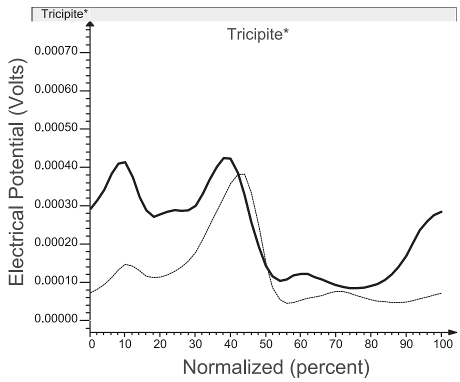

Fig. 3. Triceps enveloped EMG.

walking. Healthy young subject were asked to mimic voluntarily anterior pelvic tilt during gait analysis sessions.

Materials and methods: Six healthy young adults (29 ± 3 years old) performed a gait analysis along a 12 meters walkway barefoot. After that, they were asked to mimic anterior pelvic tilt, Fig 1. Data were collected with Vicon Mx system with 8 cameras, two AMTI OR 6-5 force platforms and Wave surface EMG system. Spatio-temporal parameters, kinematic, kinetic and surface EMG of four gait cycles were analyzed, comparing self placed barefoot gait with voluntary anterior pelvic tilt one. Digital video acquisitions were also performed.

Results: Video observation: during voluntary anterior pelvic tilt, the trunk tilted forward, the upper limbs tilted backward, the foot contact was flat or on toe, Fig. 1.

Kinematic: in comparison with barefoot gait the main differences were the ankle plantar-flexion at foot contact, the anticipation of ankle plantar-flexion during late stance, a reduced maximum of knee flexion during swing, an increased hip flexion and, of course, the requested increased anterior pelvic tilt.

Kinetic: double bump and reduction of ankle dorsal-flexion moment, increased ankle power absorption and generation during early stance, and reduced ankle power generation in late stance was observed, Fig. 2.

Spatio-temporal parameters: the cadence increased from 124 ± 5.11 steps/min to 145 ± 14.4 steps/min; the stride time decreased from 0.96 ± 0.040 s to 0.84 ± 0.078 s and consequently walking speed increased from 1.34 ± 0.11 m/s to 1.57 ± 0.26 m/s. The other spatio-temporal variables did not differ.

EMG: triceps enveloped surface EMG diagram showed anticipation of triceps activation during voluntary tilt, Fig. 3.

Discussion: Voluntary anterior pelvic tilt facilitated the forward projection of the upper body with the association of a not requested toe walking like behaviour. The kinematic, kinetic, spatio-temporal and EMG parameters showed a pattern similar with the gait of toe-walkers. From the results of this work it is possible to hypothesize that anterior pelvic tilt could be considered one of the elements facilitating toe walking. The whole body biomechanical configuration contributes to the aetiology of gait strategies. The selected adaptive solution for balancing the pelvis could constrain also distal segments configurations.

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Effectiveness of AFO orthoses in children affected by cerebral palsy: Clinical evaluation does not always define patient satisfaction

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Introduction: Orthoses represent one of the tools most frequently used for the rehabilitation course of children affected by cerebral palsy (CP). A number of studies tried to evaluate the effectiveness of orthoses [1]. At present time no homogeneous results were found, both for what concerns their impact on the motor performance, and, mainly, for what concerns their effect in the fields of activities and participation [2]. These fields are still now very slightly explored. As indicated by [2], it is therefore necessary to deeper explore these issues in order to improve the rehabilitation care. This study aims at verifying the effectiveness of the orthoses on motor performance, with relation to gross motor abilities and patient satisfaction.

