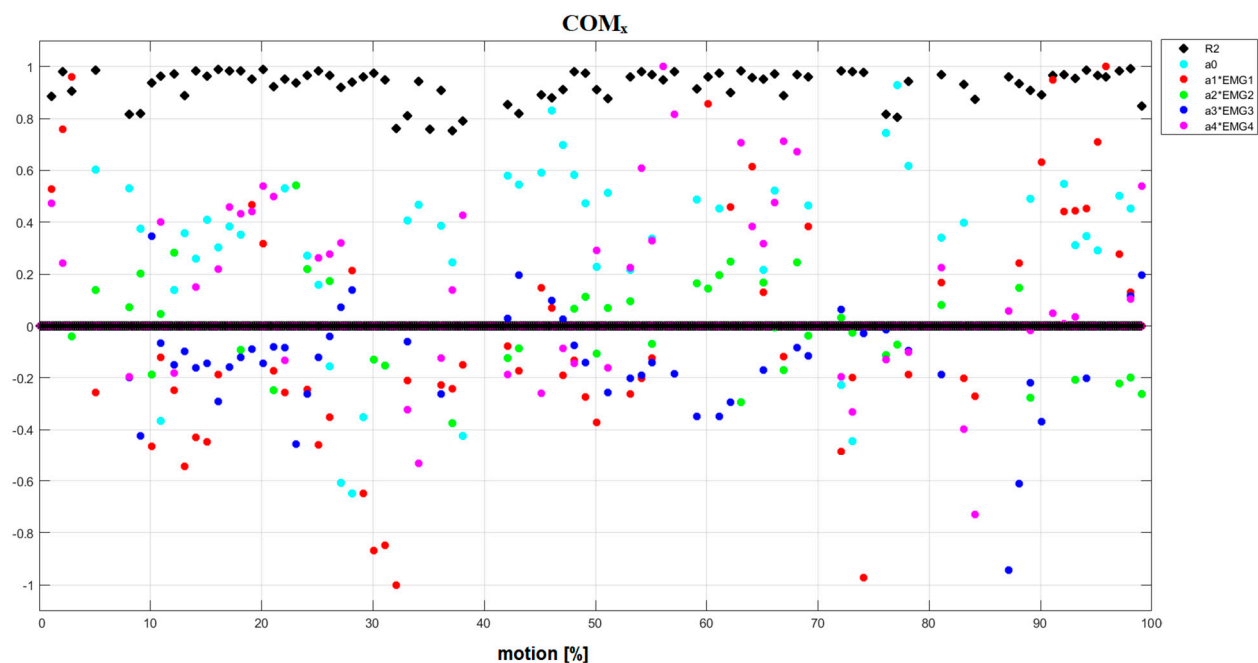


Figure S59. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for DMD patient in Motion 2. Passive manipulator conditions. COM_x .

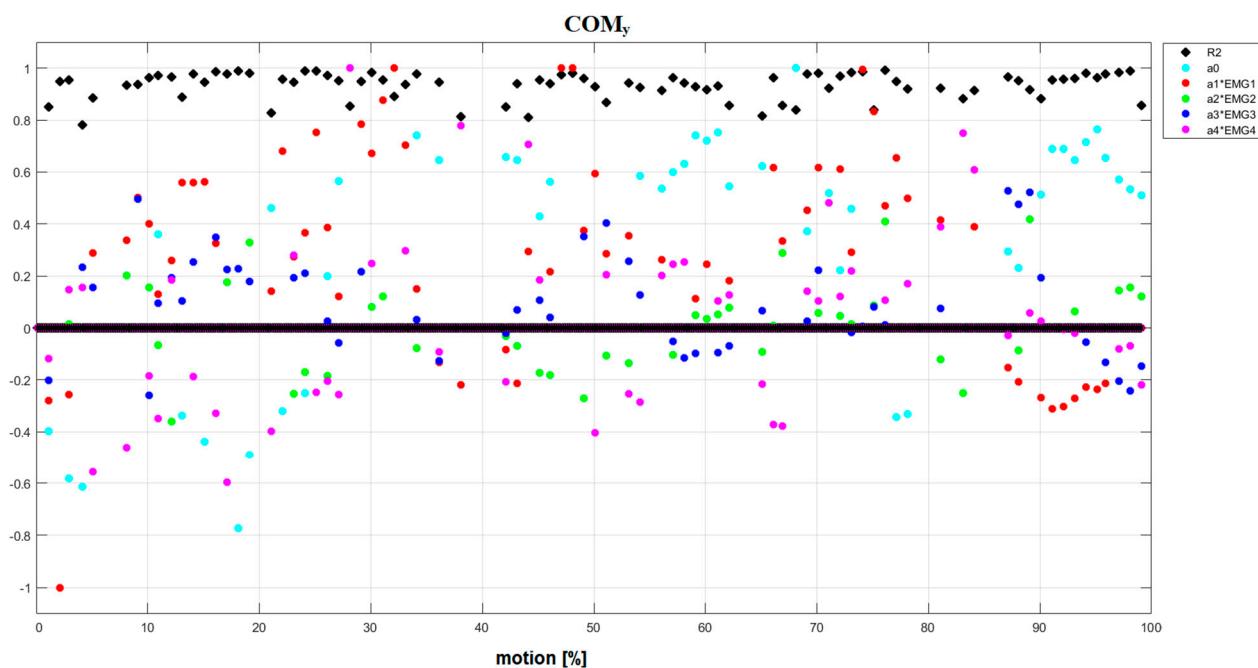


Figure S60. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for DMD patient in Motion 2. Passive manipulator conditions. COM_y .

