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SECOND NATIONAL CONGRESS ITALIAN SOCIETY OF PHYSIOTHERAPY (SIF)

APPLYING INSTRUMENTAL MOVEMENT ANALYSIS TO PHYSIOTHERAPY

Turin - June 8-9, 2012

LECTURES

ORAL COMUNICATIONS

POSTERS

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Società Italiana di Fisioterapia

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Original articles. These should be original contributions to the subject. The text should be 2500-5000 words not including references, tables, figures. No more than 50 references will be accepted. The article must be subdivided into the following sections: *introduction, materials and methods, results, discussion, conclusions*. In the introduction the aim of the study should be clearly summed up. Justify the study, why is it needed. Summarize the rationale for the study or observation. Give only pertinent references, and do not review the subject extensively. Do not include data or conclusions from the work being reported. The materials and methods section should describe in a logical sequence how the study was designed and carried out. Identify the methods, equipment and materials, and procedures in sufficient detail including pertinent references, to allow others to reproduce the study. Describe how the data were analyzed (what hypothesis was tested, what type of study was carried out, how randomization was done, how the subjects were recruited and chosen, provide accurate details of the main features of treatment, of the materials used, of drug dosages, of unusual equipments, of the statistical method. In the results section the answers to the questions posed in the introduction should be given). Describe statistical methods in enough detail to enable knowledgeable readers with access to the original data to verify the reported results. Authors should report and identify the specific statistical test used and the obtained statistical value. When analysing several outcome variables and/or investigating the relationship between many variable consider to use multivariate statistical methods. Specify any general-use computer programs used. The results should be reported fully, clearly and concisely supported, if necessary, by figures, graphs and tables. Present results in logical sequence. Avoid repeating information in text, tables and figures. Restrict tables and figures to those needed to explain arguments and to assess their support. The discussion section should sum up the main results, critically analyze the methods used, compare the results obtained with other published data and discuss the implications of the results. Discuss the limitation of the study. The conclusions should briefly sum up the significance of the study and its future implications. Do not repeat in detail data or other information presented in the Introduction or Result section. It is suggested to the authors to follow the guidelines reported by the CONSORT statement.

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Case reports. These give a description of particularly interesting cases, for which is justified do not wait to have a greater sample size. Case reports are most valuable if they identify a previously not described finding or phenomenon, or if they describe a therapy that could lead to future research or a change in practice. The text should be 1500-3000 words not including references, tables, figures. No more than 30 references will be accepted. The article must be subdivided into the following sections: introduction, case report or clinical series, discussion, conclusions.

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Vol. 2 September 2012 No. 3

CONTENTS

SECOND NATIONAL CONGRESS ITALIAN SOCIETY OF PHYSIOTHERAPY (SIF)

APPLYING INSTRUMENTAL MOVEMENT ANALYSIS TO PHYSIOTHERAPY

Turin - June 8-9, 2012

87 LECTURES

101 ORAL COMMUNICATIONS

109 POSTERS

3rd SIF National Congress State of the art and perspectives of therapeutic exercise in physiotherapy: debate about concepts and proposals

Naples, 24-25 May 2013

The objective of the SIF Congress 2013 is to underline both the rationale and specificity of therapeutic exercise and to give examples about its applications in the most frequently occurring motor impairments.

The Congress will try to answer this question: "Does the therapeutic exercise specificity exist?".

The growth of scientific research in the physiotherapy field has led to an increase in the number of physiotherapy-based scientific papers but it has not yet answered this question. In fact, an overview of the literature shows different physiotherapy approaches addressed to similar clinical conditions.

On the contrary, physiotherapists know that the best results are obtained by tailoring the exercise program to both the patient's need and the physiotherapist's experience. At the same time, they also know that the exercise program should stem from knowledge of patophysiology movement and should be adapted to the evolving scientific literature.

A potentially endless number of clinical applications of therapeutic exercise for musculoskeletal and neurologic conditions could be presented and only those judged more interesting by the Congress Scientific Committee will be discussed.

Another criterion for the realization of the Congress program is to underline the Italian expertise in both the clinical and scientific fields. Some examples are lectures and speeches about the mirror neuron system or a round tables debate about different rehabilitative approaches for subjects after stroke.

Each session will open with a lecture that deepens its clinical or physiological aspects, with both Italian and foreign speakers. Moreover, the Congress will invite oral communications, selected according to their quality among the most relevant on the topic of the sessions.

PROGRAM

Friday 24 May 2013 Morning	9.00 - 9.10	Congress presentation *Paolo Pillastrini, Bologna (S.I.F. President)*
	Session I: therapeutic exercise in balance impairments *Chair: Andrea Turolla*	
	9.10 – 9.50	**Lecture** Postural organization and sensory-motor control in voluntary movement: implications for therapeutic exercise *Luigi Tesio, Milan*
	9.50 – 10.15	Balance treatment after lower limb joint lesions *Antonio Poser, Conegliano*

