

Supplementary Material**Supplementary Table 01:** Demographics data of SCA1 patients and age, sex and site matched control group per site.

Controls						
	Age (years)	Sex		CAG repeat length	SARA	Time from Ataxia Onset (years)
		Male	Female			
Campinas	45.5±9.3	21	10	-	-	-
Essen	46.8±11.5	5	10	-	-	-
Minnesota	55.1±17.3	4	4	-	-	-
Paris	47.2±12.3	7	5	-	-	-
Tubingen	27.8±11.1	2	2	-	-	-
Patients						
	Age (years)	Sex		CAG repeat length	SARA	Time from Ataxia Onset (years)
		Male	Female			
Campinas	45.3±9.3	20	10	44.4±4.2	14.5±6.3	7.5±6.1
Essen	47.4±11.7	6	10	46.3±5.0	14.0±5.8	9.4±4.2
Minnesota	51.0±10.6	3	7	43.8±2.8	6.2±5.2	10.3±6.4
Paris	42.8±15.3	9	6	47.1±6.6	10.7±6.3	6.6±6.1
Tubingen	27.0±10.4	2	2	47.5±4.5	0.9±1.2	1.0±2.0

Supplementary Table 02: Demographics data of SCA2 patients and age, sex and site matched control group per site.

Controls						
	Age (years)	Sex		CAG repeat length	SARA	Time from Ataxia Onset (years)
		Male	Female			
Campinas	40.5±20.0	6	6	-	-	-
Milan	31.3±4.6	6	4	-	-	-
Curitiba	42.6±11.9	13	15	-	-	-
Essen	51.5±9.4	8	4	-	-	-
Mexico	41.6±14.0	7	9	-	-	-
Minnesota	55.1±17.3	4	4	-	-	-
Paris	42.3±11.4	5	5	-	-	-
Tubingen	33.8±8.5	2	2	-	-	-
Patients						
	Age (years)	Sex		CAG repeat length	SARA	Time from Ataxia Onset (years)
		Male	Female			
Campinas	41.1±18.8	8	6	45.9±10.5	18.7±13.2	8.8±5.7
Milan	46.6±9.1	1	9	41.2±3.1	13.4±6.4	11.8±4.7
Curitiba	45.2±11.6	8	9	41.7±2.9	14.5±6.1	11.5±5.2
Essen	52.1±9.8	10	4	39.8±2.1	11.7±10.8	10.8±7.8
Mexico	38.7±13.2	9	12	43.4±3.7	17.4±7.7	-
Minnesota	42.1±15.3	4	4	39.3±2.7	9.3±5.1	11.1±8.2
Paris	45.0±12.8	7	5	39.6±2.9	12.6±6.0	9.8±6.1
Tubingen	33.8±9.6	2	2	36.0±2.8	1.4±1.1	0.0±0.0

Supplementary Table 03: Demographics data of SCA3 patients and age, sex and site matched control group per site.

Controls						
	Age (years)	Sex		CAG repeat length	SARA	Time from Ataxia Onset (years)
		Male	Female			
Campinas	47.6±11.6	42	44	-	-	-
Curitiba	45.0±11.7	11	8	-	-	-
Essen	51.5±9.5	8	4	-	-	-
Mexico	43.7±12.8	5	7	-	-	-
Minnesota	55.1±17.3	4	4	-	-	-
Nijmegen	31.3±8.2	6	2	-	-	-
Paris	49.8±12.8	11	13	-	-	-
Tubingen	37.9±8.5	5	4	-	-	-
Patients						
	Age (years)	Sex		CAG repeat length	SARA	Time from Ataxia Onset (years)
		Male	Female			
Campinas	48.6±12.	39	46	71.8±3.5	13.3±8.6	10.2±6.4
Curitiba	46.1±12.5	11	8	-	14.1±5.6	11.9±7.5
Essen	53.0±13.7	13	11	68.4±4.1	12.0±8.1	14.5±7.4
Mexico	41.0±13.0	6	8	74.3±3.4	12.1±7.4	-
Minnesota	49.3±5.8	5	2	70.7±2.2	7.4±2.5	8.3±5.4
Nijmegen	37.4±9.6	9	8	66.8±2.9	1.5±1.0	0.0±0.0
Paris	51.6±12.3	7	10	68.3±5.8	12.2±7.5	8.0±4.6
Tubingen	40.4±8.3	6	3	67.6±2.4	3.3±4.0	2.0±4.4

Supplementary Table 04: Demographics data of SCA6 patients and age, sex and site matched control group per site.

Controls						
	Age (years)	Sex		CAG repeat length	SARA	Time from Ataxia Onset (years)
		Male	Female			
Campinas	64.8±5.3	9	5	-	-	-
Essen	60.4±12.5	15	9	-	-	-
Minnesota	55.1±17.3	4	4	-	-	-
Tubingen	56.3±9.1	3	0	-	-	-
Patients						
	Age (years)	Sex		CAG repeat length	SARA	Time from Ataxia Onset (years)
		Male	Female			
Campinas	67.9±7.9	10	7	-	13.9±6.3	14.1±7.0
Essen	61.6±10.9	15	10	22.4±1.3	13.3±7.0	11.3±6.3
Minnesota	65.8±8.3	2	6	22.4±1.5	13.1±8.1	13.4±6.7
Tubingen	55.7±7.5	3	0	21.7±0.6	1.3±1.3	2.7±4.6

Supplementary Table 05: Demographics data for all preataxic subjects.

		Average Age, y (range)	Sex, n (Male/Female)	CAG repeat length, long allele	Average SARA (range)	Average Time to Ataxia Onset, y (range)
SCA1	Controls (9)	35.8±13.0 (19-56)	3/6	-	-	-
	Patients (11)	35.4±12.3 (18-56)	3/8	44.9±3.7 (40-54)	0.8±0.9 (0-2.5)	-4.7±10.0 (-16.1-6.7)
SCA2	Controls (14)	34.2±9.4 (23-56)	8/6	-	-	-
	Patients (9)	32.7±8.9 (23-48)	4/5	37.8±3.0 (32-42)	1.2±0.9 (0-2.5)	-3.3±5.1 (-9.2-4.5)
SCA3	Controls (24)	38.2±9.8 (21-54)	12/12	-	-	-
	Patients (36)	39.0±9.1 (24-61)	15/21	70.3±4.3 (61-72)	11.3±8.2 (0-2.7)	-9.2±2.3 (-30.0-8.4)

Supplementary Table 06: Scanner and imaging acquisition details for each site.