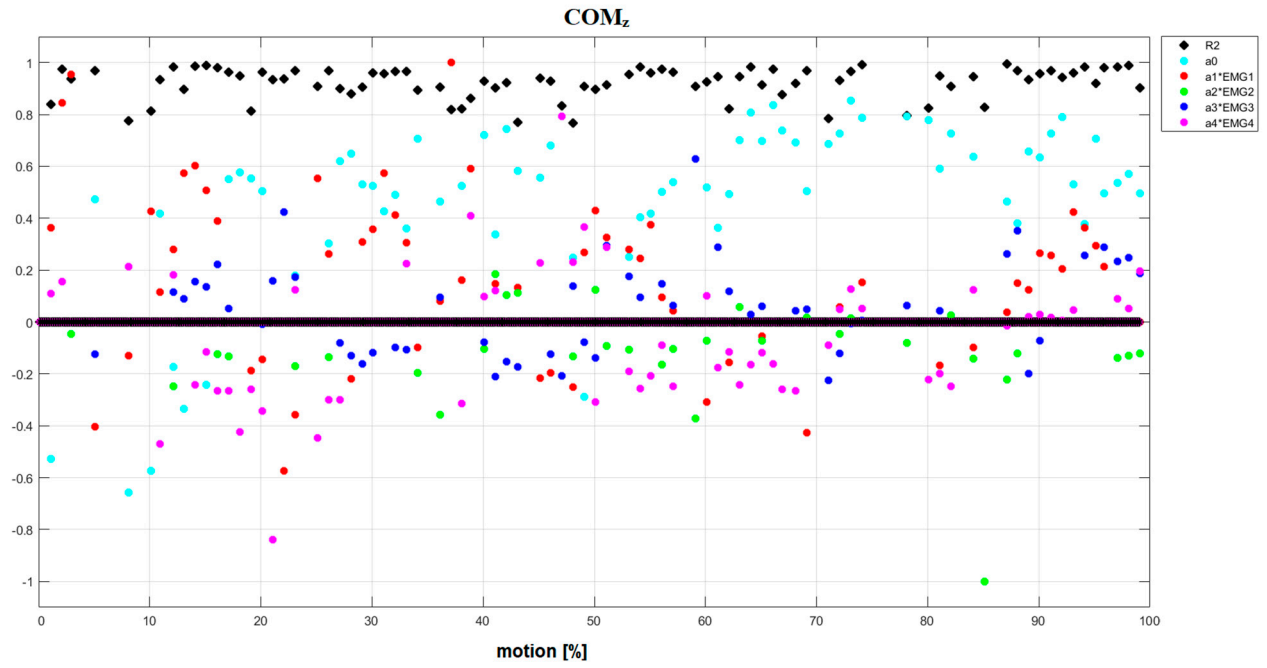


Figure S61. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for DMD patient in Motion 2. Passive manipulator conditions. COM_z .

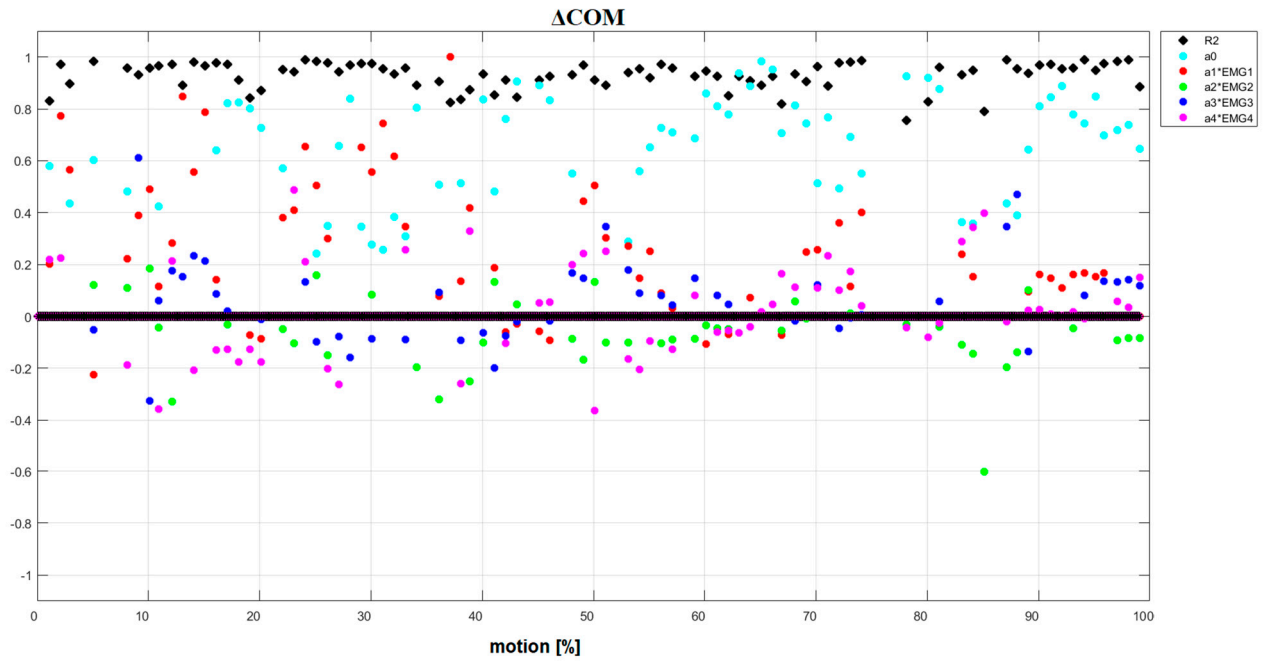


Figure S62. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for DMD patient in Motion 2. Passive manipulator conditions. ΔCOM .

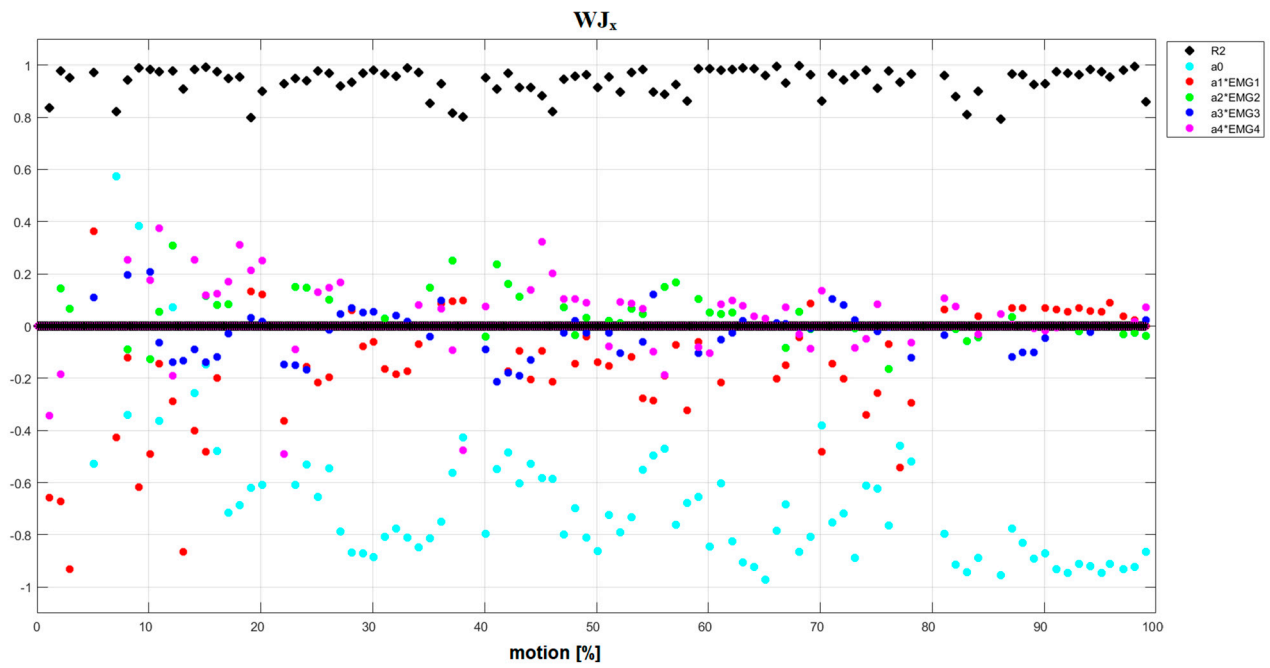


Figure S63. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for DMD patient in Motion 2. Passive manipulator conditions. WJ_x .