	10.15 –10.40	Balance treatment in Central Nervous System lesions *Davide Cattaneo, Milan*
	10-40-11.00	Discussion
	11.00-11.15	Coffee break
	11.15-11.40	Balance treatment by biofeedback *Stefano Vercelli, Veruno*
	11.40-12.25	3 Oral communications
	12.25-12.45	Discussion
12.45 lunch		
Friday 24 May 2013 Afternoon	**Session II: debate about concepts of neurological physiotherapy** *Chair: Roberto Gatti*	
	13.45 – 14.25	**Lecture** Early prediction of outcome after stroke: what is clinically relevant? *Gert Kwakkel, Amsterdam*
	14.25 – 15.25	**Round table -** *Chair: Roberto Gatti* Physiotherapy after stroke: debate about concepts *Rosario Fiolo (Palermo), Psiche Giannoni (Genoa), Gert Kwakkel (Amsterdam), Holm Thieme (Kreiska)*
	15.25 –15.45	Discussion
	15.45 –16.00 Coffee break	
	Session III : strength training *Chair: Antonio Poser*	
	16.00 – 16.40	**Lecture** Muscular activation physiopathology after joint lesion *Nicola Mafiuletti, Zurich*
	16.40 – 17.05	Training of muscles with arthrogenic inhibition *Andrea Tettamanti, Milan*
	17.05-17.30	Strength training in subjects with spasticity *Matteo Paci, Prato*
	17.30-17.45	1 Oral communication
Saturday 25 May 2013 Morning	**Session IV: cognitive facilitations and technologies supporting the therapeutic exercise** *Chair: Andrea Tettamanti*	
	9.00 – 9.40	**Lecture** Mirror neuron system and rehabilitation *Giovanni Buccino, Catanzaro*
	9.40 – 10.05	Motor imagery: to imagine to the motor performance *Roberto Gatti, Milan*
	10.05 – 10.30	Action observation treatment: to watch the motor performance *Elisa Pelosin, Genoa*
	10.30 – 10.55	Mirror therapy for improving motor function after stroke *Holm Thieme, Kreiska*
	10.55 – 11.15	Discussion
	11.15-11.30 Coffee break	
	11.30-11.55	Robotic systems in physiotherapy *Pietro Morasso, Genoa*
	11.55-12.20	Exercises performed in virtual realities *Andrea Turolla, Venice*
	12.20-12.50	2 Oral Communications
	12.50-13.00	Discussion
13.00 Lunch		

Saturday 25 May 2013 Afternoon	**Session V: therapeutic exercise in musculoskeletal disorders: debate about proposals** *Chair: Stefano Vercelli*	
	14.00-14.40	**Lecture** Low Back Pain: subgrouping classification and Clinical Prediction Rules *Antony Delitto, Pittsburgh*
	14.40-15.05	Musculoskeletal pain modulated by exercise *Marco Testa, Savona*
	15.05 – 16.15	**Round table** - *Chair: Silvano Ferrari* Therapeutic exercise in low back pain: debate about proposals *Anthony Delitto (Pittsburgh), Sara Luetchford (Milan), Robert Valentiny (Lugano), Marco Testa (Savona)*
	16.15-16.30	Discussion
	16.30-16.45 Coffe break	
	16.45-17.15	2 Oral communications
	17.15-17.30	Poster award and Congress closure

Treatment of patients with acute whiplash using a multimodal approach: a case series

A. CHIAROTTO [1], A. BOZZI [2]

[1]Private Practice, Turin, Italy; [2]Faculty of Medicine, School of Physiotherapy, University of Turin, Turin, Italy

ABSTRACT

Aim. Whiplash associated disorders often occur as a consequence of a motor vehicle crush. Researchers have investigated the effects of different physiotherapy interventions in the acute phase of the disorder. However, little evidence exists and it is about short-term effects of manual therapy, exercise and kinesio taping on pain and range of motion. The aim of this paper was to describe the management of 4 patients in the acute stage of whiplash, using a multimodal approach compound by manual therapy, therapeutic exercise and kinesio taping.

Methods. A series of 4 patients (aged 25 to 56 years) with a mean duration of WAD II of 13.5 days (range 5-20) were treated by a physical therapist twice a week for a total of 8 sessions. Outcome measures for pain, neck-specific disability, pain-related fear of movement and cervical active range of motion were taken at baseline, at the end of treatment and at 3-month follow-up.

Results. All the patients reported important clinical improvements on pain, disability and fear of movement at the end of treatment, making further progresses towards a complete resolution of symptoms at the follow-up. Improvements concerning all the movements of cervical active range of motion were also found, although they did not overcome the minimal detectable change reported in the literature.

Conclusion. The generalizability of these results is limited due to study design; nevertheless the multimodal approach presented in this paper showed promising results to be further investigated in a future clinical trial. *(It J Physiotherapy 2012;2:76-84)*

Key words: Musculoskeletal manipulations - Exercise therapy - Kinesiotape.