Materials and methods: Eleven subjects affected by CP in the form of diplegia, aged 5 to 18 (mean age 10.5) participated in this study. The subjects were selected so that their performances were not affected by other disabilities, pathologies or recent interventions, both surgical and pharmacological. All the subjects were using ankle-foot orthoses (AFO). The benefits obtained by each subject through the use of the AFO were evaluated from different points of view: the level of satisfaction by using the QUEST questionnaire [3], the motor performance using both the D and E dimensions of the Gross Motor Function Measure 88 (GMFM) [4] and the Goal Attainment Scale (GAS) [5]. The objectives of the GAS were defined before the study by the physicians who prescribed the orthoses. The achievement of each objective of the GAS was verified by means of Gait Analysis techniques (GA). In particular the kinematic and the dynamic of the gait (at least 10 gait cycles) and the standing posture of each subject was acquired, first barefoot and then with shoes and orthoses. The acquisitions were performed following the Total3DGait [6] protocol using a Vicon MX + system (Vicon Motion System, UK) equipped with 8 cameras and two force platforms.

Results: Table 1 reports the measurements of the effects resulting from orthoses use.

Discussion: According to the GAS scores, the performances improve on average 14.24 points, but they remain (47.26) below the expected value (50). The variations of the GMFM scores are always positive, and the mean variation (4.41) appears to be consistent with what reported by other authors [7]. The QUEST indicates certainly the most successful results: the median of the score corresponds to the description “very satisfied” (score 5). The difference

Table 1
Scores for each subject (s1-s11) and mean values of GAS, ΔGAS with respect to the condition without orthoses (baseline), ΔGMFM between the conditions with and without orthoses, QUEST.

	s1	s2	s3	s4	s5	s6	s7	s8	s9	s10	s11	MEAN
GAS	44.23	55.77	50.00	32.68	67.32	44.23	55.77	50.00	44.23	32.68	42.93	47.26
ΔGAS from baseline	11.55	23.09	20.00	0.00	34.64	11.55	23.09	14.14	11.55	0.00	7.07	14.24
ΔGMFM-88	2.09	5.13	5.48	2.8	5.13	0.75	1.38	12.42	2.67	8.22	2.41	4.41
QUEST	5	5	5	5	5	5	4	5	3	4	5	4.64

between the results of the measures, that moreover are not correlated, leads to the following considerations: (i) it is necessary to utilize each evaluation tool considering its specific properties, in order to use it properly; (ii) it is important to integrate the evaluation of the more purely motor aspects with those of activity and participation, in order to make the identification of the objectives to be achieved with a specific orthoses more adequate and complete, so that the orthoses is really appropriate for the patient. Understanding the reason that cause the differences in the scores, in particular why the patients are so highly satisfied even with a poor increase in the functional autonomy, it is an issue of high interest that requests further examination.

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Robotic-assisted locomotion training in children affected by Cerebral Palsy

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Introduction: There is increasing evidence that intensive functional training is effective in improving the motor abilities of children with Cerebral Palsy (CP). Based on the motor learning concept, robotic-assisted treadmill training conducted on a driven gait orthosis (DGO) in comparison with conventional over ground training and body weight-supported treadmill training offers a specific gait rehabilitation by a greater amount of stepping practice increasing speed and longer walking distance during therapy sessions. Because the parameters of each training session are well defined and continuously logged, gait training becomes easily comparable between different individuals and even different training settings. DGO training, effective in improving walking abilities in adult stroke and spinal cord injury patients [1,2], recently has been introduced and found to be a feasible and promising therapeutic option in the paediatric setting [3].

The aim of the current study was to examine the hypothesis that specific gait training on DGO improves walking ability in children affected by bilateral CP.

Materials and methods: **Participants**: 32 children (15 males and 17 females) with bilateral spastic CP, aged 4 to 16 years, were recruited from an outpatient setting (Department of Functional Rehabilitation, IRCCS "E.Medea", Bosisio Parini, Italy). The inclusion criteria were: ability to signal pain, fear or discomfort, ability to walk independently (the use of aids was allowed) and the femur length had to be at least 21 cm in order to properly use the DGO.

Apparatus: Robotic-assisted locomotion training was performed using the commercially available DGO Lokomat [4] (Hocoma Inc, Zurich, Switzerland) at Casa di Cura "Habilita" (Zingonia, Italy). This system included a treadmill, a body-weight support system and two light-weight robotic actuators that have to be attached to the subject's legs. Lokomat is fully programmable, including control of knee and hip range of motion, the amount of assistance the system provides to the patient, and the speed of deambulation [5].