	Site								
	Campinas	Milan	Curitiba	Essen	México	Minnesota	Nijmegen	Paris	Tubingen
Scanner	Philips Achieva	Philips Achieva	Siemens Skyra	Siemens Biograph	Philips Achieva	Siemens Trio and Prisma	Siemens Trio	Siemens Trio and Prisma	Siemens Trio
Field strength (T)	3	3	3	3	3	3	3	3	3
Head coil (channels)	8	32	16	16	32	32 (Trio) 64 (Prisma)	32	32 (Trio) 64 (Prisma)	32
Sequence	SPGR	SPGR	MPRAGE	MPRAGE	SPGR	MPRAGE	MPRAGE	MPRAGE	MPRAGE
TR (ms)	7	8	2530	2530	8	2530	2300	2530	2300
TE (ms)	3.201	3.5	3.36	3.26	3.7	3.65	3.03	3.65	3.51
TI (ms)	-	-	1100	1100	-	1100	1100	900	900
Flip (deg)	8	8	7	7		7	8	9	9
Plane	Sagittal	Sagittal	Sagittal	Sagittal	Sagittal	Coronal	Sagittal	Sagittal	Sagittal
Slices	180	160	176	176	160	224	192	160	176
FOV (mm x mm)	240x240	256x256	256 x 256	256x256	256x256	256x176	256x256	256x256	256x240
Voxel Size (mm, x y z)	1x1x1	1x1x1	1x1x1	1x1x1	1x1x1	1x1x1	1x1x1	1x1x1	1x1x1

Supplementary Table 07: Group differences between patients with SCA1 vs age, sex and site matched nonataxic control group.

CSA (mm²)				
Structures	Healthy Controls (mean±SD)	SCA1 (mean±SD)	p-value (Bonferroni)	Effect Size
C1	65.6 ± 7.6	49.6 ± 8.1	<0.001	2.0
C2	63.6 ± 8.0	48.6 ± 7.2	<0.001	2.0
C3	62.7 ± 7.9	47.8 ± 7.1	<0.001	2.0
C4	63.7 ± 8.2	47.8 ± 8.3	<0.001	1.9
Eccentricity				
Structures	Healthy Controls (mean±SD)	SCA1 (mean±SD)	p-value (Bonferroni)	Effect Size
C1	0.693 ± 0.061	0.733 ± 0.069	0.002	0.6
C2	0.742 ± 0.051	0.777 ± 0.052	<0.001	0.7
C3	0.792 ± 0.044	0.824 ± 0.038	<0.001	0.8
C4	0.825 ± 0.037	0.857 ± 0.030	<0.001	0.9

Supplementary Table 08: Group differences between patients with SCA2 vs age, sex and site matched nonataxic control group.

CSA (mm ²)				
Structures	Healthy Controls (mean±SD)	SCA2 (mean±SD)	p-value (Bonferroni)	Effect Size
C1	67.4 ± 8.8	49.6 ± 8.2	<0.001	2.1
C2	65.3 ± 8.2	48.0 ± 7.9	<0.001	2.1
C3	63.9 ± 8.4	47.4 ± 8.3	<0.001	2.0
C4	63.8 ± 8.5	47.9 ± 8.8	<0.001	1.8
Eccentricity				
Structures	Healthy Controls (mean±SD)	SCA2 (mean±SD)	p-value (Bonferroni)	Effect Size
C1	0.692 ± 0.079	0.743 ± 0.070	<0.001	0.7
C2	0.731 ± 0.059	0.784 ± 0.049	<0.001	0.9
C3	0.781 ± 0.051	0.818 ± 0.050	<0.001	0.7
C4	0.825 ± 0.042	0.849 ± 0.042	0.004	0.6

Supplementary Table 09: Group differences between patients with SCA3 vs age, sex and site matched nonataxic control group.

CSA (mm ²)				
Structures	Healthy Controls (mean±SD)	SCA3 (mean±SD)	p-value (Bonferroni)	Effect Size
C1	65.8 ± 7.9	50.3 ± 7.8	<0.001	2.0
C2	64.0 ± 7.5	49.3 ± 7.6	<0.001	2.0
C3	63.2 ± 7.6	48.6 ± 8.1	<0.001	1.9
C4	63.8 ± 7.9	49.9 ± 8.4	<0.001	1.7
Eccentricity				
Structures	Healthy Controls (mean±SD)	SCA3 (mean±SD)	p-value (Bonferroni)	Effect Size
C1	0.684 ± 0.073	0.728 ± 0.074	<0.001	0.6
C2	0.730 ± 0.058	0.765 ± 0.056	<0.001	0.6
C3	0.783 ± 0.050	0.809 ± 0.050	<0.001	0.5
C4	0.828 ± 0.040	0.844 ± 0.040	0.003	0.4

Supplementary Table 10: Group differences between patients with SCA6 vs age, sex and site matched nonataxic control group.

CSA (mm ²)				
Structures	Healthy Controls (mean±SD)	SCA6 (mean±SD)	p-value (Bonferroni)	Effect Size
C1	66.7 ± 10.3	63.0 ± 8.2	0.353	0.3
C2	65.1 ± 8.8	62.4 ± 8.8	0.757	0.3
C3	64.0 ± 9.1	60.7 ± 8.3	0.297	0.3
C4	65.1 ± 9.3	61.5 ± 8.9	0.451	0.3
Eccentricity				
Structures	Healthy Controls (mean±SD)	SCA6 (mean±SD)	p-value (Bonferroni)	Effect Size
C1	0.725 ± 0.058	0.728 ± 0.056	0.999	0.1
C2	0.761 ± 0.047	0.757 ± 0.046	0.999	0.1
C3	0.810 ± 0.039	0.798 ± 0.041	0.503	0.3
C4	0.837 ± 0.034	0.836 ± 0.029	0.999	0.1

Supplementary Table 11: Results of ROI-based analyses to assess spinal cord damage at each stage of SCA1. Subgroups based on disease duration, <5: Time from ataxia onset <5 years, 5-10: Time from ataxia onset between 5-10 years, 10-15: Time from ataxia onset between 10-15 years, 15>: Time from ataxia onset >15 years. Preataxic subjects present SARA score <3 during clinical and MRI assessment (Jacobi et al, 2013).

