Supplementary data

Atypical Ataxia Presentation in Variant Ataxia Telangiectasia: Iranian Case-Series and Review of the Literature

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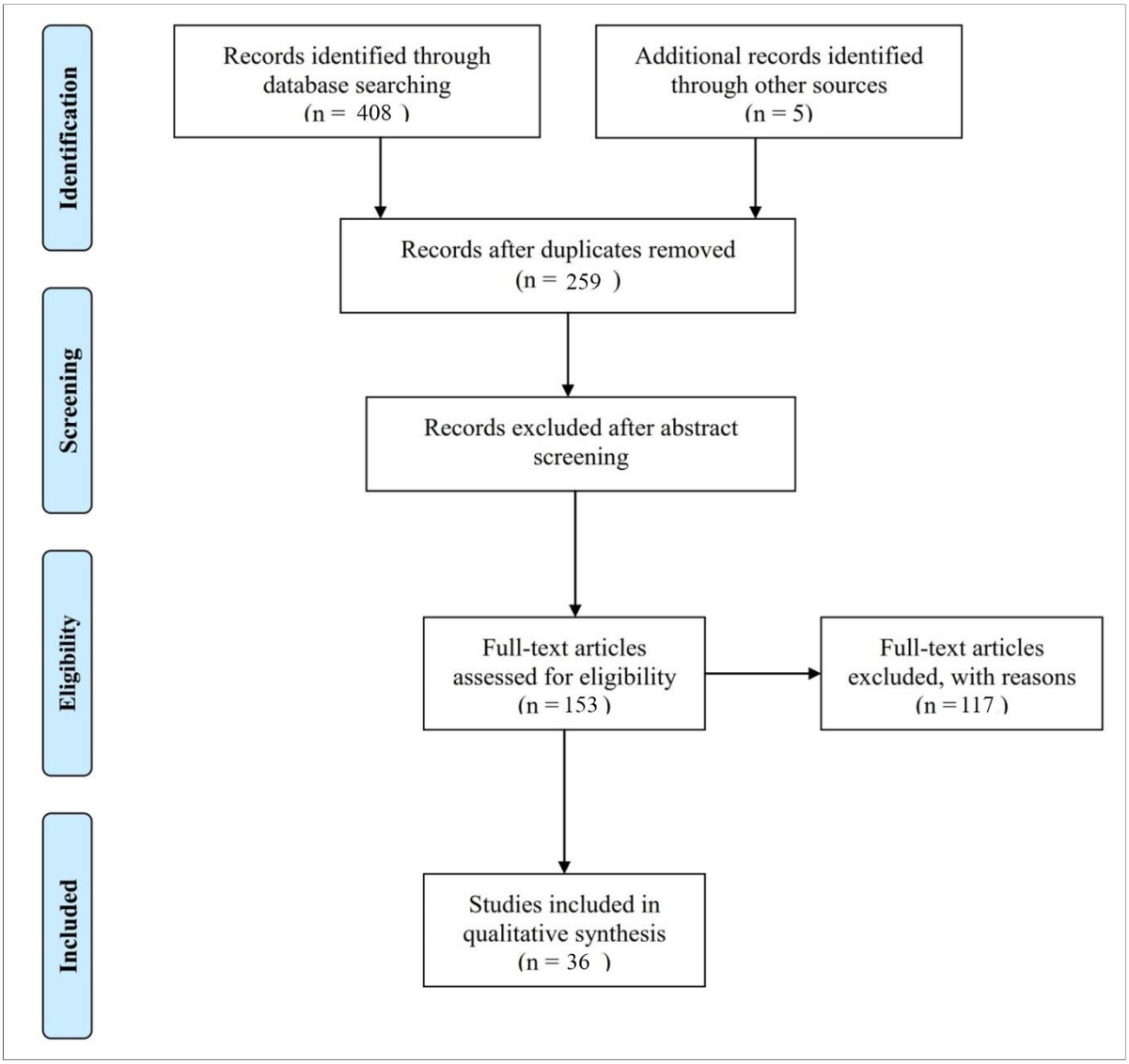

Supplementary Figure 1. Flowchart of the systematic search and study selection process.

Supplementary Table 1. Demographic, clinical, laboratory and molecular features of three atypical AT cases.

