Postural and walking patterns assessed by 3d movement analysis in the late onset Pompe disease

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INTRODUCTION

Late onset Pompe Disease (LOPD) is a neuromuscular disorder due to mutations of the gene codifying lysosomal enzyme GAA, whose absence or deficiency causes a progressive accumulation of glycogen within lysosome and myofibrils that determine cardiac, respiratory and skeletal muscles alterations. The disease is characterized by primary involvement of trunk and pelvic girdle musculature that results in relevant motor disabilities (fig.1). To the best of our knowledge, only one study has been published reporting on spatial-temporal gait parameters assessed in 22 clinically heterogeneous unrelated patients with genetically confirmed diagnosis only in few; studies on kinematic and kinetic parameters of LOPD patients have yet not been published. Aim of our study is to describe the spatial-temporal, kinematic e kinetic parameters of gait cycle in a genetically homogenous group of LOPD patients (fig.2) using gait analysis.

Methods

7 LOPD siblings, sharing the same GAA mutation compound, were assessed using clinical scales (MRC, GSCGA, 6mwt) and 3d movement analysis that allowed to measure spatial-temporal and kinematic parameters of gait cycle. Age and sex-matched healthy individuals were used as controls. The RMSE difference between patients' kinematics and the reference normal pattern was computed, averaged over the gait cycle and normalized by the ROM of the normal pattern, thus obtaining a dimensionless indicator. Hip and Ankle peaks of generated power were also extracted from gait analysis data.

Results

The results of 7 patients (gender 4F-3M, mean age 56 years), showed significant abnormalities of spatial-temporal parameters consisting in a trend towards decreased velocity and cadence, increased stance phase and double limb support, a wider base of support, a shorter step and stride length. Moreover the assessment of kinematic parameters revealed an increase of anterior pelvic-tilt and posterior trunk-tilt, while pelvic obliquity, active hip extension and ankle dorsiflexion were variably reduced. Kinetic parameters showed a reduction of Hip and Ankle peaks of generated power.

Discussion

LOPD is characterized by a marked phenotypic variability among related and unrelated patients even if they share the same mutation. This study shows, in related individuals with the same genetic background, some similar alterations of spatial-temporal, kinematic and kinetic parameters regardless of the severity of their phenotypes. The use of 3d movement analysis improves our understanding of specific clinical and functional features in LOPD highlighting the typical gait pattern alterations not detectable with the usual clinical examinations. Moreover, this instrumental examination may be used as outcome measures to monitor disease progression and response to Enzyme Replacement Therapy.

References

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[2] Lachmann R, Schoser B. The clinical relevance of outcomes used in late-onset Pompe disease: can we do better? Orphanet J Rare Dis.2013;8:160

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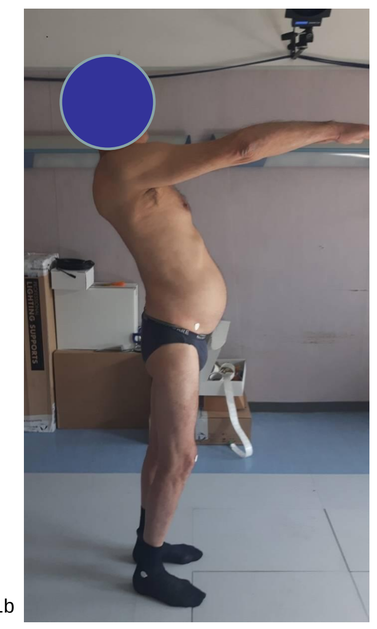
1a



1b

Fig.1-Sagittal plane: a t rest (1a) and after shoulder-flexion test (1b)

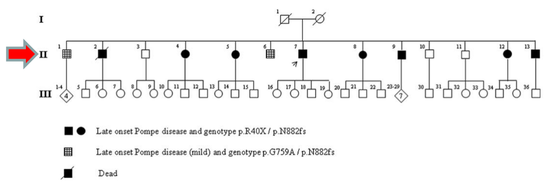


Fig.2 – the complete pedigree of the Pompe italian family whose 2° generation has been studied