Vertebral Labels	Subgroup	Measures	Controls (mean±SD)	SCA1 (mean±SD)	p-value (Bonferroni)	Effect Size	
C1	Preataxic	Area (mm ²)	63.8 ± 8.1	57.9 ± 6.2	0.362	0.8	
		ECC	0.696 ± 0.064	0.719 ± 0.070	0.999	0.3	
	<5 years	Area (mm ²)	65.5 ± 5.5	51.2 ± 6.5	<0.001	2.3	
		ECC	0.673 ± 0.054	0.742 ± 0.068	0.036	1.1	
	5-10 years	Area (mm ²)	66.2 ± 7.8	48.3 ± 8.0	<0.001	2.3	
		ECC	0.693 ± 0.061	0.729 ± 0.078	0.333	0.5	
	10-15 years	Area (mm ²)	63.7 ± 4.8	46.8 ± 7.2	<0.001	2.7	
		ECC	0.689 ± 0.045	0.767 ± 0.047	0.010	1.7	
	15> years	Area (mm ²)	66.8 ± 8.2	46.7 ± 5.5	<0.001	2.9	
		ECC	0.728 ± 0.051	0.732 ± 0.043	0.999	0.1	
	C2	Preataxic	Area (mm ²)	62.5 ± 8.7	56.6 ± 5.2	0.346	0.8
			ECC	0.737 ± 0.059	0.778 ± 0.025	0.250	0.9
<5 years		Area (mm ²)	64.3 ± 7.6	49.1 ± 5.6	<0.001	2.3	
		ECC	0.737 ± 0.042	0.775 ± 0.067	0.465	0.6	
5-10 years		Area (mm ²)	63.6 ± 7.7	47.4 ± 7.2	<0.001	2.2	
		ECC	0.748 ± 0.053	0.774 ± 0.053	0.340	0.5	
10-15 years		Area (mm ²)	60.9 ± 5.7	46.4 ± 6.0	<0.001	2.5	
		ECC	0.733 ± 0.050	0.799 ± 0.043	0.034	1.4	
15> years		Area (mm ²)	65.4 ± 7.6	46.9 ± 5.4	<0.001	2.8	
		ECC	0.756 ± 0.038	0.781 ± 0.028	0.442	0.8	
C3		Preataxic	Area (mm ²)	62.8 ± 8.8	56.1 ± 6.2	0.282	0.9
			ECC	0.764 ± 0.056	0.811 ± 0.023	0.103	1.1

	<5 years	Area (mm ²)	63.5 ± 6.4	47.7 ± 5.6	<0.001	2.6	
		ECC	0.787 ± 0.038	0.823 ± 0.048	0.143	0.9	
	5-10 years	Area (mm ²)	62.7 ± 8.4	46.2 ± 6.8	<0.001	2.2	
		ECC	0.803 ± 0.042	0.825 ± 0.033	0.204	0.6	
	10-15 years	Area (mm ²)	59.8 ± 6.4	46.5 ± 6.0	0.001	2.2	
		ECC	0.786 ± 0.039	0.839 ± 0.024	0.011	1.7	
	15> years	Area (mm ²)	62.8 ± 7.0	46.2 ± 6.1	<0.001	2.5	
		ECC	0.800 ± 0.026	0.838 ± 0.034	0.067	1.2	
	C4	Preataxic	Area (mm ²)	66.1 ± 8.7	56.9 ± 6.4	0.204	1.2
			ECC	0.798 ± 0.022	0.832 ± 0.032	0.181	1.3
		<5 years	Area (mm ²)	63.9 ± 6.7	48.0 ± 6.8	<0.001	2.3
			ECC	0.814 ± 0.032	0.861 ± 0.030	0.001	1.5
5-10 years		Area (mm ²)	66.2 ± 8.1	46.8 ± 7.7	<0.001	2.5	
		ECC	0.829 ± 0.040	0.860 ± 0.028	0.038	0.9	
10-15 years		Area (mm ²)	59.7 ± 5.9	45.2 ± 9.5	0.014	1.8	
		ECC	0.837 ± 0.034	0.866 ± 0.027	0.314	1.0	
15> years		Area (mm ²)	58.3 ± 7.3	46.4 ± 9.1	0.034	1.4	
		ECC	0.842 ± 0.031	0.859 ± 0.020	0.787	0.6	

Supplementary Table 12: Results of ROI-based analyses to assess spinal cord damage at each stage of SCA2. Subgroups based on disease duration, <5: Time from ataxia onset <5 years, 5-10: Time from ataxia onset between 5-10 years, 10-15: Time from ataxia onset between 10-15 years, 15>: Time from ataxia onset >15 years. Preataxic subjects present SARA score <3 during clinical and MRI assessment (Jacobi et al, 2013).

Vertebral Labels	Subgroup	Measures	Controls (mean±SD)	SCA2 (mean±SD)	p-value (Bonferroni)	Effect Size	
C1	Preataxic	Area (mm ²)	65.7 ± 5.9	56.7 ± 5.9	0.003	1.6	
		ECC	0.647 ± 0.090	0.708 ± 0.080	0.350	0.7	
	<5 years	Area (mm ²)	65.7 ± 6.8	51.4 ± 7.3	0.001	2.0	
		ECC	0.651 ± 0.066	0.725 ± 0.054	0.046	1.2	
	5-10 years	Area (mm ²)	68.7 ± 9.3	51.4 ± 8.6	<0.001	2.4	
		ECC	0.712 ± 0.085	0.763 ± 0.054	0.464	0.8	
	10-15 years	Area (mm ²)	68.5 ± 10.3	48.0 ± 7.8	<0.001	2.4	
		ECC	0.702 ± 0.068	0.729 ± 0.082	0.999	0.4	
	15> years	Area (mm ²)	63.3 ± 8.4	46.7 ± 7.6	<0.001	2.2	
		ECC	0.711 ± 0.076	0.780 ± 0.048	0.013	1.2	
	C2	Preataxic	Area (mm ²)	63.5 ± 6.9	53.1 ± 5.9	0.001	1.6
			ECC	0.690 ± 0.058	0.757 ± 0.065	0.046	1.1
<5 years		Area (mm ²)	63.5 ± 7.6	49.5 ± 7.1	0.001	1.9	
		ECC	0.704 ± 0.052	0.775 ± 0.039	0.009	1.6	
5-10 years		Area (mm ²)	65.8 ± 8.0	50.0 ± 7.9	<0.001	2.3	
		ECC	0.767 ± 0.044	0.802 ± 0.045	0.350	0.8	
10-15 years		Area (mm ²)	67.2 ± 8.9	47.1 ± 8.6	<0.001	2.4	
		ECC	0.741 ± 0.049	0.779 ± 0.047	0.062	0.8	
15> years		Area (mm ²)	61.7 ± 8.8	45.7 ± 8.0	<0.001	2.0	
		ECC	0.737 ± 0.078	0.807 ± 0.029	0.003	1.4	
C3		Preataxic	Area (mm ²)	62.6 ± 7.2	52.3 ± 8.2	0.001	1.4
			ECC	0.752 ± 0.063	0.773 ± 0.075	0.999	0.3