Parameters	Case 1	Case 2	Case 3	Normal values
Sex	M	F	F	
Age, y	9	13	24	
Presenting features, y	respiratory infections (0.7 y)	thrombocytopenia, purpura (3 y)	ataxic gait, telangiectasia (8 y)	
Age at onset of ataxia, y	6	6	8	
Telangiectasia	+	+	+	
Chromosomal instability	+	+	+	
Autoimmunity (Treatment)	ITP (IVIG, corticosteroids)	ITP (Prednisolone)	Psoriasis (Adalimumab)	
Recurrent infections	+	+	-	
WBC × 10^3 (cell/ µL)	2.7	10.6		4.5–13.5
Hemoglobin (g/dL)	11.2	11.9		11.5–15.5
Anti-Diphtheria (IgG; IU/mL)	<0.1	0.8		>0.1
Anti-Tetanus (IgG; IU/mL)	<0.1	0.2		>0.1
AFP (ng/mL)	275.5 ↑	152 ↑	411 ↑	<8.5
IgG (mg/dL)	27 ↓	227 ↓	1113	500-1600
IgA (mg/dL)	2 ↓	3 ↓	8 ↓	33-202
IgM (mg/dL)	724 ↑	3021 ↑	225	38-251
Immunoglobulin profile	HIgM	HIgM	IgA deficient	
CD8 + T cells, (cell/µL)	90 ↓	28 ↓	420	258-797
CD8 + Naïve T cells, (cell/µL)	1.9 ↓	3.7 ↓	54.2 ↓	105-476
CD8 + Central Memory T cells, (cell/µL)	0.4 ↓	0.1 ↓	24.3	1-55
CD8 + TEMRA T cells, (cell/µL)	46 ↓	14 ↓	148	56-282
CD8 + Effector memory T cells, (cell/µL)	42	10 ↓	194	28-324
CD4 + T cells, (cell/µL)	56 ↓	111 ↓	633	512-1253
CD4 + Naïve T cells, (cell/µL)	1.7 ↓	98 ↓	50 ↓	179-827
CD4 + Central Memory T cells, (cell/µL)	5 ↓	3 ↓	277 ↑	67-163
CD4 + TEMRA T cells, (cell/µL)	4.8 ↓	1.1 ↓	33.8	7-117
CD4 + Effector memory T cells, (cell/µL)	44 ↓	9 ↓	273	58-577
CD4 + regulatory T cells, (cell/µL)	2.4 ↓	3.6 ↓	2 ↓	5-25.5
CD19+ B cells, (cell/µL)	24.4 ↓	2 ↓	250.6	88.5-284.5
Naïve B cells, (cell/µL)	12.1 ↓	0 ↓	68.9	36-227
Marginal zone B cells, (cell/µL)	4.4	0 ↓	22.6 ↑	1.5-21
Switched Memory B cells, (cell/µL)	0.7 ↓	0.2 ↓	6	2.5-22
IgM-only memory B cells, (cell/µL)	1.22	0 ↓	17.54	0.2-26
Transitional B cells, (cell/µL)	0.33 ↓	0.02 ↓	6.56	2.5-41.5
$CD21^{low}$ B cells, (cell/µL)	0.2	0 ↓	7.5	0.1-14
Plasmablast, (cell/µL)	0.37 ↓	1.09	1.5	0.4-9.5
***ATM* mutations**	c.3895 delG	Large deletion EX37-48	c.6658C>T	-
Mutation Type	Frameshift	Large deletion	Nonsense	-
Severity based on mutation	Severe	Severe	Severe	-
Predicted Protein Alternation	p.A1299Pfs*50	-	p.Q2220*	-

ClinVar reported	rs786203501/ PP5	Not reported	rs1060501536/ PP5	-
gnomAD population frequency	PM2	PM2	PM2	
ACMG criteria	PVS1	PVS1	PVS1	-
Heredity	Homozygous	Homozygous	Homozygous	-
ITP; idiopathic thrombocytopenic purpura, AFP; alpha-fetoprotein, WBC; white blood cells, IVIG; intravenous immunoglobulin, HIgM: Hyper IgM phenotype.				

Supplementary Table 2. Demographic, clinical and laboratory characteristics of the 73 described variant atypical AT patients.