Whiplash is a painful musculoskeletal condition that usually occurs as a consequence of a motor vehicle crash (MVC). The term whiplash associated disorders (WAD) is used to describe physical and psychological consequences due to the whiplash injury. Even if a large part of WAD patients has a natural recovery, literature is concordant in indicating that approximately 50% of patients continues to report whiplash-related symptoms up to 1 year after their MVC.[1, 2] A recent prospective cohort study showed that subjects who had moderate levels of disability (measured with the Neck Disability Index) at baseline (39% of the cohort) were likely to have mild levels of pain and disability at 1-year follow-up, whereas those who reported severe disability levels (16% of the cohort) reported moderate or severe levels of pain and disability.[3] However, different studies agree that most recovery occurs in the first two or three months after injury.[2, 3]

Costs associated to the whiplash injury, including medical care, legal services, low work productivity, as well as personal costs, are very high. Taking into acount the number of people who develop chronic symptoms and their related costs, the development of therapies that may prevent chronicity is fundamental.[4]

Despite the relevance of targeting treatments in the acute phase of WAD, only a few studies of early management were carried out and it re-

mains unclear what is the best the best therapeutic approach.[4]

In clinical practice, physiotherapists deliver different interventions for acute WAD and the majority of them (like education, exercise and manual therapy) have been investigated in the literature.[5-7] However, not all the interventions are sustained by the same level of evidence. Rehabilitation programs that include ROM and muscle retraining exercises, besides requiring patients to maintain normal life activities and to stay active, are recommended by the guidelines.[8]. The use of mobilization and exercise in reducing pain in the short-term is supported by moderate quality evidence as reported in a recent systematic review.[6] Nevertheless, the same systematic review is in agreement with a previous one [7] in affirming that there is a lack of quality evidence for these interventions in acute WAD. In fact, only one randomized controlled trial (RCT) of high-quality could be detected, in which manual therapy following Maitland's regimen and active exercises were more effective than rest and collar in reducing pain and improving range of motion in the short-term.[9] Another recent systematic review examined exercise in greater details, highlighting that, even if conflicting evidence exists, active exercise programs are associated with reduced pain intensity in the short and medium term and they are superior to immobilization with a collar.[5] In the effort to describe the exercises that showed more evidence of effectiveness, Gross *et al.*[10] found that neck active range of motion exercises are those having the most prominent results for acute WAD.

Nowadays, other than exercise and manual therapy, an intervention often adopted in clinical practice is kinesio taping.[11] This intervention is not included in systematic reviews because only one RCT was conducted in subjects with acute WAD, therefore it is sustained by a lower level of evidence. This high-quality RCT (PEDro score = 8) showed that kinesio taping is effective in decreasing pain and increasing range of motion immediately after the application and at a 24-hour follow-up.[12]

This research was inspired by the clinical setting, where physical therapists often combine different interventions when treating patients. In an attempt to link evidence to practice, the aim of this study was to contribute to the literature by illustrating the effectiveness of a multimodal approach constituted by the best available evidence for acute whiplash. Before conducting a clinical trial, this treatment was evaluated describing outcomes for a series of patients who reported the consequence of a recent MVC. Outcomes were also evaluated at a 3-month follow-up to determine whether this intervention may prevent the chronicity of the condition. To date, this is the first attempt to evaluate the effectiveness of a multimodal approach for subjects in the acute phase of WAD.

Furthermore, the existing evidence found improvements in pain and range of motion without showing clinical improvements for other relevant outcomes, like disability and psychological distress, both demonstrated to be clinical features of the chronic stage of whiplash.[2, 3] Thus, outcome measures to evaluate these constructs were used in this case series.

Materials and methods

Consecutive patients referred by their general practitioner to a private clinic in Torino, Italy, presenting with neck symptoms over a 2-month period (June 2011-August 2011) following a MVC were examined for eligibility criteria. Inclusion criteria for this case series were: WAD grade II within 30 days from the injury, currently experiencing at least moderate disability, not currently receiving care for whiplash, proficiency in written and spoken Italian. Exclusion criteria included a suspected serious spinal pathology, spinal surgery in the past 12 months, diagnosis of mental health disease, WAD grade III (nerve root involvement), WAD grade IV (fracture or dislocation), coexisting problems that would limit participation in the therapeutic program. A total of 4 patients met all the criteria and participated in the study. Patients demographic characteristics are shown in Table I. All of them were treated in the private clinic where they were referred. This study was carried out as part of a bachelor thesis for the degree in Physiotherapy, at University of Turin. The study was approved by the Institutional Review Board at University

Table I.—*Patients demographic characteristics.*

Patient	Age	Gender	Duration of Symptoms (days)
1	32	F	19
2	44	M	20
3	25	M	5
4	56	M	10

F: female; M: male.

of Turin, Italy. Privacy and informed consent were presented to the eligible participants who signed them before entering in the study.

Examination

Patients completed a number of baseline self-report questionnaires, followed by a comprehensive examination carried out by a physical therapist. The historical examination included patient age, sex, occupation, sport activities, days passed from the MVC, area of current symptoms recorded on a body chart, behavior of symptoms during 24 hours with aggravating and easing factors, symptoms irritability, past neck complaints and medical history.[16]

The physical examination included postural assessment,[16] cervical active range of motion (CAROM) measurements,[17, 18] neurological assessment (myotomes, dermatomes, reflexes and neurodynamic tests),[16] testing of passive physiological intervertebral movements (PPIVM's) of the cervical spine,[16] testing of passive accessory intervertebral movements of the cervical and thoracic (T1 through T4) spine,[16] muscle control of the deep cervical neck flexors (DCNF).[19]

CAROM measurements were the only part of the examination that was carried out by an assistant physical therapist.