	<5 years	Area (mm ²)	63.1 ± 8.0	50.1 ± 6.6	0.003	1.8	
		ECC	0.753 ± 0.051	0.804 ± 0.026	0.036	1.3	
	5-10 years	Area (mm ²)	64.7 ± 8.4	49.0 ± 7.7	<0.001	2.2	
		ECC	0.815 ± 0.026	0.838 ± 0.039	0.634	0.6	
	10-15 years	Area (mm ²)	65.1 ± 9.4	46.0 ± 8.4	<0.001	2.2	
		ECC	0.793 ± 0.042	0.822 ± 0.037	0.129	0.8	
	15> years	Area (mm ²)	59.5 ± 8.3	45.3 ± 8.8	0.001	1.7	
		ECC	0.798 ± 0.042	0.841 ± 0.023	0.006	1.3	
	C4	Preataxic	Area (mm ²)	64.6 ± 8.6	49.4 ± 7.8	0.056	1.8
			ECC	0.814 ± 0.057	0.810 ± 0.055	0.999	0.1
<5 years		Area (mm ²)	62.6 ± 8.1	51.3 ± 6.4	0.008	1.6	
		ECC	0.801 ± 0.053	0.847 ± 0.023	0.064	1.2	
5-10 years		Area (mm ²)	65.4 ± 7.0	49.9 ± 8.9	<0.001	2.0	
		ECC	0.842 ± 0.028	0.860 ± 0.035	0.999	0.5	
10-15 years		Area (mm ²)	64.1 ± 9.0	45.7 ± 9.6	<0.001	2.1	
		ECC	0.837 ± 0.029	0.861 ± 0.031	0.187	0.8	
15> years		Area (mm ²)	59.5 ± 8.8	47.0 ± 10.2	0.053	1.3	
		ECC	0.820 ± 0.034	0.862 ± 0.026	0.017	1.4	

Supplementary Table 13: Results of ROI-based analyses to assess spinal cord damage at each stage of SCA3. Subgroups based on disease duration, <5: Time from ataxia onset <5 years, 5-10: Time from ataxia onset between 5-10 years, 10-15: Time from ataxia onset between 10-15 years, 15>: Time from ataxia onset >15 years. Preataxic subjects present SARA score <3 during clinical and MRI assessment (Jacobi et al, 2013).

Vertebral Labels	Subgroup	Measures	Controls (mean±SD)	SCA3 (mean±SD)	p-value (Bonferroni)	Effect Size	
C1	Preataxic	Area (mm ²)	65.6 ± 6.6	56.6 ± 5.5	<0.001	1.7	
		ECC	0.673 ± 0.085	0.703 ± 0.079	0.742	0.4	
	<5 years	Area (mm ²)	65.3 ± 8.1	53.2 ± 6.7	<0.001	2.0	
		ECC	0.689 ± 0.080	0.726 ± 0.049	0.433	0.6	
	5-10 years	Area (mm ²)	65.8 ± 7.5	49.8 ± 8.3	<0.001	2.1	
		ECC	0.684 ± 0.065	0.727 ± 0.080	0.030	0.6	
	10-15 years	Area (mm ²)	65.5 ± 8.1	48.6 ± 6.6	<0.001	2.1	
		ECC	0.683 ± 0.062	0.719 ± 0.071	0.089	0.5	
	15> years	Area (mm ²)	66.6 ± 9.2	45.9 ± 7.8	<0.001	2.4	
		ECC	0.704 ± 0.067	0.766 ± 0.049	<0.001	1.1	
	C2	Preataxic	Area (mm ²)	65.2 ± 7.0	55.6 ± 4.9	<0.001	1.7
			ECC	0.723 ± 0.066	0.757 ± 0.051	0.166	0.6
<5 years		Area (mm ²)	64.2 ± 7.8	51.9 ± 6.5	<0.001	2.0	
		ECC	0.731 ± 0.074	0.764 ± 0.045	0.440	0.5	
5-10 years		Area (mm ²)	63.4 ± 6.8	48.5 ± 7.8	<0.001	2.1	
		ECC	0.729 ± 0.054	0.766 ± 0.059	0.019	0.6	
10-15 years		Area (mm ²)	63.1 ± 7.7	47.7 ± 7.2	<0.001	2.0	
		ECC	0.734 ± 0.048	0.755 ± 0.060	0.362	0.4	
15> years		Area (mm ²)	64.6 ± 8.2	45.0 ± 7.5	<0.001	2.5	
		ECC	0.743 ± 0.057	0.788 ± 0.051	0.002	0.9	
C3		Preataxic	Area (mm ²)	64.7 ± 7.4	55.7 ± 4.8	<0.001	1.6
			ECC	0.787 ± 0.045	0.803 ± 0.040	0.897	0.4

	<5 years	Area (mm ²)	62.3 ± 7.3	51.1 ± 7.1	<0.001	1.8	
		ECC	0.779 ± 0.062	0.805 ± 0.041	0.557	0.5	
	5-10 years	Area (mm ²)	62.7 ± 6.9	48.1 ± 7.9	<0.001	2.0	
		ECC	0.780 ± 0.048	0.811 ± 0.047	0.025	0.6	
	10-15 years	Area (mm ²)	61.9 ± 7.7	46.9 ± 7.4	<0.001	1.9	
		ECC	0.790 ± 0.045	0.809 ± 0.051	0.398	0.4	
	15> years	Area (mm ²)	64.0 ± 8.0	43.7 ± 8.3	<0.001	2.5	
		ECC	0.793 ± 0.045	0.826 ± 0.047	0.019	0.7	
	C4	Preataxic	Area (mm ²)	65.2 ± 8.6	56.9 ± 5.3	0.001	1.3
			ECC	0.826 ± 0.035	0.836 ± 0.037	0.999	0.3
<5 years		Area (mm ²)	62.5 ± 6.1	51.7 ± 7.6	<0.001	1.6	
		ECC	0.827 ± 0.047	0.841 ± 0.031	0.999	0.4	
5-10 years		Area (mm ²)	63.7 ± 7.2	49.0 ± 8.8	<0.001	1.8	
		ECC	0.823 ± 0.039	0.853 ± 0.045	0.025	0.7	
10-15 years		Area (mm ²)	63.2 ± 8.7	49.2 ± 7.7	<0.001	1.6	
		ECC	0.833 ± 0.040	0.842 ± 0.036	0.999	0.2	
15> years		Area (mm ²)	64.1 ± 8.0	45.2 ± 8.4	<0.001	2.3	
		ECC	0.840 ± 0.032	0.854 ± 0.038	0.568	0.4	

Supplementary Table 14: Correlations between ataxia severity (SARA score) and CSA or eccentricity for individuals with SCA1, SCA2, SCA3 and SCA6.