No	Sex/ Origin	First presenting features	IgG	IgA	IgM	AFP	Age at onset of ataxia, y	Wheelc hair	Telangiectasia	Cerebellar Atrophy (MRI)	Chromosomal instability	Karyotype abnormalities	Major symptoms	Ref.
Group I (Mild): - no ataxic signs														
P1	F/ Iraq	Recurrent infections (3 y)	L	N	H	H	no ataxia	no	+	+	+		Otitis media, sinusitis, pneumonia, cutaneous granulomas, café au lait macule	(68)
P2	F/ Italy	Recurrent respiratory infections (0.1 y)	L	N	H	H	no ataxia	no	+		+		Recurrent respiratory infections	(30)
P4	M/ Circassia	Neurologic problem (9.5 y)	N	N	N	H	no ataxia	no	+	+	+			(38)
P7	F/ Greece	Bronchitis (0.1 y)	N	L	H	H	no ataxia	no	+	+	+		Recurrent nasal infections, bronchitis	(29)
P10	F/ Belgium	Gait unsteadiness		L	N	H	no ataxia	no	-	-	+	-	Recurrent sinopulmonary	(3)
P20	M/ Netherlands	Tremor (18 y)	N	N	H	H	no ataxia	no	+	+	-	+		(69)
P21	M/ Netherlands	Tremor (26 y)	N	N	N	H	no ataxia	no	+	-	+	+		(69)
P25	F/ Arab	Mild myoclonus	N	L	N	H	no ataxia	no	-		+			(70)
P29	F/ Germany	Neurologic problem (childhood)	N	L	N	H	no ataxia	no	-	-				(71)
P31	M/ Netherlands	Hypotonia, clumsiness, slurred speech (2.5 y)	N	N	N	H	no ataxia	no	-		+		T-cell lymphoblastic non-Hodgkin lymphoma (12y)	(72)
P48	M/ USA	Cough, facial swelling (17 y)	N	N	N	H	no ataxia	no	-	-		+	T-cell acute lymphoblastic leukemia (17 y)	(73)
P49	F/ Germany	Neurologic problem (12 y)	N	N	N	H	no ataxia	no	-	-			Pneumonia, recurrent bronchitis, pharyngitis,	(74)
P50	F/ India	Dystonia (15 y)				H	no ataxia	no	+	-	-	+	Orofacial dyskinesias	(32)
P59	F/ Netherlands	Resting tremor and dysarthria (12 y)	N	N	N	H	no ataxia	no	-	-			Breast cancer (32 y)	(7)
P64	F/ -		N	L	N	H	no ataxia	no	-	-		+		(75)

P65	-/ France		N	L	N	H	no ataxia	no	-				T-lymphoma lymphoblastic (4 y), Gliomatosis cerebri (13 y)	(76)
Group II (Moderate): + ataxic signs, - not using a wheelchair														
P3	M/ Circassia	Gait unsteadiness, dysarthria (6 y)	N	L	H	H	6	no	+	+	+			(38)
P8	F/ UK	Ataxia (52 y)	L	N	L	H	52	no (walk with walking aids)	+	+	+			(77)
P9	F/ UK	Chorea (teenage)	N	L	N	H	teenage	no	+	+	+	+		(35)
P11	M/ Netherlands	Neurologic problem (10 y)	N	L	N	H	>11	no	-	+	+	+	died from lymphoma (57 y)	(78)
P12	F/ Italy	Ataxia (27 y)	N	N	N	H	27	no	-	-	+	+		(34)
P13	M/ UK	Ataxia, telangiectasia (17 y)	N	N	N		17	no	+	+	+			(37)
P14	M/ UK	Ataxia (22 y)	N	N	N		22	no	+	+	+			(37)
P15	M/ -					H	29	no	+	-	-	+		(79)
P16	M/ -					H	30	no	+	+	+	+		(79)
P17	M/ -					H	37	no	+			+		(79)
P18	F/ -					H	32	no	+	-		+		(79)
P23	M/ Italy	Gait unsteadiness (35 y)	N	N	N	H	39	no (walk with leg orthoses)	+	+	-			(80)
P24	M/ -	Neurologic problem (9 y)	N	L	N	H	9	no	+					(81)
P32	F/ India		N	N	H	H	28	no			+	+		(82)
P38	NR	Dysarthria (6 y)	N	N	N	H	>6	no	-	+		-		(28)
P39	NR	Dysarthria (6 y)	N	L	N	H	>6	no	-	+		-		(28)
P40	NR	Dystonia (8 y)	N	N	N	H	>8	no	-	+		-		(28)
P41	NR	Dystonia (6 y)	N	N	N	H	>6	no	-	+		-		(28)
P44	F/ Japan	Tremor, gait unsteadiness (17 y)	N	N	N	H	17	no	-	+			died from gallbladder cancer (70 y)	(83)