Outcomes

Self-reported measures included a pain Visual Analogue Scale (VAS), the Neck Pain and Disability Scale (NPDS-I), and the Tampa Scale of Kinesiophobia (TSK-I). The VAS used to measure pain intensity was constituted by an horizontal line 100-mm long with the anchors "no pain" on its left and "worst pain imaginable" on its right. Patients were asked to put a mark on the line to rate how bad their pain was in the last 24 hours. Then VAS measures were registered by measuring the distance in millimeters from the left anchor to the mark that the patient made on the line.[13] The VAS rating for the last 24 hours was shown to be the most responsive measure for clinical change of pain in comparison with VAS for pain "at the moment" and the McGill Pain Questionnaire.[13] The Italian version of the NPDS was used to measure neck-specific disability. The NPDS contains 20 items related to 4 dimensions: neck pain intensity, neck problems, effects of neck pain on emotions and interference with daily life activities. Each item ranges from 0 (meaning normal function) to 5 (meaning the worst possible situation experienced on the problem) on a line where patients have to put a mark; hence, total score ranges from 0 to 100.[14] The Italian version of the NPDS showed good validity and reliability in a population of subjects with non-specific neck pain in its subacute (lasting more than 4 weeks) and chronic phase.[14] In a population of subjects with chronic low back pain the Italian version of the TSK was tested and showed good reliability and validity.[15] The TSK is a widely used questionnaire to assess pain beliefs and pain-related fear of movement in subjects with musculoskeletal complaints. The Italian version is a 13-item questionnaire in which each question can be scored using a 4-point Likert scale ranging from 1 (strongly disagree) to 4 (strongly agree).[15] Total score can range from 13 to 52, with higher scores representing stronger fear-avoidance beliefs. Although both Italian versions of NPDS and TSK were validated in samples where patients with acute neck pain following whiplash injury were not included, these questionnaires were included because, at the time of this work, they were the only cross-

cultural adapted tools validated in Italian to measure these constructs.

Cervical active range of motion (CAROM) measurements were included in the outcomes as objective measures; they were registered with patients in sitting, placing an inclinometer on the top of the head and asking to move the head as far as possible without pain in flexion, extension, right and left lateral flexions (RLF and LLF). This procedure was shown to have an excellent reliability, reporting intraclass correlation coefficients (ICCs) for these movements between 0.91 and 0.93.[18] A universal goniometer was used to measure right and left rotation (RR and LR); a previous study showed that this simple instrument has an excellent reliability (ICCs between 0.84 and 0.88).[17] Self-reported questionnaires and CAROM measurements were repeated at discharge and at follow-up at 3 months after the end of treatment.

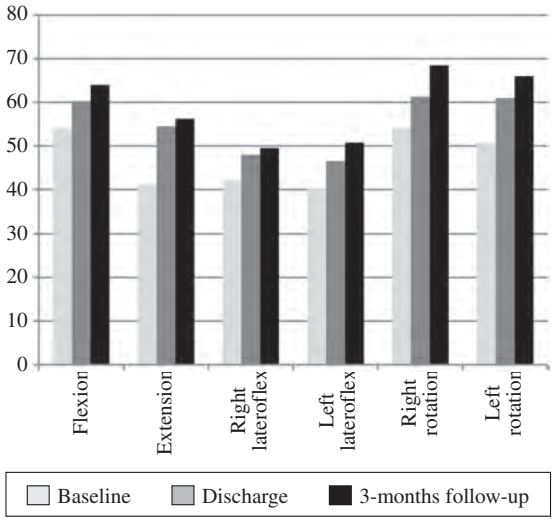

Figure 1.—Cervical active range of motions at baseline, discharge and 3-month follow-up.

Intervention

All the treatments and the evaluation were performed by the same physical therapist, with 5-year experience in the treatment of subjects with musculoskeletal complaints. The treatment schedule consisted of 2-weekly sessions of one hour for 4 weeks. All patients received the following 4 treatment components: cervical and thoracic (T1 through T4) accessory movements mobilization, retraining exercises of the DCNF, active range of motion exercise, and kinesio taping. Patients were reassessed on each session for subjective complaints of pain and other symptoms (area and behavior), for CAROM, passive accessory intervertebral movments and muscle control of the DCNF. Moreover, patients were asked to inform the physical therapist in case they reported any side effects or took painkillers/antinflammatory drugs.

Accessory movements mobilization was determined by the treating therapist and based on the clinical examination of each respective patient. During every session, examination of postero-anterior (PA) and antero-posterior (AP) accessory movements was done in order to detect the point where treatment could begin. According to Maitland,[16] in patients with symptoms severity-irritability (SI), grade I and II mobilizations were used without causing pain in the pain-free movements. These are large (grade II) or small-amplitude (I) oscillatory, slow movements short of resistance. In contrast, when SI was not present (or diminished between sessions), grade III and IV mobilizations were used to the point of pain onset or partially reproducing it. These are large (grade III) or small-amplitude (IV), fast, smooth, oscillatory movements inside the resistance of the accessory movement. Every mobilization involved three repetitions of a treatment technique, each lasting between 30 seconds and 1 minute, because this was the time used by research that demonstrated positive effects of cervical joint mobilization.[20] The number of mobilization techniques was decided upon patients levels of pain and SI.