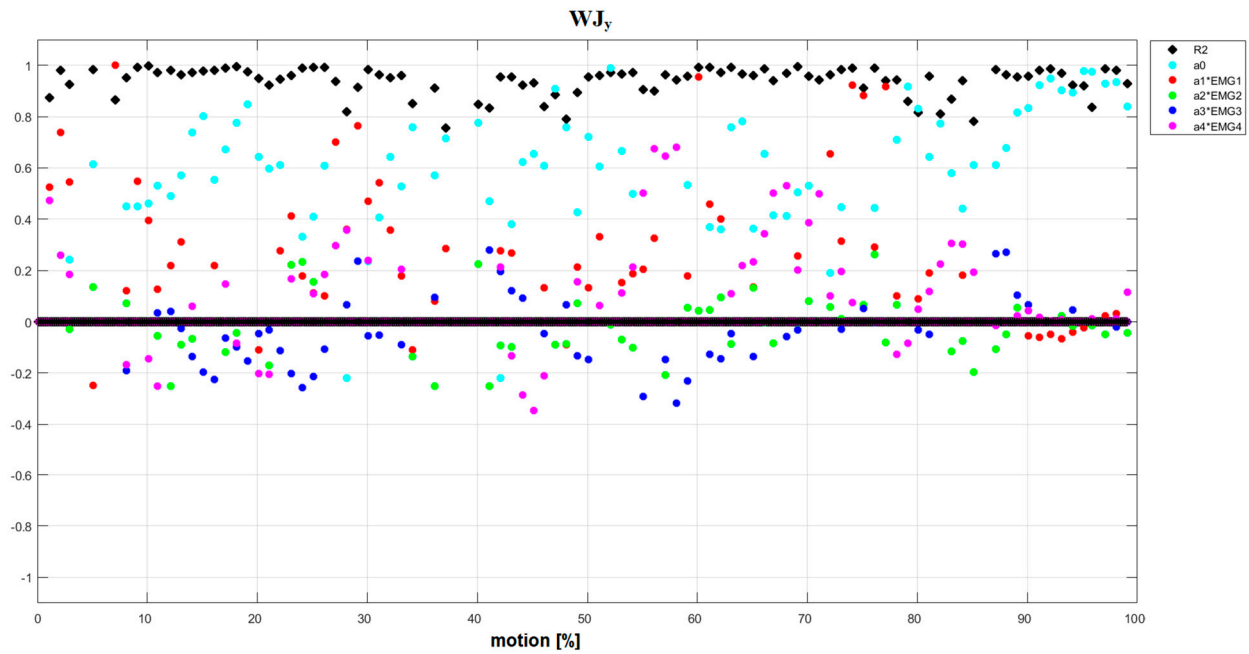


Figure S64. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for DMD patient in Motion 2. Passive manipulator conditions. WJ_y .

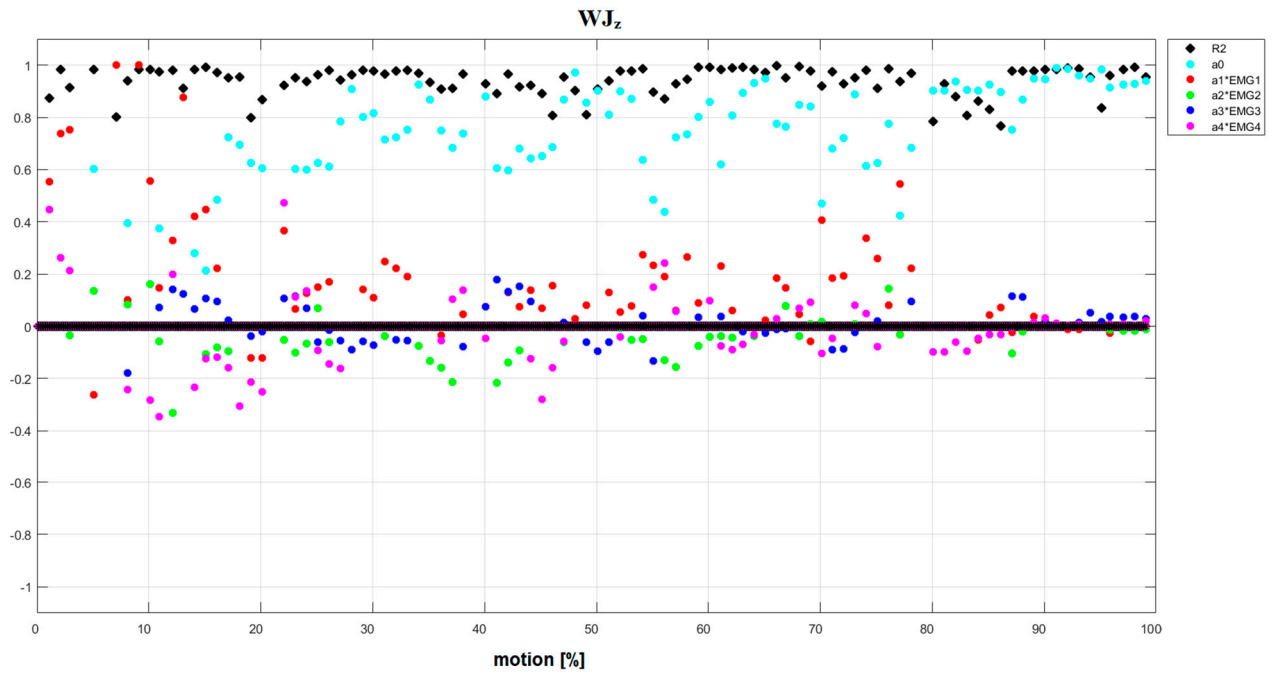


Figure S65. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for DMD patient in Motion 2. Passive manipulator conditions. WJ_z .