P45	F/ Japan	Tremor, gait unsteadiness (17 y)	N	N	N	H	17	no	-	+			died from chronic lymphocytic leukemia (76 y)	(83)
P47	F/ Austria	Gait unsteadiness (34 y)	N	N	N	N	34	no	+	+				(84)
P51	M/ Netherlands	Resting tremor (26 y)	N	N	N	H	>6	no	+	+	+	+		(7)
P52	M/ Netherlands	Resting tremor (16 y)	N	N	N	H	>6	no	+	-	-	+		(7)
P53	M/ Netherlands	Resting tremor (34 y)	N	N	N	H	>6	no	+	-		+	died from acute lymphoblastic leukemia (51 y)	(7)
P56	M/ Netherlands	Chorea-athetosis (0.5 y)	N	N	N	H	>6	no	-	-		+	died from an ectopic pituitary tumor (23 y)	(7)
P57	F/ Netherlands	Chorea-athetosis (0.5 y)	N	N	N	H	>6	no	-	-	-	+		(7)
P58	F/ Netherlands	Chorea-athetosis (4 y)	N	N	N	H	>6	no	-	+	+	+		(7)
P62	F/ Netherlands	Gait disturbance and resting tremor (32 y)	N	N	N	H	>6	no	+	-	+	+		(7)
P66	-/ France		N	L	N	H	>15	no	-					(76)
P67	-/ France		N	N	N	H	>7	no	+	+			Dermatofibrosarcoma (17 y)	(76)
P69	-/ France		N	N	N	H	26	no	+	+		+		(76)
P71	-/ France		N	N	N	H	15	no	-	+		+	Carcinoma thyroid	(76)
Group III (Severe): + ataxic signs, + using a wheelchair														
P5	M/ Turkey	Gait unsteadiness (7 y)	L	N	N	H	7	(13 y)	+				Pneumonia	(85)
P6	F/ Brazil	Ataxia (6 y)	N	L	N	H	6	yes	+				Pneumonia, died from severe pulmonary infection (16 y)	(86)
P22	F/ Italy	Tremor (13 y)	N	N	N	H	28	35	+	+	+			(80)
P30	M/ -	Progressive motor disturbances (6 y)	N	N	N	H	6	(18 y)	-	+	+	+		(87)
P33	NR	Ataxia (9 y)	N	N	N	H	9	(14 y)	+	+		+		(28)
P34	NR	Ataxia (7 y)	N	N	N	H	7	(11 y)	+			-		(28)
P35	NR	Ataxia (8 y)	N	N	N	H	8	(14 y)	+	+		-		(28)
P36	NR	Ataxia (5 y)	N	N	N	N	5	(12 y)	-			-		(28)
P37	NR	Ataxia (14 y)	N	N	N	H	14	(25 y)	-	+		-		(28)
P42	NR	Ataxia (10 y)	N	N	N	H	10	(18 y)	+	+		+		(28)

P46	F/ Saudi	Gait unsteadiness (14 y)	N	N	N	H	14	(22 y)	+	+				(88)
P54	Netherlands	Chorea-athetosis (1 y)	N	N	N	H	>6	(> 15 y)	-	+	-			(7)
P55	F/ Netherlands	Chorea-athetosis (1 y)	N	N	N	H	>6	(> 15 y)	+	+	+	+		(7)
P60	F/ Netherlands	Chorea-athetosis (0.5 y)	N	N	N	H	>6	(> 15 y)	+	-			Breast cancer (32 y)	(7)
P61	F/ Netherlands	Chorea-athetosis (1.5 y)	N	N	N	H	>6	(> 15 y)	-	-				(7)
P63	F/ Netherlands	Distal muscle weakness (6 y)	N	N	N	H	>6	(> 15 y)	+	+	+			(7)
P68	-/ France		N	N	N	H	12	(23 y)	+	+		+		(76)
P70	-/ France		N	N	N	H	<50	(50 y)	-			+		(76)
P72	M/ Germany	Ataxia (7y)					7	(45 y)	-		+	+	Recurrent infections, died from cachexia (60 y)	(50)
Data on using a wheelchair not available (Not included in the classification)														
P19	F/ Italy	Neurologic problem				H	9		+	-	+	+		(89)
P26	-/ France		N	L	N	N	6		+			+		(63)
P27	F/ France		N	L	N	H	8		+		+	+	died from breast cancer (43 y)	(63)
P28	-/ France		N	N	N	H	10		-			+		(63)
P43	-/ Netherlands	The neurologic problem, recurrent respiratory infections (9 y)	L	L	H	H	9		+				Recurrent infections, died from hepatocellular carcinoma (10 y)	(41)
P73	M/ Japan	Upper respiratory tract infections, gastrointestinal tract infections, pharyngitis (3 y)	L	L	H		6		+	+			ITP (3y), Treatment: (IVIG, Prednisolone, IVCY, cyclophosphamide), splenomegaly	(90)