PA unilateral and central mobilizations of the atlanto-occipital joint (C0-C1) were carried out with the patient lying prone and thumb pressure was applied over the posterior arch of the occiput with an upward and forward direction towards the patient's eyes (Figure 2). PA unilateral and central mobilizations between C2 and C7 were executed with patient prone and applying thumb pressure in a forward direction to the spinous process and to the articular pillar of the vertebrae (Figure 3). PA central mobilization of the thoracic spine (T1-T4) was done with patient lying prone, with a pisiform grip in

Figure 2.—C0-C1 postero-anterior mobilization.

Figure 3.—C2-C7 postero-anterior mobilization.

a forward direction on the spinous processes. On the other hand, thumb forward pressure on the transverse process was used for unilateral thoracic PA mobilization. AP unilateral mobilization (C2-C7) was carried out with the patient supine and thumb pressure was applied in a backward direction to the anterior aspect of the transverse processes, with care to avoid pressure over the carotid artery (Figure 4).

Deep cervical neck flexors training was included in the "Neck Care Tool Kit" developed to translate evidence into practice.[10] The choice of this training was also based on the evidence concerning impairment of DCNF muscles in subjects following whiplash injury [21] and on the effectiveness of this specific training in improving DCNF activity in subjects with neck pain.[22] The training is based upon the results of the test.[19] In supine lying, patients had to perform craniocervical flexion during the 5 stages of the test at different pressure level (22, 24, 26, 28 or 30 mmHg reported on a biofeedback stabilizer)

Figure 4.—Unilateral C2-C7 antero-posterior mobilization.

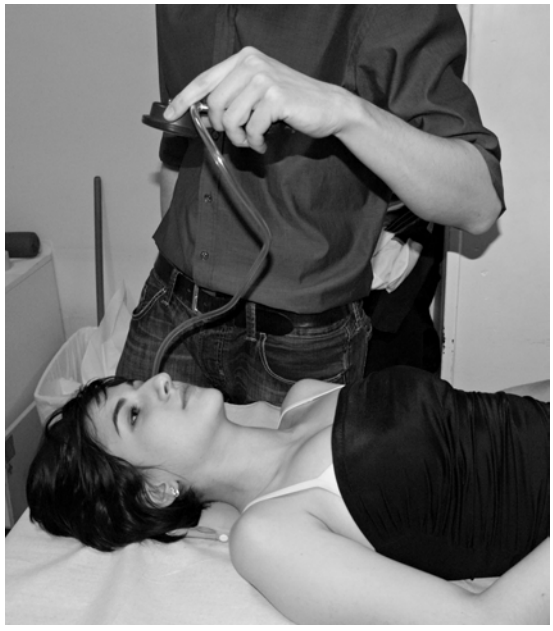

Figure 5.—Deep neck cervical flexors training.

activating the DNCF muscles (longus colli and longus capitis), avoiding substitution strategies with superficial muscles (Figure 5).[23] At the pressure level in which patients were able to do the correct movement, training of the holding ca-

pacity of the DCNF could begin. Patients had to start with repetitions of 10 seconds and they were discouraged to carry on in case they performed jerky movements or when they felt manifestations of fatigue like tremor. Once the holding contractions at a certain pressure level could be performed for 10 repetitions of 10 seconds, the exercise was progressed to train endurance at the next pressure level (from 22 to 24, from 24 to 26, etc).[21] Home practice endurance training was encouraged to be repeated twice a day, every day. The ultimate goal of this training is to end-up performing 10 repetitions of 10 seconds at the 30 mmHg pressure level.[23]

Neck active range of motion exercises were taken from a high-quality RCT for acute WAD that showed positive results [9] and they were also present in the "Neck Care Tool Kit".[10] During every session, the patient seated had to perform from the neutral position 10 slow movements of forward flexion until the onset of pain and return. In the same manner, they had to perform 10 repetitions for each of the following movements: bending backward, lateral flexion from side to side and turning head right and left.

Kinesio taping application was used at the end of every single session. Although there is a lack of evidence supporting its effectiveness with repeated applications on whiplash patients, it was decided to follow this standardized protocol often used in the clinical setting. For the tape application it was followed the procedure presented in other works.[11, 12] The tape that was used (Kinesio Tex Tape) is adhesive and water-resistant, 5 cm wide and 0,5 mm thick. Two pieces of tape were cut and one of them was divided into 2 same-width tails forming an Y. With patients seated, this piece was attached in its largest part to the cervico-thoracic junction (T1-T2) with a cranial direction. Then, patients were asked to move the neck towards coupled lateral flexion and rotation while the tail opposite to the side of movement was applied with an approximately 20% stretch towards the upper cervical spine (C1-C2). The same procedure, towards the other coupled movement, was followed to attach the second tail of the first piece. The second piece was a space-tape opening and it was applied with the neck positioned in full-flexion (in order to apply tension to the posterior structures) over the mid cervical spine (C3-C6) directed perpendicularly to the neck (Figure 6).

Figure 6.—Cervical kinesio taping application.

Results

Baseline and post-treatment values of self-reported questionnaires can be seen in Table II. Mean values of cervical active range of motion can be found in Figure 1.