Table 1
Outcome measures (*: $p < 0.017$ vs T0).

		OUTCOME MEASURES			
		T0	T1	T2	p-value
GMFM-66	L + TOP	71.7 ± 14.4	73.5 ± 13.6	74.2 ± 12.0	0.026
	ITOP	67.7 ± 9.4	68.9 ± 9.2*	70.5 ± 10.1*	0.009
	ILok	69.4 ± 10.0	70.8 ± 10.7*	71.7 ± 10.5*	0.005
GMFM-88 dim D	L + TOP	82 (19.5)	90 (16.5)	95 (16.5)	0.024
	ITOP	85 (20)	90 (15)	90 (18)*	0.001
	ILok	83.5 (12.5)	85 (15.25)	85 (15.25)	0.076
GMFM-88 dim E	L + TOP	63 (49)	64 (46.5)	64 (43)	0.032
	ITOP	65 (40)	65 (43)*	67 (38)*	0.001
	ILok	65 (30)	68.5 (39.5)*	67 (38)	0.004
Ashworth	L + TOP	1.2 (0.9)	1.0 (1.05)	0.8 (0.7)	0.000
	ITOP	0.8 (0.6)	1.0 (0.8)	0.8 (0.5)	0.059
	ILok	0.8 (0.2)	0.8 (0.4)	0.8 (0.4)	0.024
6MinWT	L + TOP	298.7 ± 168.9	312.0 ± 144.4	323.0 ± 156.4	0.972
	ITOP	301.7 ± 144.6	310.3 ± 142.5	311.7 ± 145.7	0.529
	ILok	318.3 ± 112.4	340.5 ± 125.8	342.3 ± 117.3	0.076
GGI	L + TOP	163.4 ± 125.2	172.0 ± 133.3	174.2 ± 129.2	0.097
	ITOP	131.8 ± 93.8	165.7 ± 103.5	160.9 ± 95.9	0.016
	ILok	176.2 ± 85.6	177.8 ± 85	196.2 ± 95.8	0.779

Protocol: The children participating in the study were divided into three groups: Lokomat (L + TOP), Intensive Task-Oriented Physiotherapy (ITOP) and Intensive Lokomat (ILok) group. For all the children the trial consisted of 40 rehabilitative sessions, each of 30 min, over a 10 week course. Children of L + TOP had 20 sessions on the DGO and 20 of additional physiotherapy; for children of ITOP and for children of ILok 40 sessions exclusively of physiotherapy or on the DGO were scheduled respectively. The exercises of physiotherapy and the physiotherapist were the same for all children of L + TOP and ITOP.

Outcome Measures: Three clinical assessments were performed: pre (T0), post-treatment (T1) and 3 months after the end of treatment (T2). Gait endurance was assessed by measuring the walked distance (dist) with the 6-minute walking test (6minWT). The Gross Motor Function Measure (GMFM-66) and particularly the relative dimensions D (standing) and E (walking, running, jumping) of GMFM-88 were assessed by GMFM-certified therapists. The Ashworth scale was used to assess the muscle spasticity. 3D-Gait Analysis (3DGA, Elite, BTS Bioengineering, Italy) was used to quantitatively describe the gait pattern of children, who wore their usual orthoses and footwear, and utilized their regular walking aids during the test [6].

Results: Evaluating the data of clinical assessments, all groups showed significant improvement in GMFM-66 ($p < 0.05$), in particular in the dimensions D and E of GMFM-88. In the Ashworth scale only for L + TOP and ILok a significantly reduced spasticity was found. In 6minWT children of L + TOP and ILok group increased their walked distance more than those of ITOP. After the treatment, GGI derived from 3DGA was unchanged for L + TOP and ILok group, whereas children of ITOP showed a worsening in gait pattern (Table 1).

Discussions: Our data suggested that DGO therapy is safe, feasible to implement and well-accepted by children. DGO Lokomat seemed to be generally as effective as intensive traditional physiotherapy, with an additional slightly positive effect on gait endurance and maintenance of gait pattern of children.

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