CSA (mm ²)								
	SCA1		SCA2		SCA3		SCA6	
	R	p-value	R	p-value	R	p-value	R	p-value
C1	-0.620	<0.001	-0.614	<0.001	-0.424	<0.001	0.064	0.999
C2	-0.612	<0.001	-0.543	<0.001	-0.434	<0.001	0.021	0.999
C3	-0.618	<0.001	-0.504	<0.001	-0.509	<0.001	-0.035	0.999
C4	-0.618	<0.001	-0.413	<0.001	-0.524	<0.001	-0.054	0.999
Eccentricity								
	SCA1		SCA2		SCA3		SCA6	
	R	p-value	R	p-value	R	p-value	R	p-value
C1	0.229	0.212	0.277	0.024	0.141	0.210	0.064	0.999
C2	0.173	0.581	0.228	0.099	0.118	0.426	0.021	0.999
C3	0.223	0.241	0.335	0.004	0.126	0.352	-0.035	0.999
C4	0.424	0.002	0.167	0.622	0.129	0.438	-0.054	0.999

Supplementary Table 15: Correlations between time from ataxia onset and CSA or eccentricity for individuals with SCA1, SCA2, SCA3 and SCA6.

CSA (mm ²)								
	SCA1		SCA2		SCA3		SCA6	
	R	p-value	R	p-value	R	p-value	R	p-value
C1	-0.205	0.381	-0.310	0.021	-0.219	0.015	0.119	0.999
C2	-0.153	0.868	-0.238	0.133	-0.209	0.022	0.144	0.999
C3	-0.154	0.852	-0.180	0.462	-0.313	<0.001	0.093	0.999
C4	-0.173	0.712	-0.144	0.999	-0.238	0.016	0.166	0.999
Eccentricity								
	SCA1		SCA2		SCA3		SCA6	
	R	p-value	R	p-value	R	p-value	R	p-value
C1	0.171	0.668	0.288	0.038	0.118	0.479	0.119	0.999
C2	0.198	0.430	0.239	0.131	0.051	0.999	0.144	0.999
C3	0.152	0.874	0.267	0.072	0.017	0.999	0.093	0.999
C4	0.107	0.999	0.159	0.826	-0.015	0.999	0.166	0.999

Supplementary Table 16: Results of ROI-based analyses to assess progressive spinal cord damage at each stage of SCA1 relative to the preataxic cohort.

CSA (mm ²)								
	<5 years		5-10 years		10-15 years		15> years	
	p-value	ES	p-value	ES	p-value	ES	p-value	ES
C1	0.023	1.0	0.001	1.3	0.001	1.3	<0.001	1.9
C2	0.008	1.3	<0.001	1.4	0.019	0.9	0.001	1.8
C3	0.010	1.4	0.001	1.5	0.032	0.8	0.002	1.6
C4	0.013	1.3	0.005	1.4	0.245	0.5	0.019	1.3
Eccentricity								
	<5 years		5-10 years		10-15 years		15> years	
	p-value	ES	p-value	ES	p-value	ES	p-value	ES
C1	0.598	0.3	0.661	0.1	0.449	0.3	0.621	0.2
C2	0.598	0.1	0.742	0.1	0.265	0.4	0.791	0.1
C3	0.268	0.3	0.134	0.4	0.011	1.0	0.058	0.9
C4	0.045	0.9	0.059	1.0	0.006	1.3	0.053	1.0

Supplementary Table 17: Results of ROI-based analyses to assess progressive spinal cord damage at each stage of SCA2 relative to the preataxic cohort.

CSA (mm ²)								
	<5 years		5-10 years		10-15 years		15> years	
	p-value	ES	p-value	ES	p-value	ES	p-value	ES
C1	0.058	0.8	0.029	0.8	0.001	1.3	0.001	1.3
C2	0.177	0.6	0.171	0.5	0.019	0.9	0.012	1.0
C3	0.402	0.4	0.166	0.5	0.032	0.8	0.024	0.9
C4	0.638	0.2	0.968	0.0	0.245	0.5	0.489	0.3
Eccentricity								
	<5 years		5-10 years		10-15 years		15> years	
	p-value	ES	p-value	ES	p-value	ES	p-value	ES
C1	0.557	0.2	0.029	0.8	0.449	0.3	0.005	1.1
C2	0.448	0.3	0.033	0.8	0.265	0.4	0.011	1.0
C3	0.176	0.6	0.003	1.2	0.011	1.0	0.001	1.4
C4	0.043	1.0	0.007	1.3	0.006	1.3	0.004	1.4

Supplementary Table 18: Results of ROI-based analyses to assess progressive spinal cord damage at each stage of SCA3 relative to the preataxic cohort.

CSA (mm ²)								
	<5 years		5-10 years		10-15 years		15> years	
	p-value	ES	p-value	ES	p-value	ES	p-value	ES
C1	0.010	0.7	<0.001	1.1	<0.001	1.3	<0.001	1.7
C2	0.006	0.8	<0.001	1.1	<0.001	1.3	<0.001	1.7
C3	0.002	0.9	<0.001	1.2	<0.001	1.4	<0.001	1.8
C4	0.008	0.8	<0.001	1.0	<0.001	1.1	<0.001	1.6
Eccentricity								
	<5 years		5-10 years		10-15 years		15> years	
	p-value	ES	p-value	ES	p-value	ES	p-value	ES
C1	0.243	0.3	0.180	0.3	0.362	0.2	<0.001	1.0
C2	0.630	0.1	0.481	0.2	0.906	<0.1	0.011	0.6
C3	0.801	0.1	0.408	0.2	0.557	0.1	0.021	0.5
C4	0.647	0.1	0.108	0.4	0.564	0.2	0.076	0.5

Supplementary Table 19: Results of ROI-based analyses to assess spinal cord damage at each stage of SCA6. Subgroups based on disease duration, <5: Time from ataxia onset <5 years, 5-10: Time from ataxia onset between 5-10 years, 10-15: Time from ataxia onset between 10-15 years, 15>: Time from ataxia onset >15 years.