Mean values of all the outcomes are reported as mean ± standard deviation (SD). At discharge, the patients had a mean reduction of 31.75±3.3 mm on the VAS. The minimum decrease of pain was reported by patient 1 with 28 mm (range: 28-35 mm). Mean reduction on the NPDS-I

Table II.—*Self-report measures scores at baseline, discharge and 3-month follow-up.*

Patient	VAS (mm)			NPDS-I			TSK-I		
	Initial	Discharge	3-month FU	Initial	Discharge	3-month FU	Initial	Discharge	3-month FU
1	51	23	0	32	8	0	27	16	13
2	59	27	12	41	6	3	30	19	15
3	42	11	4	35	1	1	19	13	13
4	64	29	0	45	13	0	27	19	13

was 31.25±4.99 points with a range between 24 and 35. The decrease in pain-related fear of movement (TSK-I) had an average score of 9±2.44 points.[6-11]

These results were maintained and further improved at the 3-month follow-up (FU). Mean reductions from baseline were of 50±10.8 mm for VAS, 37.25±5.73 points on the NPDS-I and 12.25±4.19 on the TSK-I. At that time point, patient 1 and 4 displayed zero values in all of the three self-reported measures. Patient 4 was the one who reported best improvements since he had the highest scores on VAS and NPDS-I at baseline (64 and 45 respectively). Patient 2 and 3, although did not report the minimum score in the questionnaires, displayed minimal values of VAS, NPDS-I and TSK-I.

All patients showed improvements in the CAROM at discharge (Figure 1), with a mean improvement in flexion of 6.25±0.96° (range: 5-7°), extension of 13.25±3.27° (11-15°), RLF of 6±2.82° (4-10°), LLF of 6.25±3.2° (3°-9°), RR of 7.25±3.95° (4-13°) and LR of 10.25° ± 0.5° (10-11°). From discharge to FU, movements that had the biggest improvements were flexion (mean change from baseline: 10±3.27°, range: 6-14°), RR (14.5±3.87°, 9-18°) and LR (15.25±7.68°, 7-25°). The only exception was represented by patient 3 that at the FU did not improve flexion (-1° change from discharge), right lateral flexion (-2°), left lateral flexion (-2°) and left rotation (-3°) (Figures 1-3).

All the patients did not have problems to tolerate the proposed intervention and they did not report any side effects during the treatment period.

Discussion

In recent years some studies evaluated the effectiveness of physiotherapy approaches for people in the acute phase of whiplash.[5-7] However, the majority of these trials studied the effectiveness of one intervention alone and failed in demonstrating superior benefits for one of them. This case series is likely to be the first attempt to describe a multimodal intervention for this group of patients. The aim of the study was to describe the outcomes of patients with WAD who underwent a standardized physiotherapy treatment regimen that included manual therapy, active motor control exercise, active range of motion exercise and kinesio taping.

Improvements for pain at discharge (mean ± SD=31.75±3.3 mm) may be considered clinically meaningful because the mean value subtracted by its SD (28.45 mm) is greater than the minimal clinically important difference (MCID) reported in the literature for the VAS, which ranges between 13 and 19 mm.[24, 25] At the FU, previous improvements became even greater with 2 patients out of 4 reporting "no pain". No data could be found in the literature that report the MCID for the NPDS-I and the TSK-I. However, it can be noticed in the results that, at the FU, 2 out of 4 patients had no complaints on neck-related disability and 3 out of 4 had no complaints of kinesiophobia. The other subjects displayed scores really close to zero that can be classified as "minimal".

Considering the design of the study a cause-and-effect relationship cannot be established. Nevertheless, on the basis of these results, this multimodal approach can be evaluated as a possible treatment for improvements in the outcomes analyzed in patients who respond to the same inclusion criteria; furthermore, these effects may be maintained and further improved at a 3-month follow-up.

The follow-up was, for all the patients, at least 4 months after the MVC when persistent WAD usually occurs for 50% of the patients.[1, 2] Subjects with moderate levels of disability at baseline, like the subjects of this study, were predicted to have mild disability and pain in this phase,[3] whereas our patients displayed none or minimal pain and disability. In a large prospective cohort study, a significant relationship between pain-related fear of movement and the duration of neck symptoms in acute WAD was found, showing a negative predictive value for kinesiophobia.[26] Although our patients had some initial symptoms of kinesiophobia, they did not report any pain at the FU. These above mentioned considerations support the value of the findings for self-reported measures.

Among CAROM increases at discharge, considering mean values minus SD no movements

were superior to the minimal detectable change (MDC) of 13° reported in a previous reliability investigation.[27] The MDC can be defined as the minimum amount of change in the result that indicates that the change is not due to a measurement error. MDC for CAROM measurements like those used in this study ranged from 10° for RLF to 19° for LLF.[27] At the FU, mean CAROM differences further improved but none of them surpassed the MDC. These results are in line with previous trials that did not exceed those values for any CAROM movement, although their results were statistically significant between and within groups.[9, 12]

A limitation of this study is the lack of evaluation of post-traumatic stress disorder (PTSD) that was found to be a clinical feature of chronic WAD. In fact, PTSD symptoms were found to be present for 22.3% of a cohort of patients 3 months after the MVC and for 17.1% at 1-year follow-up.[3] Therefore, it is not known if this proposed intervention can have any effects on PTSD.

The external validity of this study may be limited by its design, but also by the fact that all patients were examined and treated by one physical therapist; in fact, manual therapy skills may differ substantially among physical therapists. A further limitation for the generalizability of findings may be represented by the absence of measures to determine patients' participation in the home-based program.