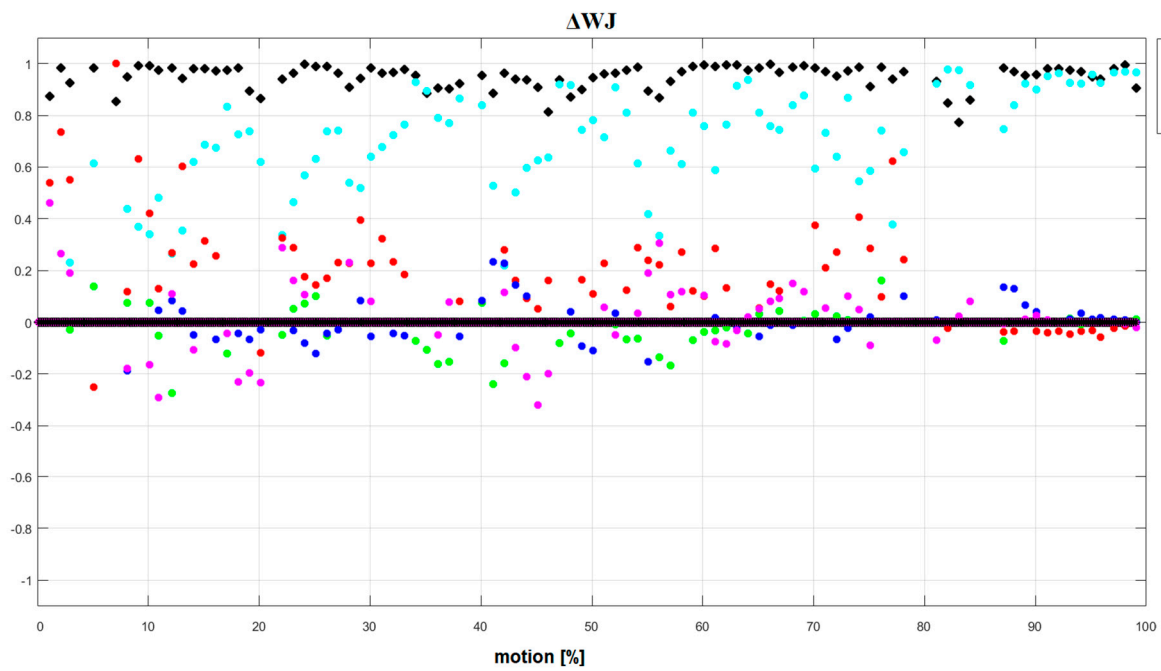


Figure S66. Results of linear piecewise multi-regression analysis performed in each tested fragment of the motion for DMD patient in Motion 2. Passive manipulator conditions. ΔW .

Supplement S4 – (Table S1 – Table S8, Figure S67-S74)

Table S1. Wilcoxon test results of kinematic data of the reference subject and DMD patient tested in natural conditions and passive manipulator conditions in both motions ($p \leq 0.01$).

		COM _x	COM _y	COM _z	ΔCOM	WJ _x	WJ _y	WJ _z	ΔWJ
Reference subject Motion 1	range 1	+	+	X	X	+	+	+	+
	range 2	+	+	X	X	+	+	+	+
	range 3	+	+	+	+	+	+	X	+
	range 4	+	+	+	+	+	+	+	+
	range 5	+	+	+	+	+	+	+	+
DMD patient Motion 1	range 1	X	X	X	X	+	+	+	+
	range 2	+	+	+	+	+	+	+	+
	range 3	+	+	+	X	+	+	+	+
	range 4	+	+	+	+	+	X	X	X
	range 5	+	+	+	+	+	X	+	+
Reference subject Motion 2	range 1	+	+	+	+	+	X	+	X
	range 2	+	X	+	+	+	X	+	+
	range 3	+	+	+	X	+	+	+	+
	range 4	+	+	X	+	+	+	+	+
	range 5	X	+	X	X	+	+	+	X
DMD patient Motion 2	range 1	X	+	X	+	+	+	+	+
	range 2	X	+	+	+	X	+	+	+
	range 3	+	X	+	+	+	+	+	+
	range 4	+	X	+	+	+	X	+	X
	range 5	+	X	+	+	X	+	+	+

Symbol “+” means the statistical significant difference. Symbol “X” means lack of statistical significant difference

Table S2. U Mann-Whitney test results of statistical significant differences in kinematic data between the reference subject and the DMD patient for natural conditions and passive manipulator in both motions ($p \leq 0.01$).

		COM _x	COM _y	COM _z	ΔCOM	WJ _x	WJ _y	WJ _z	ΔWJ
Motion 1. Natural conditions	range 1	+	+	+	+	+	+	+	+
	range 2	+	+	X	+	+	+	+	+
	range 3	+	+	X	X	+	X	+	+
	range 4	+	+	X	X	+	X	+	X
	range 5	+	+	+	+	+	X	+	X
Motion 2. Natural conditions	range 1	+	+	+	X	+	X	+	+
	range 2	+	+	+	X	+	+	+	+
	range 3	+	X	+	+	+	X	+	+
	range 4	+	X	+	+	+	+	+	X
	range 5	+	+	+	X	+	+	+	+
Motion 1. Passive manipulator conditions	range 1	+	+	+	X	X	X	+	X
	range 2	+	+	+	X	+	+	+	+
	range 3	X	+	+	+	+	X	+	X
	range 4	+	+	+	+	+	+	+	+
	range 5	+	+	+	+	+	+	+	+
Motion 2. Passive manipulator conditions	range 1	+	+	+	X	X	+	+	X
	range 2	X	X	+	X	X	+	+	X
	range 3	+	+	+	+	+	X	+	+
	range 4	+	+	+	+	X	+	+	X
	range 5	+	+	+	+	+	+	+	X

Symbol “+” means the statistical significant difference. Symbol “X” means lack of statistical significant difference

Table S3. Wilcoxon test results of statistical significant differences in muscle activity between natural conditions and passive manipulator conditions in both motions for the reference subject and DMD patient ($p \leq 0.01$).

		EMG₁	EMG₂	EMG₃	EMG₄
Reference subject Motion 1	range 1	+	X	+	X
	range 2	X	X	X	+
	range 3	X	+	+	X
	range 4	+	+	+	X
	range 5	+	+	X	+
Reference subject Motion 2	range 1	+	X	X	X
	range 2	+	+	X	X
	range 3	+	+	X	+
	range 4	+	+	X	X
	range 5	+	+	X	+
DMD patient Motion 1	range 1	+	X	X	+
	range 2	+	+	+	X
	range 3	X	+	X	X
	range 4	X	+	+	X
	range 5	+	+	+	+
DMD patient Motion 2	range 1	X	X	X	+
	range 2	+	X	+	+
	range 3	+	+	+	+
	range 4	+	X	X	+
	range 5	+	X	X	X

Symbol “+” means the statistical significant difference. Symbol “X” means lack of statistical significant difference

Table S4. ANOVA Kruskal-Wallis test results of statistical significant differences between five sets of muscle activity for the reference subject and DMD patient tested in natural conditions and passive manipulator in both motions ($p \leq 0.01$).

	RS NC motion1	RS PMC motion1	RS NC motion2	RS PMC motion2	DMD NC motion1	DMD PMC motion1	DMD NC motion2	DMD PMC motion2
EMG₁-EMG₂-EMG₃								
range 1			+		+	+		
range 2	+		+		+	+	+	+
range 3	+		+		+	+	+	+
range 4	+	+	+	+	+			+
range 5	+	+	+		+	+	+	
EMG₁-EMG₂-EMG₄								
range 1			+			+	+	
range 2	+		+	+		+	+	+
range 3	+		+	+	+		+	+
range 4	+		+	+	+		+	+
range 5	+		+	+	+	+	+	
EMG₂-EMG₃-EMG₄								
range 1						+	+	
range 2	+		+		+	+	+	+
range 3	+		+	+	+	+		+
range 4	+	+	+	+	+		+	
range 5	+	+	+	+	+	+		
EMG₁-EMG₃-EMG₄								
range 1			+		+	+		
range 2	+		+	+	+	+	+	+
range 3	+		+	+	+	+	+	
range 4	+	+	+				+	
range 5	+	+	+	+	+	+	+	
EMG₁-EMG₂-EMG₃-EMG₄								
range 1			+		+	+	+	
range 2	+		+	+	+	+	+	+
range 3	+		+	+	+	+	+	+
range 4	+	+	+	+	+		+	+
range 5	+	+	+	+	+	+	+	

Symbol “+” means the statistical significant difference

Table S5 – S12 and Figure S67 - S74. Results of linear piecewise multi-regression analysis presenting accumulated synergistic and antagonistic participations calculated between kinematic data and muscular activity for the reference subject and DMD patient in natural conditions and passive manipulator conditions in both motions ($p \leq 0.05$, $R^2 \geq 0.75$): the $a_1 \cdot EMG_1$ part describes RT TRAPEZIUS muscle participation, the $a_2 \cdot EMG_2$ part describes RT LAT. TRICEPS muscle participation, the $a_3 \cdot EMG_3$ part describes RT ANT.DELTOID muscle participation, the $a_4 \cdot EMG_4$ part describes RT BICEPS BR muscle participation.