Vertebral Labels	Subgroup	Measures	Controls (mean±SD)	SCA3 (mean±SD)	p-value (Bonferroni)	Effect Size	
C1	Preataxic	Area (mm ²)	-	-	-	-	
		ECC	-	-	-	-	
	<5 years	Area (mm ²)	66.6 ± 5.0	62.5 ± 7.5	0.859	0.6	
		ECC	0.744 ± 0.068	0.705 ± 0.043	0.711	0.7	
	5-10 years	Area (mm ²)	62.7 ± 8.1	65.1 ± 8.8	0.667	0.3	
		ECC	0.731 ± 0.064	0.758 ± 0.035	0.747	0.5	
	10-15 years	Area (mm ²)	64.7 ± 7.9	61.2 ± 8.7	0.999	0.4	
		ECC	0.726 ± 0.037	0.724 ± 0.076	0.999	<0.1	
	15> years	Area (mm ²)	69.3 ± 10.5	64.5 ± 8.3	0.743	0.5	
		ECC	0.712 ± 0.060	0.713 ± 0.047	0.999	<0.1	
	C2	Preataxic	Area (mm ²)	-	-	-	-
			ECC	-	-	-	-
<5 years		Area (mm ²)	63.5 ± 5.0	62.6 ± 5.5	0.999	0.2	
		ECC	0.768 ± 0.044	0.739 ± 0.027	0.481	0.8	
5-10 years		Area (mm ²)	60.9 ± 7.4	65.3 ± 7.8	0.667	0.6	
		ECC	0.773 ± 0.046	0.774 ± 0.042	0.999	<0.1	
10-15 years		Area (mm ²)	63.8 ± 6.7	59.8 ± 7.3	0.768	0.6	
		ECC	0.750 ± 0.038	0.768 ± 0.056	0.999	0.4	
15> years		Area (mm ²)	69.1 ± 6.4	64.3 ± 9.7	0.565	0.6	
		ECC	0.758 ± 0.043	0.737 ± 0.033	0.645	0.5	
C3		Preataxic	Area (mm ²)	-	-	-	-
			ECC	-	-	-	-
	<5 years	Area (mm ²)	62.1 ± 6.4	62.1 ± 8.7	0.999	<0.1	

		ECC	0.809 ± 0.033	0.778 ± 0.034	0.353	0.9
	5-10 years	Area (mm ²)	61.7 ± 6.9	62.8 ± 8.1	0.999	0.2
		ECC	0.814 ± 0.034	0.816 ± 0.025	0.999	0.1
	10-15 years	Area (mm ²)	62.3 ± 8.4	58.9 ± 6.2	0.999	0.5
		ECC	0.816 ± 0.037	0.800 ± 0.059	0.999	0.3
	15> years	Area (mm ²)	66.7 ± 7.5	62.4 ± 9.0	0.760	0.5
		ECC	0.809 ± 0.035	0.789 ± 0.031	0.514	0.6
C4	Preataxic	Area (mm ²)	-	-	-	-
		ECC	-	-	-	-
	<5 years	Area (mm ²)	67.1 ± 6.6	57.6 ± 4.2	0.134	1.8
		ECC	0.837 ± 0.053	0.845 ± 0.024	0.999	0.2
	5-10 years	Area (mm ²)	60.0 ± 9.6	62.9 ± 9.8	0.999	0.3
		ECC	0.839 ± 0.026	0.844 ± 0.031	0.999	0.2
	10-15 years	Area (mm ²)	63.4 ± 9.2	61.7 ± 9.2	0.999	0.2
		ECC	0.847 ± 0.024	0.832 ± 0.031	0.938	0.6
	15> years	Area (mm ²)	67.3 ± 8.7	62.7 ± 8.7	0.853	0.5
		ECC	0.839 ± 0.027	0.826 ± 0.028	0.999	0.5

Supplementary Table 20: Results of ROI-based analyses to assess progressive spinal cord damage at each stage of SCA6 relative to the cohort with time from ataxia onset <5 years.

CSA (mm ²)								
	<5 years		5-10 years		10-15 years		15> years	
	p-value	ES	p-value	ES	p-value	ES	p-value	ES
C1	-	-	0.538	0.3	0.966	0.2	0.425	0.1
C2	-	-	0.389	0.4	0.808	0.4	0.331	0.1
C3	-	-	0.722	0.1	0.692	0.5	0.419	0.1
C4	-	-	0.166	0.5	0.303	0.4	0.206	0.5
Eccentricity								
	<5 years		5-10 years		10-15 years		15> years	
	p-value	ES	p-value	ES	p-value	ES	p-value	ES
C1	-	-	0.010	1.4	0.416	0.3	0.231	0.2
C2	-	-	0.053	0.9	0.216	0.6	0.531	0.1
C3	-	-	0.008	1.3	0.443	0.4	0.414	0.3
C4	-	-	0.875	0.1	0.591	0.5	0.446	0.8

Supplementary Table 21: Comparison of coefficients between linear and quadratic models for the graph of z-transformed CSA/eccentricity versus time from ataxia onset of the SCA1 cohort.