Even if the results seem to be interesting, future research in the form of clinical trials is necessary to investigate the effectiveness of such a multimodal approach.

Conclusions

In this case series, 4 patients with moderate disability in the acute phase of WAD were treated with a multimodal approach of manual therapy, therapeutic exercise and kinesio taping. They exhibited clinically important reductions in pain, disability and fear of movement at the time of discharge, and an almost complete resolution of self-reported complaints at a 3-month follow-up. Also cervical active range of motion for all the movements showed a tendency to increase at both re-evaluation time points. Because a case series cannot establish a cause-effect relationship, further research in the form of a clinical trial is necessary to test the exact potential of this combined approach.

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Second National Congress
ITALIAN SOCIETY OF PHYSIOTHERAPY (SIF)

APPLYING INSTRUMENTAL MOVEMENT ANALYSIS TO PHYSIOTHERAPY

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LECTURES

Motor performance analysis by surface electromyoghraphy.

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The aim is to present some experiences in which the use of surface electromyography (sEMG) has been necessary for the comprehension of the motor performance.

sEMG to compare the involvement of the same muscle in two different exercises.

The strengthening of abdominal muscles is traditionally performed by isometric or concentric abdominal contractions. A study about the comparison of the two rectus abdominis activity during AB Slider and crunch exercises has been conducted (1). The AB Slider is a device permitting exercises in quadrupedic position (Fig 1). During the AB Slider exercise the rectus abdominis activation was greater than during the crunch. The reason is that during AB Slider exercise the activity of latissimus dorsi and the hips flexors muscles and the body weight would cause an anteversion of the pelvis that is stabilized by the abdominal muscles.

sEMG to detect the postural activity during the coordination of voluntary movements.

Literature data show that in-phase movements are easier than anti-phase ones. The hypothesis of the study was that a minor metabolic cost is the cause of the in-phase easiness (2). Enrolled subjects were told to perform cyclic movements of upper arms abduction/adduction and flexion/extension in the following tasks: 1) only the right limb was moved, 2) both limbs were in-phase moved, 3) both limbs were anti-phase moved. sEMG of following stabilization muscles was recorded: Adductor Longus, Gluteus Medius, Rectus Femoris, Biceps Femoris. The sEMG intensity was greatest in the anti-phase condition and lowest during the in-phase condition. It could be speculated that the easiest patterns of movement are those with minor postural activity and, consequently, minor metabolic cost.

sEMG to detect the postural activity of intra-body stabilization

The objective of this work was to assess the activation of the stabilization muscles used to keep one lower limb raised from supine position in healthy subjects and in subjects with multiple sclerosis (MS) in two different conditions (3). The test required subjects to keep the right lower limb at 45° from the supine position on a horizontal plane, with the knee extended. The position was reached: by raising the right limb (A), by resting the left lower limb on the bed after both limbs had been raised (B). SEMG activity was acquired in fourteen healthy subjects and 14 subjects with multiple sclerosis. In condition A healthy subjects had a greater activation of the biceps femoris than the abdominal muscles, while in the condition B the difference between the two muscles decreased. In the MS group there was no difference for the two conditions. The data show that in the MS subjects there is an alteration of the stabilization muscles activation.

sEMG to detect muscle inhibition after knee surgery

After joint trauma or surgery a neurologic inhibition of the muscles involved in the injured joint movement is described. Literature data underline the role of an alteration of spinal reflex mechanisms as an explanation of this phenomena. Nevertheless, clinical experience shows that the same inhibited muscle changes its level of maximal activation depending on the exercise performed. Normally, the quadriceps is more activated during knee extension than the raising lower limb. By sEMG it has been demonstrated that the day after knee surgery of meniscectomy the quadriceps is more activated during maximal isometric attempt of lower limb raising than maximal isometric attempt of knee extension (4) (Fig. 2). An alteration of spinal reflex mechanisms would not seem sufficient to explain the phenomena of muscle inhibition after joint injury.

Figure 1.—Lateral view of the AB Slider exercise.

Figure 2.—After knee surgery the sEMG activation is greater during the attempt of lower limb raising than during the attempt to extend the knee.

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Applications of EMG imaging in physiology, ergonomics, rehabilitation, and obstetrics.

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Electromyography is becoming an imaging technique where two-dimensional (2D) electrode arrays are used as a "retina" providing pictures of electrical potentials. Two types

Figure 1.—Example of an array placed over the biceps brachii muscle. The array has 64 electrodes (5x13 -1) with an inter-electrode distance of 8mm. The differential EMG signal is taken in the fiber direction between adjacent electrodes. The ARV of each channel is computed over a few seconds during which the elbow slowly flexes by 80°. A time changing image of the ARV (5x12 -1 pixels) is obtained and is interpolated to obtain a smoother picture which evolves as the biceps shortens. The first and last images are shown in Fig. 2.