Table S5. Reference subject. Motion 1. Natural conditions.

	$a_1 \cdot EMG_1$ Synerg.	$a_1 \cdot EMG_1$ Antagon.	$a_2 \cdot EMG_2$ Synerg.	$a_2 \cdot EMG_2$ Antagon.	$a_3 \cdot EMG_3$ Synerg.	$a_3 \cdot EMG_3$ Antagon.	$a_4 \cdot EMG_4$ Synerg.	$a_4 \cdot EMG_4$ Antagon.
COM _x	3,56	-3,56	1,37	-1,42	2,55	-0,72	1,25	-2,94
COM _y	13,48	-6,91	2,40	-3,84	2,32	-6,66	4,92	-2,96
COM _z	4,05	-3,80	2,67	-1,66	1,81	-1,93	1,72	-3,26
ΔCOM	4,79	-3,14	1,68	-2,34	2,21	-1,45	1,71	-2,50
WJ _x	3,41	-3,12	1,08	-1,37	2,52	-0,48	1,02	-2,47
WJ _y	10,42	-12,49	3,32	-5,68	2,42	-9,39	3,08	-12,31
WJ _z	4,81	-3,73	4,92	-2,88	1,98	-2,93	2,36	-13,38
ΔW	4,56	-1,92	1,83	-2,36	1,11	-2,29	4,97	-1,60

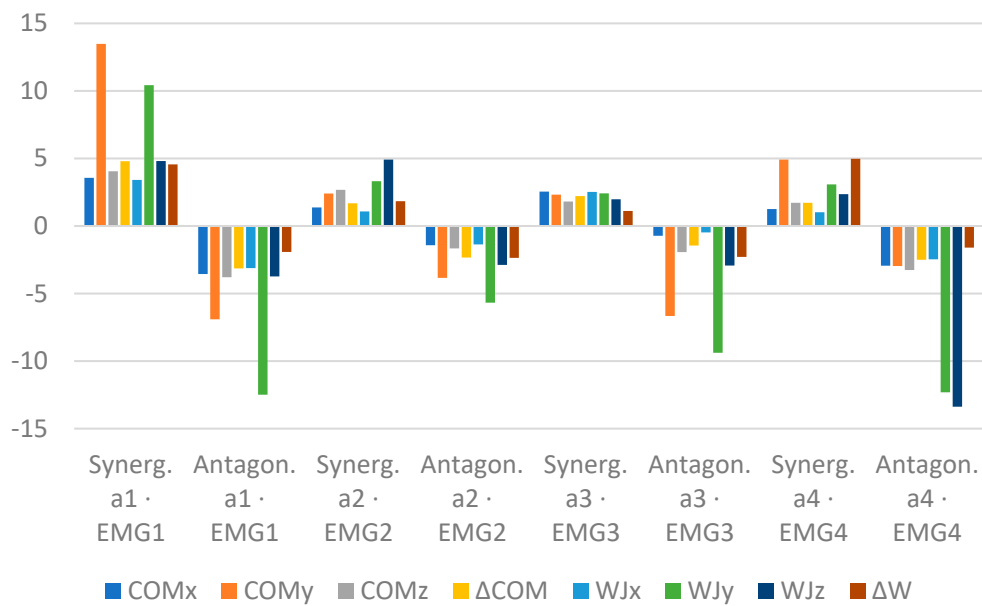


Figure S67 Reference subject. Motion 1. Natural conditions.

Table S6. Reference subject. Motion 1. Passive manipulator conditions.

	$a_1 \cdot EMG_1$ Synerg.	$a_1 \cdot EMG_1$ Antagon.	$a_2 \cdot EMG_2$ Synerg.	$a_2 \cdot EMG_2$ Antagon.	$a_3 \cdot EMG_3$ Synerg.	$a_3 \cdot EMG_3$ Antagon.	$a_4 \cdot EMG_4$ Synerg.	$a_4 \cdot EMG_4$ Antagon.
COM _x	2,26	-3,17	1,52	-7,47	1,63	-5,94	2,55	-6,30
COM _y	2,89	-0,35	0,22	-7,16	5,29	-1,20	2,21	-1,38
COM _z	1,64	-3,38	5,27	-4,20	1,57	-9,15	2,86	-2,53
ΔCOM	2,93	-0,47	0,64	-6,08	6,04	-1,15	1,55	-1,75
WJ _x	2,08	-0,54	0,43	-8,50	1,38	-1,04	4,30	-0,76
WJ _y	0,62	-2,17	3,63	-1,13	2,21	-3,14	3,84	-2,45
WJ _z	1,37	-3,03	3,32	-3,33	5,52	-4,78	1,41	-3,54
ΔW	0,90	-1,30	2,81	-1,36	2,25	-2,76	2,17	-2,30

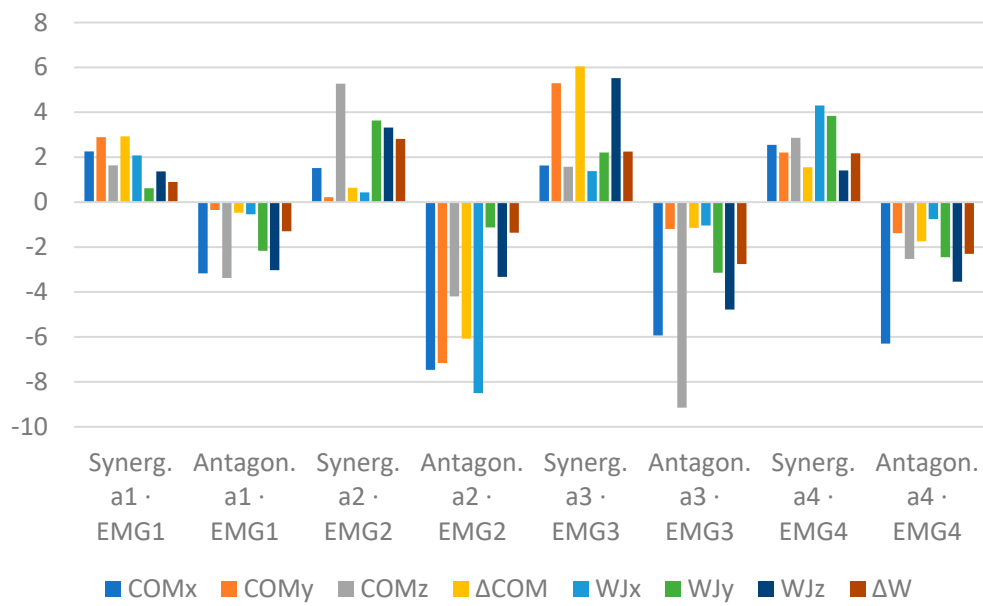


Figure S68. Reference subject. Motion 1. Passive manipulator conditions.