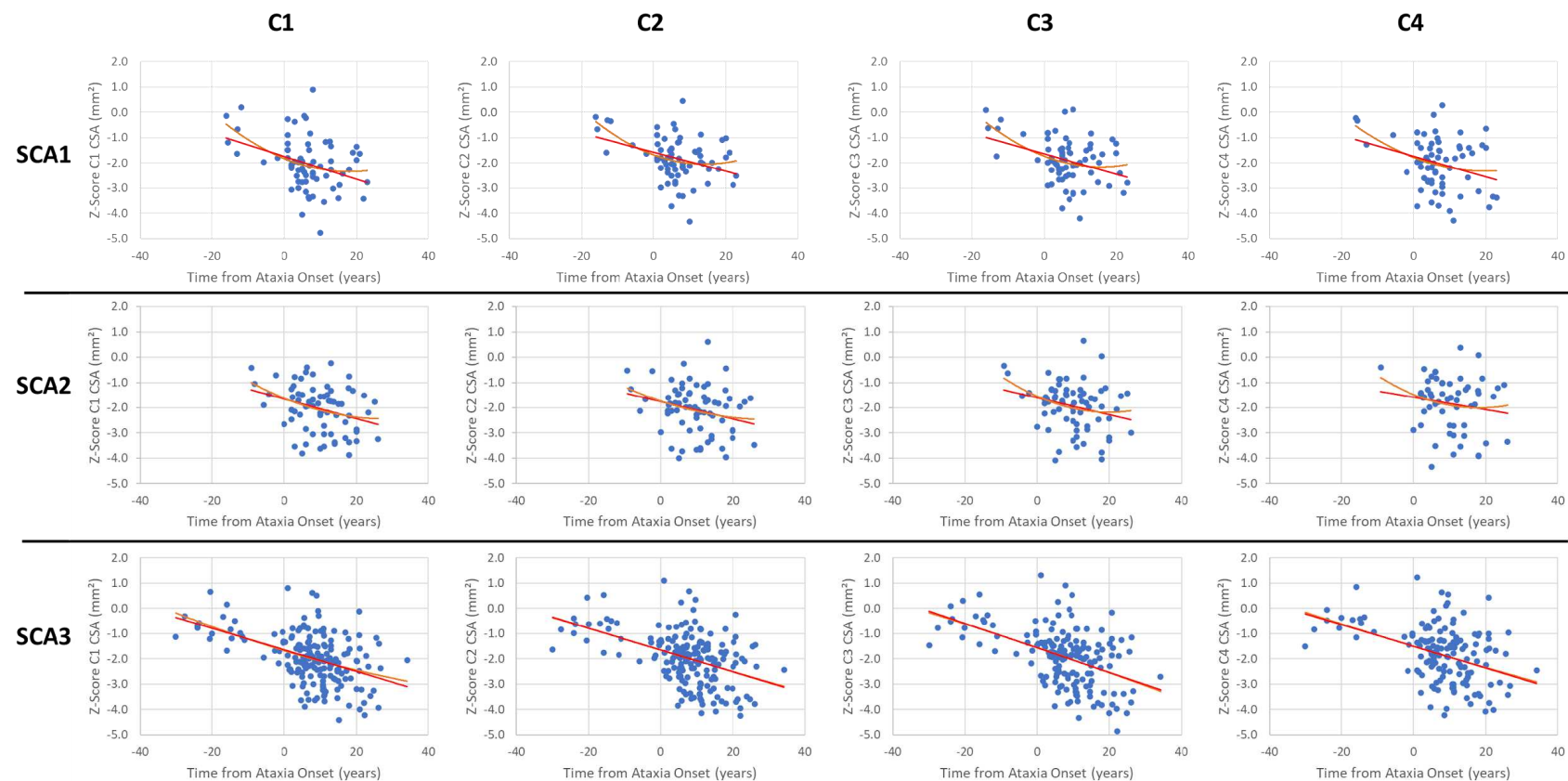
CSA (mm ²)								
Vertebral Level	Model	RMSE	R-Squared	Adjusted R-Squared	F-statistic	Model p-value	R-squared Change	p-value
C1	Linear	0.960	0.129	0.116	10.2	0.002	0.030	0.112
	Quadratic	0.950	0.159	0.134	6.4	0.003		
C2	Linear	0.811	0.124	0.112	9.8	0.003	0.055	0.032
	Quadratic	0.791	0.179	0.155	7.4	0.001		
C3	Linear	0.845	0.134	0.122	10.7	0.002	0.045	0.050
	Quadratic	0.828	0.180	0.155	7.4	0.001		
C4	Linear	0.994	0.094	0.080	6.5	0.013	0.021	0.220
	Quadratic	0.991	0.115	0.086	4.0	0.023		
Eccentricity								
Vertebral Level	Model	RMSE	R-Squared	Adjusted R-Squared	F-statistic	Model p-value	R-squared Change	p-value
C1	Linear	1.147	0.004	-0.010	0.3	0.601	0.002	0.698
	Quadratic	1.154	0.006	-0.023	0.2	0.812		
C2	Linear	0.982	0.013	-0.002	0.9	0.348	<0.001	0.972
	Quadratic	0.989	0.013	-0.016	0.4	0.646		
C3	Linear	0.791	0.049	0.035	3.5	0.065	0.009	0.403
	Quadratic	0.793	0.058	0.030	2.1	0.131		
C4	Linear	0.765	0.074	0.059	5.0	0.028	0.080	0.015
	Quadratic	0.737	0.154	0.127	5.6	0.006		

Supplementary Table 22: Comparison coefficients between linear and quadratic models for the graph of z-transformed CSA/eccentricity versus time from ataxia onset of the SCA2 cohort.