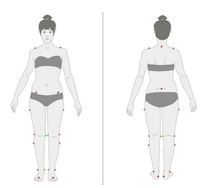


Fig.3 – Helen-Hayes markers'protocol

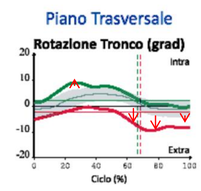


Fig.4 – Root Main Square Error

	età	ciclo dx sec	ciclo sx sec	% app dx	% app sx	%osc dx	%oscil sx	%singSupDX	%SingSupSx	%dopSupDX	%dopSupSx	VelM, m/s	VelM, %h	cade p/min	lung stride	lung step m	larg pas m
1-F	56	1,2	1,32	67,02	64,74	32,98	29,25	31,45	30,81	17,94	16,78	0,9	55,52	96,8	1,08	0,53	0,09
2-F	62	1,24	1,24	70,18	70,7	29,82	23,71	23,63	29,95	20,4	20,3	0,7	44,85	97,2	0,9	0,45	0,1
3-M	58	1,57	1,51	70,37	68,7	29,6	31,3	30,16	30,78	18,89	21,23	0,7	36,16	78,1	1,01	0,5	0,09
4-F	64	1,67	1,63	73,67	69,02	26,33	30,9	30,3	26,94	21,24	22,52	0,6	36,78	72,96	0,93	0,46	0,12
5-F	50	1,34	1,36	69,8	67,8	30,1	32,1	32,7	29,6	18,2	19,5	0,8	44,9	89,4	1,04	0,5	0,11
6-M	47	1,2	1,2	65,5	66,6	34,4	33,3	33,4	34,2	16,7	15,7	1	56,3	99,7	1,22	0,6	0,09
7-M	55	1,5	1,5	66,44	66,84	33,5	31,5	31,4	33,9	19,1	16,1	0,6	29,7	76,9	0,85	0,4	0,1
Medie + DS	56± 6	1,38±0,19	1,39±0,15	68,99±2,84	67,77±1,93	30,78±2,81	31,82±3,15	31,59±3,22	30,88±2,52	18,92±1,52	18,87±2,69	0,75±0,15	43,45±10,0	87,29±11,1	1,00±0,12	0,49±0,06	0,1±0,01

Tab.1 spatial-temporal parameters

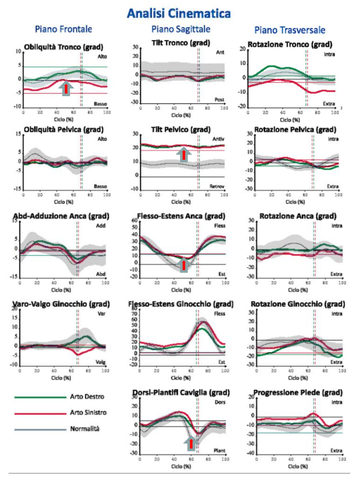
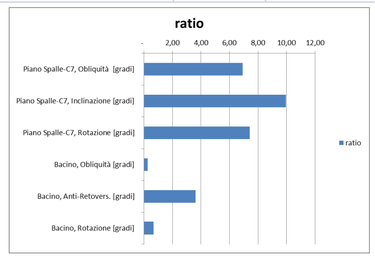


Fig.5- Kinematic graphs

Angle	average	normal range	ratio
Shoulder plane-C7, Obliquity	4,5	0,65	6,92
Shoulder plane-C7, Inclination	27,9	2,8	9,96
Shoulder plane-C7 Rotation	4	0,54	7,41
Pelvis, Obliquity	2	8,3	0,24
Pelvis, tilt.	5,8	1,6	3,63
Pelvis, Rotation	3,4	5,2	0,65



Tab.2 - Root Main Square Error

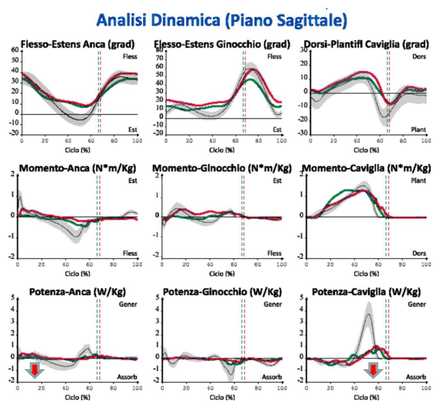


Fig.6- Kinetic graphs

		caviglia sx	%ciclo passo	caviglia dx	%ciclo passo
1	Caviglia, Potenza Sagitt. [W/kg]	1,4	58	1,3	60
2	Caviglia, Potenza Sagitt. [W/kg]	1,4	63	1,8	63
3	Caviglia, Potenza Sagitt. [W/kg]	1,5	63	1,4	61
4	Caviglia, Potenza Sagitt. [W/kg]	0,9	60	1,2	64
5	Caviglia, Potenza Sagitt. [W/kg]	1,6	61	2	61
6	Caviglia, Potenza Sagitt. [W/kg]	1,9	58	1,7	60
7	Caviglia, Potenza Sagitt. [W/kg]	1,2	62	1,4	61
	Medie e DS	1,41±0,31	60,71±2,13	1,54±0,29	61,42±1,51

		anca sx	% ciclo passo	anca dx	%ciclo passo
1	Anca, Potenza Sagitt. [W/kg]	0,6	6	0,4	5
2	Anca, Potenza Sagitt. [W/kg]	0,4	16	0,4	16
3	Anca, Potenza Sagitt. [W/kg]	0,7	20	0,7	18
4	Anca, Potenza Sagitt. [W/kg]	0,5	14	0,3	13
5	Anca, Potenza Sagitt. [W/kg]	0,1	5	0,4	15
6	Anca, Potenza Sagitt. [W/kg]	0,5	8	0,9	12
7	Anca, Potenza Sagitt. [W/kg]	0,6	11	0,1	12
	Medie e DS	0,48±0,19	11,42±5,5	0,45±0,26	13±4,16

tab.3 – values of ankle and hip of generated power