Table S7. Reference subject. Motion 2. Natural conditions.

	$a_1 \cdot EMG_1$ Synerg.	$a_1 \cdot EMG_1$ Antagon.	$a_2 \cdot EMG_2$ Synerg.	$a_2 \cdot EMG_2$ Antagon.	$a_3 \cdot EMG_3$ Synerg.	$a_3 \cdot EMG_3$ Antagon.	$a_4 \cdot EMG_4$ Synerg.	$a_4 \cdot EMG_4$ Antagon.
COM _x	1,36	-1,11	2,80	-1,05	1,56	-2,08	1,04	-5,62
COM _y	2,67	-4,63	5,83	-3,61	12,94	-2,89	4,05	-10,47
COM _z	0,66	-0,36	0,89	-0,34	1,52	-1,92	0,92	-1,59
ΔCOM	1,07	-0,63	2,24	-0,48	2,76	-1,91	2,09	-1,78
WJ _x	1,29	-1,14	1,83	-0,46	0,93	-4,30	0,73	-5,47
WJ _y	3,83	-4,26	4,87	-5,86	13,81	-4,07	8,73	-10,16
WJ _z	3,15	-1,39	2,48	-3,15	4,99	-8,71	11,49	-1,20
ΔW	1,74	-1,15	2,08	-1,56	4,54	-3,96	3,49	-3,29

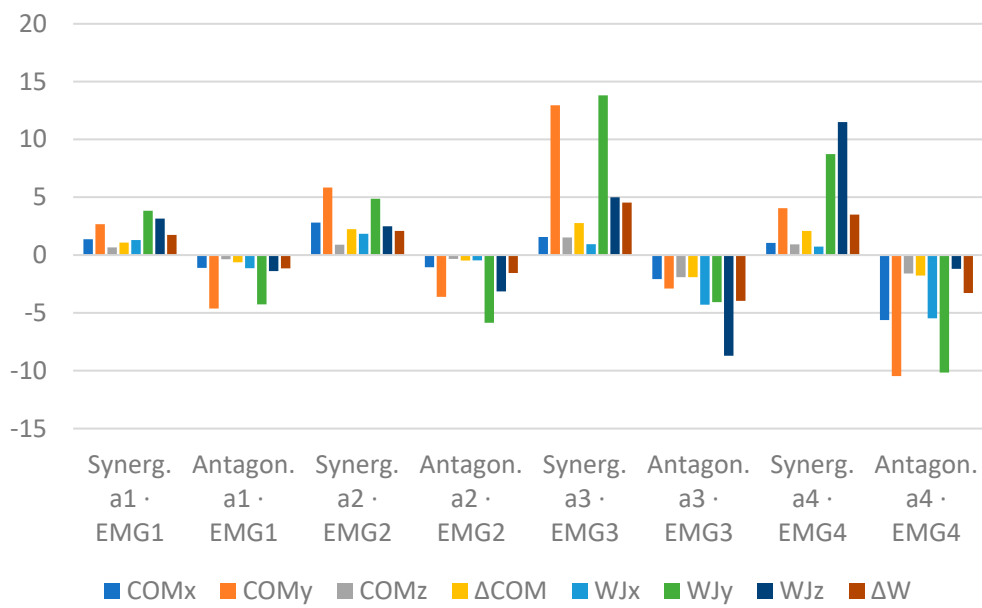


Figure S69. Reference subject. Motion 2. Natural conditions.

Table S8. Reference subject. Motion 2. Passive manipulator conditions.

	$a_1 \cdot EMG_1$ Synerg.	$a_1 \cdot EMG_1$ Antagon.	$a_2 \cdot EMG_2$ Synerg.	$a_2 \cdot EMG_2$ Antagon.	$a_3 \cdot EMG_3$ Synerg.	$a_3 \cdot EMG_3$ Antagon.	$a_4 \cdot EMG_4$ Synerg.	$a_4 \cdot EMG_4$ Antagon.
COM _x	1,08	-0,69	5,32	-0,53	0,49	-1,18	0,66	-2,55
COM _y	1,41	-1,87	2,52	-6,39	3,90	-3,73	5,89	-2,01
COM _z	1,05	-1,11	8,72	-1,04	0,67	-1,92	1,06	-3,54
ΔCOM	0,85	-1,42	0,76	-6,43	2,77	-1,62	3,49	-1,24
WJ _x	1,36	-1,91	6,39	-0,64	0,92	-1,09	1,49	-2,26
WJ _y	2,72	-2,81	1,43	-27,09	5,43	-2,49	8,99	-3,67
WJ _z	1,04	-1,68	5,63	-2,53	1,56	-2,63	2,28	-4,29
ΔW	1,22	-0,95	1,21	-6,54	1,94	-1,29	3,34	-1,97

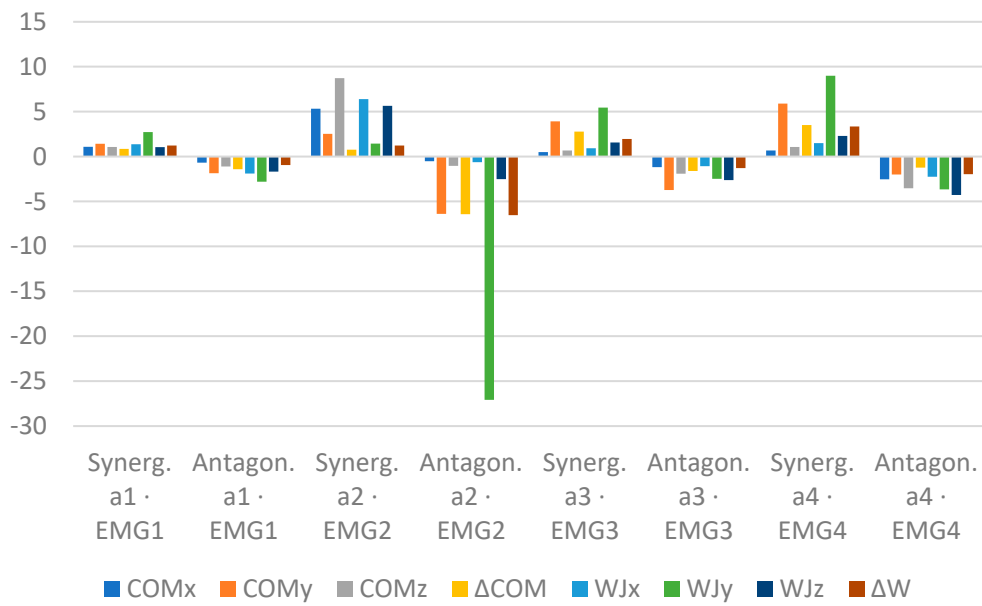


Figure S70. Reference subject. Motion 2. Passive manipulator conditions.