N; number, P; patient, M; male; F; female, Y; year, AFP; alpha-fetoprotein, ITP: idiopathic thrombocytopenic purpura, IVIG: intravenous immunoglobulin, IVCY: high-dose intravenous cyclophosphamide, L: low, H: high, N: normal, NR: not reported.

Supplementary Table 3. Genetics characteristics of the 73 described variant atypical AT patients.

N	Gene	Mutation at cDNA level	Mutation at protein level	HEREDITY	Mutation Type	Severity based on mutation	ATM protein/ATM kinase activity *	Severity based on functional assay**
Group I (Mild): - no ataxic signs								
P1	*ATM*	c.2250G>A	p.Lys750=	HMZ	Synonymous	Mild	Absence of ATM protein	Severe
P2	*ATM*	c.6679C>T c.8484delA	p. Arg2227Cys p.Gln2828fs*	HTZ	Missense, Frameshift	Mild	Reduction of ATM protein	Mild
P4	*ATM*	c.5653delA	p.Thr1885fs*	HMZ	Frameshift	Severe	Absence of ATM	Severe
P7	*ATM*	c.8850G>T	p.Glu2950Asp	HMZ	Missense	Mild	NR	NR
P10	*ATM*	c.8122G>A c.8851-1G>T	p. Asp2708Asn -	HTZ	Missense, splicing	Mild	Reduction of ATM protein with kinase activity	Mild
P20	NR	NR	NR	NR	NR	NR	NR	NR
P21	NR	NR	NR	NR	NR	NR	NR	NR
P25	*ATM*	c.1514T>C	p.Phe505Ser	HMZ	Missense	Mild	Reduction of ATM protein with kinase activity	Mild
P29	*ATM*	c.8147T>C c.8578_8580delTCT	p. Val2716Ala p.S2860del	HTZ	Missense, In- Frame	Mild	NR	NR
P31	*ATM*	c.5932G>T	p.Glu1978*	HMZ	Nonsense	Severe	Absence of ATM protein	Severe
P48	*ATM*	c.5585T>A	p.Leu1862His	HMZ	Missense	Mild	Reduction of ATM protein	Mild
P49	*ATM*	c.5573G>A c.6154G>A	p. Trp1858* p.Glu2052Lys	HTZ	Nonsense, Missense	Mild	NR	NR
P50	*ATM*	c.590G>A	p. Gly197Gln	HMZ	Missense	Mild	Reduction of ATM protein with kinase activity	Mild
P59	*ATM*	c.8147 T>C Unidentified	p. Val2716Ala Unidentified	?	Missense -	Mild	NR	NR
P64	*ATM*	c.572T>A c.6679C>T	p.Ile191Asn p.Arg2227Cys	HTZ	Missense, Missense	Mild	Reduction of ATM protein with kinase activity	Mild
P65	*ATM*	c.4776+1G>T c.6814G>A	- p.Glu2272Lys	HTZ	Splicing, Missense	Mild	Reduction of ATM protein with kinase activity	Mild
Group II (Moderate): + ataxic signs, - not using a wheelchair								