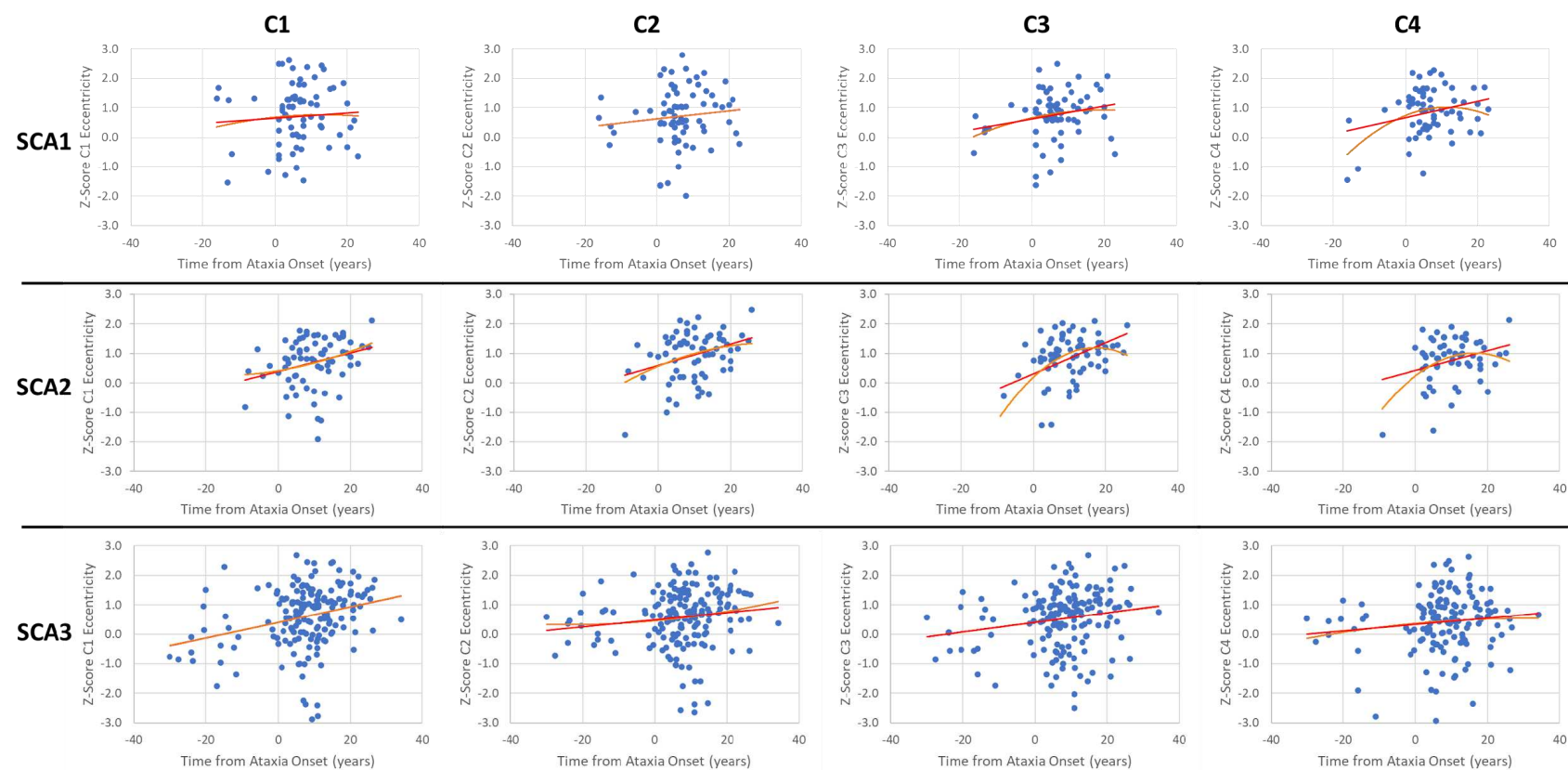
CSA (mm ²)								
Vertebral Level	Model	RMSE	R-Squared	Adjusted R-Squared	F-statistic	Model p-value	R-squared Change	p-value
C1	Linear	0.878	0.102	0.089	7.9	0.006	0.007	0.448
	Quadratic	0.881	0.109	0.083	4.2	0.019		
C2	Linear	0.952	0.067	0.054	5.0	0.028	0.004	0.583
	Quadratic	0.957	0.071	0.044	2.6	0.079		
C3	Linear	0.927	0.066	0.052	4.8	0.032	0.016	0.272
	Quadratic	0.926	0.082	0.054	3.0	0.058		
C4	Linear	1.059	0.025	0.007	1.4	0.240	0.011	0.427
	Quadratic	1.063	0.035	0.000	1.0	0.374		
Eccentricity								
Vertebral Level	Model	RMSE	R-Squared	Adjusted R-Squared	F-statistic	Model p-value	R-squared Change	p-value
C1	Linear	0.812	0.077	0.064	5.8	0.018	0.003	0.619
	Quadratic	0.817	0.080	0.053	3.0	0.056		
C2	Linear	0.769	0.110	0.097	8.7	0.004	0.006	0.471
	Quadratic	0.772	0.117	0.091	4.6	0.014		
C3	Linear	0.824	0.178	0.166	14.7	<0.001	0.077	0.009
	Quadratic	0.790	0.255	0.232	11.4	<0.001		
C4	Linear	0.767	0.083	0.066	5.0	0.029	0.060	0.047
	Quadratic	0.748	0.143	0.112	4.6	0.014		

Supplementary Table 23: Comparison coefficients between linear and quadratic models for the graph of z-transformed CSA/eccentricity versus time from ataxia onset of the SCA3 cohort.

CSA (mm ²)								
Vertebral Level	Model	RMSE	R-Squared	Adjusted R-Squared	F-statistic	Model p-value	R-squared Change	p-value
C1	Linear	0.899	0.212	0.208	46.6	<0.001	0.002	0.507
	Quadratic	0.901	0.214	0.205	23.5	<0.001		
C2	Linear	0.940	0.201	0.197	43.6	<0.001	<0.001	0.934
	Quadratic	0.943	0.201	0.192	21.7	<0.001		
C3	Linear	0.975	0.235	0.231	51.3	<0.001	<0.001	0.862
	Quadratic	0.977	0.235	0.226	25.5	<0.001		
C4	Linear	1.124	0.147	0.141	25.0	<0.001	<0.001	0.895
	Quadratic	1.127	0.147	0.135	12.4	<0.001		
Eccentricity								
Vertebral Level	Model	RMSE	R-Squared	Adjusted R-Squared	F-statistic	Model p-value	R-squared Change	p-value
C1	Linear	0.990	0.079	0.074	14.9	<0.001	<0.001	0.981
	Quadratic	0.993	0.079	0.069	7.4	0.001		
C2	Linear	0.958	0.019	0.013	3.3	0.072	0.002	0.523
	Quadratic	0.960	0.021	0.010	1.8	0.162		
C3	Linear	0.956	0.034	0.029	5.9	0.016	<0.001	0.973
	Quadratic	0.959	0.034	0.023	3.0	0.055		
C4	Linear	1.000	0.014	0.007	2.0	0.160	0.001	0.663
	Quadratic	1.003	0.015	0.001	1.1	0.341		



Supplementary Figure 01: Graphs of z-transformed CSA versus time from ataxia onset. The negative values for disease duration indicate the predicted time to ataxia onset calculated using Tezenas formulas for SCA1 and SCA2 (Tezenas du Montcel et al, 2014) and Peng formula for SCA3 (Peng et al, 2021), both are based on CAG repeat length and current participant age.



Supplementary Figure 02: Graphs of z-transformed Eccentricity versus time from ataxia onset. The negative values for disease duration indicate the predicted time to ataxia onset calculated using Tezenas formulas for SCA1 and SCA2 (Tezenas du Montcel et al, 2014) and Peng formula for SCA3 (Peng et al, 2021), both are based on CAG repeat length and current participant age.