Table S9. DMD patient. Motion 1. Natural conditions.

	$a_1 \cdot EMG_1$ Synerg.	$a_1 \cdot EMG_1$ Antagon.	$a_2 \cdot EMG_2$ Synerg.	$a_2 \cdot EMG_2$ Antagon.	$a_3 \cdot EMG_3$ Synerg.	$a_3 \cdot EMG_3$ Antagon.	$a_4 \cdot EMG_4$ Synerg.	$a_4 \cdot EMG_4$ Antagon.
COM _x	8,31	-3,67	10,55	-2,58	14,88	-6,39	19,40	-2,09
COM _y	13,49	-3,95	3,65	-6,71	5,28	-17,74	4,38	-7,77
COM _z	2,26	-8,87	1,61	-10,44	4,34	-27,56	3,33	-13,77
ΔCOM	6,80	-2,34	7,50	-1,87	22,15	-3,86	14,90	-2,00
WJ _x	2,98	-5,13	1,31	-7,51	3,11	-20,42	1,13	-15,01
WJ _y	4,98	-3,93	8,01	-3,27	9,16	-11,17	19,30	-2,90
WJ _z	5,82	-3,48	8,06	-1,34	19,56	-3,89	16,16	-1,33
ΔW	5,61	-3,19	7,38	-1,19	15,94	-4,01	14,97	-1,23

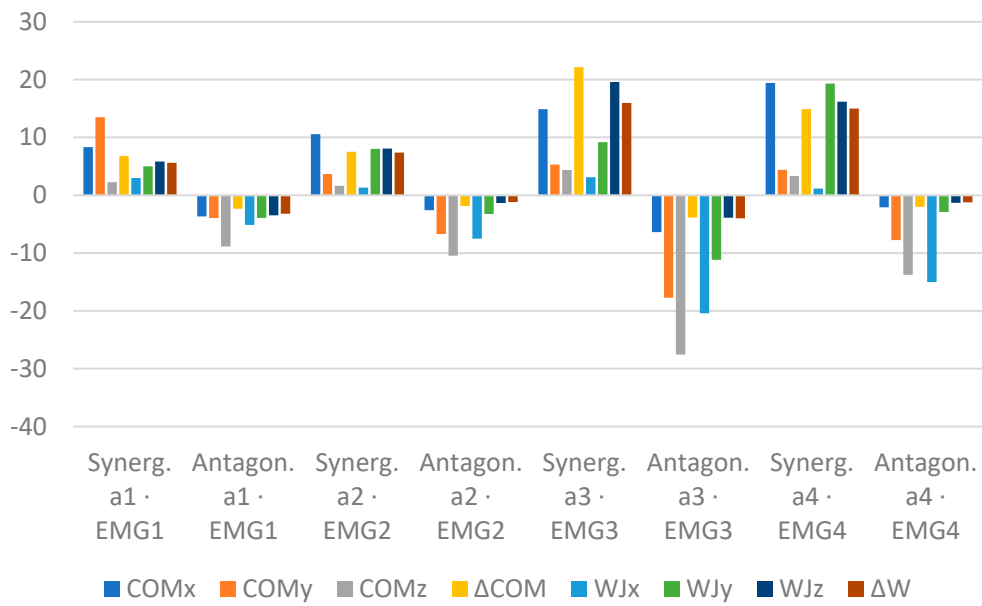


Figure S71. DMD patient. Motion 1. Natural conditions.

Table S10. DMD patient. Motion 1. Passive manipulator conditions.

	$a_1 \cdot EMG_1$ Synerg.	$a_1 \cdot EMG_1$ Antagon.	$a_2 \cdot EMG_2$ Synerg.	$a_2 \cdot EMG_2$ Antagon.	$a_3 \cdot EMG_3$ Synerg.	$a_3 \cdot EMG_3$ Antagon.	$a_4 \cdot EMG_4$ Synerg.	$a_4 \cdot EMG_4$ Antagon.
COM _x	0,73	-11,79	1,62	-11,31	11,72	-4,24	12,04	-7,13
COM _y	13,14	-0,37	16,48	-2,75	1,97	-18,61	12,18	-2,90
COM _z	9,87	-6,23	5,36	-9,01	6,74	-5,87	4,47	-14,34
ΔCOM	10,30	-2,33	6,28	-3,60	2,63	-8,51	10,10	-2,78
WJ _x	1,20	-4,61	2,91	-3,31	1,85	-3,67	2,24	-6,67
WJ _y	6,75	-3,10	1,80	-8,82	7,20	-4,05	13,92	-0,89
WJ _z	7,93	-0,73	2,69	-4,88	7,19	-1,51	8,75	-1,76
ΔW	5,88	-0,79	1,93	-4,04	4,72	-0,85	8,81	-1,35

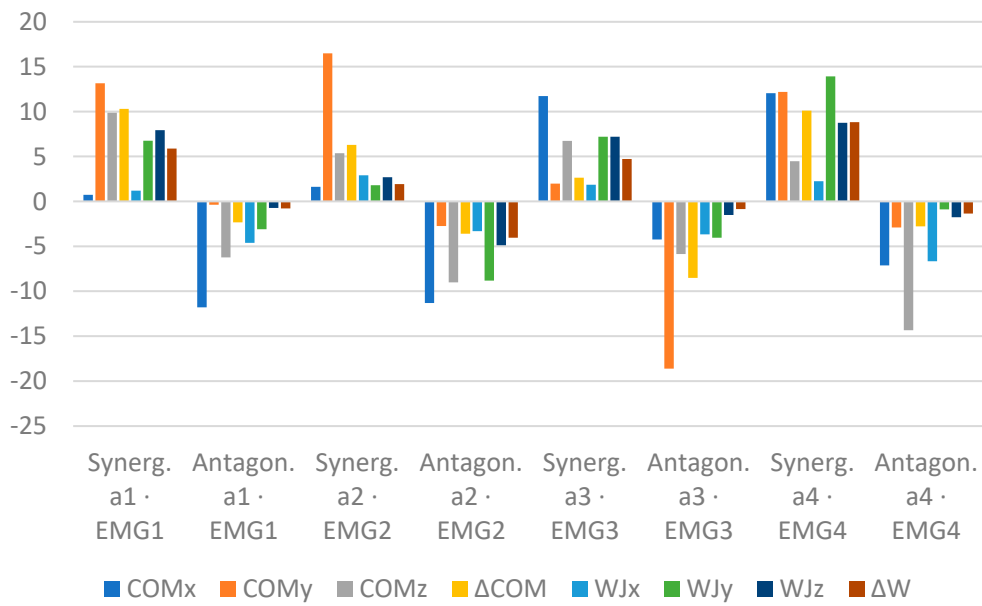


Figure S72. DMD patient. Motion 1. Passive manipulator conditions.