P3	*ATM*	c.5653delA	p.Thr1885fs*	HMZ	Frameshift	Severe	Absence of ATM protein	Severe
P8	*ATM*	c.1066-6T>G c.7271T>G	- p.Val2424Gly	HTZ	Splicing, Missense	Mild	NR	NR
P9	*ATM*	c.5177þ5 G>A c.1290_1291delTG (	p.Glu1669Valfs*12 p.Cys430*	HTZ	Frameshift, Nonsense	Severe	Absence of ATM protein	Severe
P11	NR	NR	NR	NR	NR	NR	NR	NR
P12	*ATM*	c.8030 A>G c.7481insA	p. Tyr2677Cys p.Asn2494Lysfs*	HTZ	Missense, Frameshift	Mild	Reduction of ATM protein with kinase activity	Mild
P13	*ATM*	c.5762A>G	p.Arg1921Lys	HMZ	Missense	Mild	Reduction of ATM protein with kinase activity	Mild
P14	*ATM*	c.5762A>G	p.Arg1921Lys	HMZ	Missense	Mild	Reduction of ATM protein with kinase activity	Mild
P15	*ATM*	c.7622T>G c.3136C>T	p.Leu2541Arg p.Leu1046Phe	HTZ	Missense, Missense	Mild	Reduction of ATM protein with kinase activity	Mild
P16	*ATM*	c.7622T>G c.3136C>T	p.Leu2541Arg p.Leu1046Phe	HTZ	Missense, Missense	Mild	Reduction of ATM protein with kinase activity	Mild
P17	*ATM*	c.7622T>G c.3136C>T	p.Leu2541Arg p.Leu1046Phe	HTZ	Missense, Missense	Mild	Reduction of ATM protein with kinase activity	Mild
P18	*ATM*	c.IVS21-1G> A c.8147T>C	- p.Val2716Ala	HTZ	Missense, Missense	Mild	Reduction of ATM protein with kinase activity	Mild
P23	*ATM*	c.6325T>G	p.Trp2109Gly	HMZ	Missense	Mild	Absence of ATM protein	Severe
P24	NR	NR	NR	NR	NR	NR	NR	NR
P32	NR	NR	NR	NR	NR	NR	NR	NR
P38	*ATM*	IVS19+2T>G c.8147T>C	- p.Val2716Ala	HTZ	Splicing, Missense	Mild	NR	NR
P39	*ATM*	IVS19+2T>G c.8147T>C	- p.Val2716Ala	HTZ	Splicing, Missense	Mild	NR	NR
P40	*ATM*	IVS19+2T>G c.8147T>C	- p.Val2716Ala	HTZ	Splicing, Missense	Mild	NR	NR
P41	*ATM*	IVS19+2T>G c.8147T>C	- p.Val2716Ala	HTZ	Splicing, Missense	Mild	NR	NR
P44	*ATM*	c.496G>C	p.Glu166Gln	HMZ	Missense	Mild	NR	NR

P45	*ATM*	c.496G>C	p.Glu166Gln	HMZ	Missense	Mild	NR	NR
P47	*ATM*	c.6205C>T c.1235+3A>G	p. Gln2069* -	HTZ	Nonsense, splicing	Mild	NR	NR
P51	*ATM*	c.3136 C>T c.7622 T>G	p. Leu1046Phe p.Leu2541Arg	HTZ	Missense, Missense	Mild	Reduction of ATM kinase activity	Mild
P52	*ATM*	c.3136 C>T c.7622 T>G	p. Leu1046Phe p.Leu2541Arg	HTZ	Missense, Missense	Mild	Reduction of ATM kinase activity	Mild
P53	*ATM*	c.3136 C>T c.7622 T>G	p. Leu1046Phe p.Leu2541Arg	HTZ	Missense, Missense	Mild	NR	NR
P56	*ATM*	c. 2909 T>G c.6908dupA	p. Leu970Arg p.Glu2304fs*	HTZ	Missense, Frameshift	Mild	NR	NR
P57	*ATM*	c. 2909 T>G c.6908dupA	p. Leu970Arg p.Glu2304fs*	HTZ	Missense, Frameshift	Mild	Normal ATM protein expression	Mild
P58	*ATM*	c.5932 G>T c.8147 T>C	p. Glu1978* p.Val2716Ala	HTZ	Nonsense, Missense	Mild	Normal ATM protein expression	Mild
P62	*ATM*	c.2922–1G>A c.8147 T>C	- p.Val2716Ala	HTZ	Splicing, Missense	Mild	Reduction of ATM kinase activity	Mild
P66	*ATM*	c.7157C>A	p.Ala2386Glu	HMZ	Missense	Mild	Reduction of ATM protein with kinase activity	Mild
P67	*ATM*	c.3712_3716del c.1164A>T	p.Leu1238fs* p.Ser49Phe	HTZ	Frameshift, Missense	Mild	Normal ATM protein expression	Mild
P69	*ATM*	c.3049C>T c.8083G>A	p.Gln1017* p.Gly2695Cys	HTZ	Nonsense, Missense	Mild	Reduction of ATM protein with kinase activity	Mild
P71	*ATM*	c.68G>A c.6059G>A	p.Arg23Gln p.Gly2020Val	HTZ	Missense, Missense	Mild	Normal ATM protein expression	Mild
Group III (Severe): + ataxic signs, + using a wheelchair								
P5	NR	NR	NR	NR	NR	NR	NR	NR
P6	NR	NR	NR	NR	NR	NR	NR	NR
P22	*ATM*	c.6325T>G	p.Trp2109Gly	HMZ	Missense	Mild	Absence of ATM protein	Severe
P30	NR	NR	NR	NR	NR	NR	NR	NR
P33	*ATM*	c.9022C>T	p.Arg3008Cys	HMZ	Missense	Mild	NR	NR
P34	*ATM*	c.7456C>T	p. Arg2486*	HTZ	Nonsense,	Mild	NR	NR

		c.8161 G>A	p.Asp2721Asn		Missense			
P35	*ATM*	c.7456C>T c.8161 G>A	p. Arg2486* p.Asp2721Asn	HTZ	Nonsense, Missense	Mild	Reduction of ATM protein	Mild
P36	*ATM*	IVS21+1G>A IVS55+5delG	- -	HTZ	Splicing, Frameshift	Mild	Reduction of ATM protein	Mild
P37	*ATM*	IVS28-1G>C IVS34+32insAlu	- -	HTZ	Splicing, Missense	Mild	NR	NR
P42	*ATM*	Dup Exon 64-65 c.6108T>G	- p.Tyr2036*	HTZ	Frameshift, Nonsense	Severe	NR	NR
P46	*ATM*	c.1516G>T	p.Gly506Cys	HMZ	Missense	Mild	NR	NR
P54	*ATM*	c.331+5G>A	-	HMZ	Splicing	Mild	Reduction of ATM kinase activity	Mild
P55	*ATM*	c.331+5G>A	-	HMZ	Splicing	Mild	Reduction of ATM kinase activity	Mild
P60	*ATM*	c.8147 T>C Unidentified	p. Val2716Ala Unidentified		Missense -	Mild	NR	NR
P61	*ATM*	c.717_720delCCTC c.8147 T>C	p. Leu240fs* p.Val2716Ala	HTZ	Frameshift, Missense	Mild	NR	NR
P63	*ATM*	c.496+5G>A c.7875_7876delTGinsGC	p. Arg111_Glu166del55insLys p.Asp2625_Ala2626delinsGluPro	HTZ	Splicing, Double missense	Mild	NR	NR
P68	*ATM*	c.6188G>A	p.Gly2063Val	HMZ	Missense	Mild	Reduction of ATM protein with kinase activity	Mild
P70	*ATM*	c.7024G>T c(2466+1_2467-1)_(8850+1_8851-1)dup	p.Gly2342Val -	HTZ	Missense, Frameshift	Mild	Reduction of ATM protein with kinase activity	Mild
P72	*ATM*	c.496+5G>A c.7875_7876delinsGC	- p.Asp2625_Ala2626delinsGluPro	HTZ	Splicing Double missense	Mild	Reduction of ATM protein and kinase activity	Mild
Data on using a wheelchair not available (Not included in the classification)								
P19	*ATM*	c.6572ins7 (IVS47-9G>A) c.5435del3	- p.Ala1812Val	HTZ	Frameshift, In-frame	Mild	Normal ATM protein expression	Mild

P26	*ATM*	c.7570G>C c.3663G>A	p. Ala2524Pro p.Trp1221*	HTZ	Missense, Nonsense	Mild	Reduction of ATM protein and absence of ATM kinase activity	Severe
P27	*ATM*	c.5189G>T c.8585del87	p. Arg1730Leu p.2862del29	HTZ	Missense, Frameshift	Mild	Reduction of ATM protein and the absence of ATM kinase activity	Severe
P28	*ATM*	c.6203T>C	p.Leu2068Ser	HMZ	Missense	Mild	Reduction of ATM protein with kinase activity	Mild
P43	NR	NR	NR	NR	Frameshift or Nonsense	Severe	Absence of ATM protein	Severe
P73	*ATM*	NR	NR	NR	NR	NR	Absence of ATM protein	Severe

ATM; ataxia-telangiectasia mutated, HMZ; homozygous, HTZ; compound heterozygous, NR: not reported.

** Based on Western blot experiment.*

*** Based on the presence or absence of protein patients were divided into two groups of severe (without residual of expression or function) and mild (with residual of expression and function)*