Table S11 DMD patient. Motion 2. Natural conditions.

	$a_1 \cdot EMG_1$ Synerg.	$a_1 \cdot EMG_1$ Antagon.	$a_2 \cdot EMG_2$ Synerg.	$a_2 \cdot EMG_2$ Antagon.	$a_3 \cdot EMG_3$ Synerg.	$a_3 \cdot EMG_3$ Antagon.	$a_4 \cdot EMG_4$ Synerg.	$a_4 \cdot EMG_4$ Antagon.
COM _x	3,53	-3,41	5,01	-3,08	7,04	-4,90	4,31	-6,13
COM _y	6,10	-7,62	10,42	-5,99	4,76	-5,70	16,41	-6,97
COM _z	3,60	-4,99	1,76	-10,04	3,31	-2,54	5,47	-9,01
ΔCOM	2,88	-2,62	2,22	-3,41	2,69	-0,68	7,99	-2,20
WJ _x	4,52	-4,13	1,53	-9,01	2,95	-2,17	6,83	-6,95
WJ _y	4,45	-4,99	8,07	-1,80	3,70	-3,36	4,22	-7,62
WJ _z	4,44	-4,57	8,86	-0,98	2,18	-2,35	4,95	-9,56
ΔW	3,62	-2,72	6,97	-1,62	1,30	-0,84	5,48	-3,75

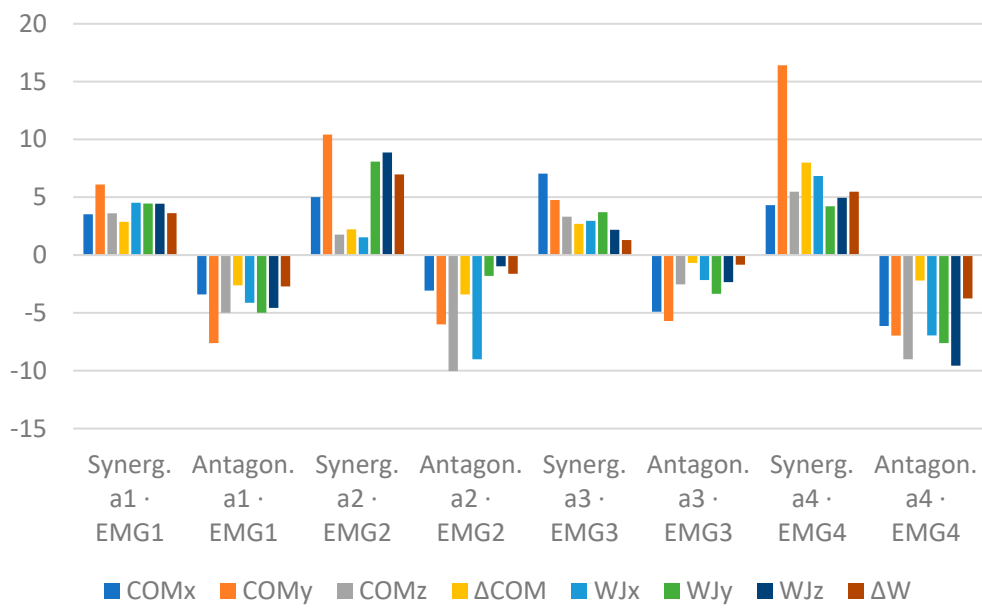


Figure S73. DMD patient. Motion 2. Natural conditions.

Table S12. DMD patient. Motion 2. Passive manipulator conditions.

	$a_1 \cdot EMG_1$ Synerg.	$a_1 \cdot EMG_1$ Antagon.	$a_2 \cdot EMG_2$ Synerg.	$a_2 \cdot EMG_2$ Antagon.	$a_3 \cdot EMG_3$ Synerg.	$a_3 \cdot EMG_3$ Antagon.	$a_4 \cdot EMG_4$ Synerg.	$a_4 \cdot EMG_4$ Antagon.
COM _x	11,35	-12,62	3,44	-3,50	1,28	-8,63	12,83	-4,23
COM _y	23,05	-4,38	3,12	-2,73	6,75	-1,89	8,29	-6,53
COM _z	14,61	-3,99	0,64	-4,92	5,70	-2,61	4,46	-8,16
ΔCOM	17,40	-0,87	1,14	-4,07	4,71	-1,57	5,17	-3,67
WJ _x	1,80	-13,48	3,14	-0,81	1,36	-3,03	5,06	-2,79
WJ _y	19,28	-0,85	2,11	-3,14	2,03	-4,24	10,77	-2,25
WJ _z	14,11	-0,75	0,74	-3,00	2,27	-1,40	3,06	-4,39
ΔW	14,73	-0,78	0,94	-2,44	1,73	-1,50	3,88	-2,75

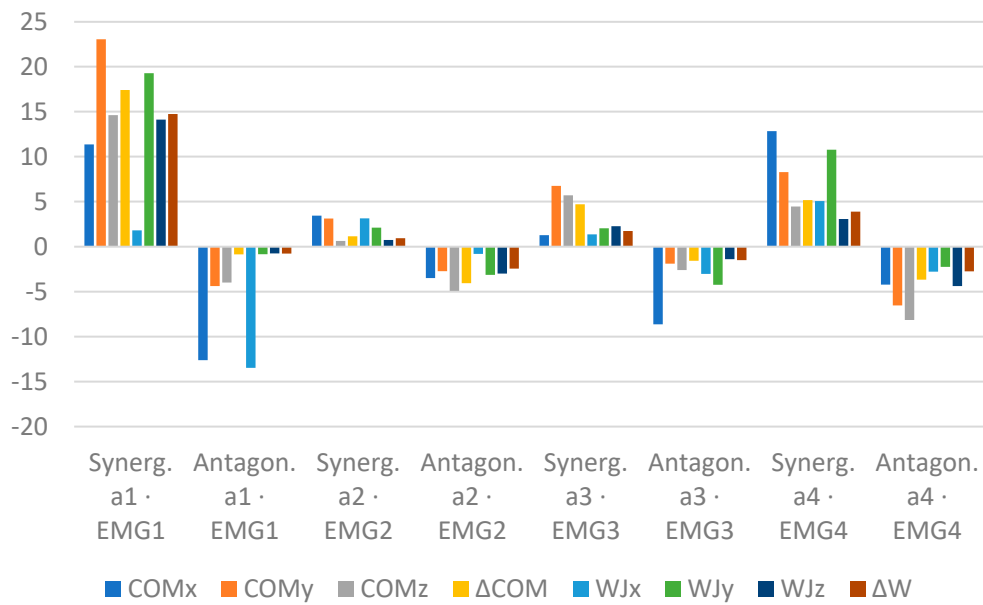


Figure S74. DMD patient. Motion 2. Passive manipulator conditions.