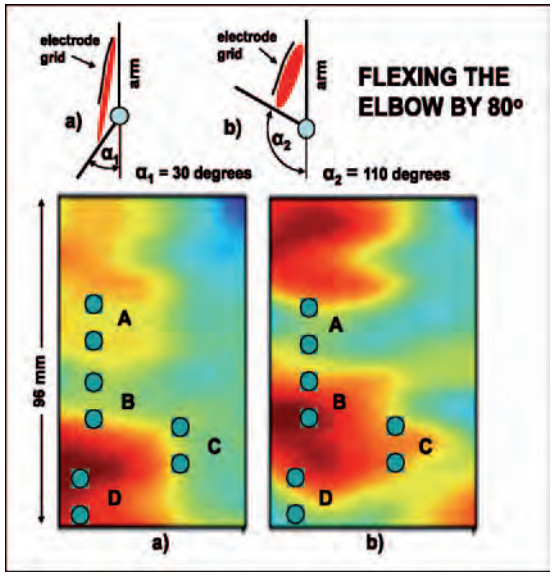

Figure 2.—a) Elbow extended and interpolated map of the ARV distribution. b) Elbow flexed and interpolated map of the ARV distribution. Consider a single pair of electrodes placed on the muscle. Operator A places the electrode pair in location A and observes a decrease of EMG with elbow flexion. Operator B places the electrode pair in location B and observes an increase of EMG with elbow flexion. Similarly for cases C and D. It is clear that the conclusions reached by the different operators may be very different and even opposite. Red means high amplitude, Blue means low or zero amplitude.

o pictures can be obtained: 1) pictures of the instantaneous potential distribution taken 1000 or 2000 time per second and later displayed as a movie at a much lower rate, 2) picture of average amplitude values over a given "epoch" of 0.25s or 0.5 s or longer duration, where "amplitude means Average Rectified Value (ARV) or Root Mean Square Value (RMS) of the monopolar or longitudinal single differential EMG signals. Images representing the distribution of spectral variables, are possible. Fig. 1 and 2 show an example of amplitude maps over and extended and e flexed biceps brachii.

It is clear that the amplitude of single differential (SD or bipolar) EMG signal may be very different over different regions of a muscle. In particular, over a fusiform muscle with fibers parallel to the skin the innervation zone and the muscle-tendon regions correspond to low amplitudes and should be avoided. However their location is unknown, unless a 2D electrode array (grid) is used to outline it. A shortening and shift, in the proximal direction, of the muscle under the electrode grid is evident in Fig. 2. If the muscle moves under the electrodes, the relative electrode-muscle position of the electrode changes. Therefore, the signals change during movement. This example outlines the difficulties of EMG interpretation in dynamic conditions when a single pair of electrodes is used. Very often the signals are misinterpreted. For additional information see the recent book "Atlas of muscle innervation zones: understanding surface electromyography and its applications", Springer Verlag, 2012.

One-dimensional (1D, one linear electrode array) or 2D arrays provide estimates of muscle fiber conduction velocity, an important indicator of myoelectric manifestations of muscle fatigue.

Segmentation of the maps in regions of high and low amplitude provides information about the activity of individual muscles. Electrodes placed along the circumference of an intra-anal probe provide information about the innervation zones of the external anal sphincter. Such information is useful in minimizing neuromuscular damage of this muscle if episiotomy is performed during child delivery. Other applications concern the development of EMG controlled rehabilitation games or toys, and the evaluation of countermeasures in microgravity environments.

The role of EMG mapping technique in the analysis of the neuromuscular system

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High-density sEMG allows to place many electrodes on a limited skin portion, providing information about the distribution of the electrical activity of the muscle under the electrode grid[1]. With such a representation, it is possible to disclose the influence of a number of anatomical and neurophysiological factors on the EMG signal. Figure 1 shows a map of the average amplitude (RMS) of the single-differential EMG signal collected from the vastus medialis muscle during a low-effort isometric contraction. Through visual analysis it is possible to identify areas with different electrical activity (outlined with the black dashed lines). The EMG signals with the lowest amplitude were recorded on the musculo-tendinuous junction (E) and over the innervation zone, localized in the center of the muscle belly (A); knowing the anatomical details of the muscle under the electrodes can be useful to select which channels should be considered in order to limit the effect of the anatomical, confounding factors, improving the estimation

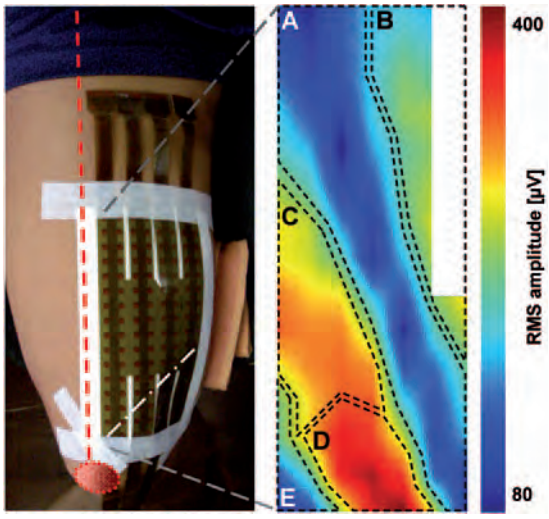

Figure 1.—Example of a grid (left) and the EMG RMS amplitude distribution over the vastus medialis muscle (right). The red line in the left panel links the patella and the anterior superior iliac spine. Monopolar signals were collected (16x8 electrodes spaced 1 cm) during a low-effort, isometric contraction. Single differential signals were obtained differentiating electrodes along the 45° diagonal direction (approximate fiber direction, dash-dotted white line in panel A). The resulting amplitude map was interpolated with a factor of 10, and the colours refer to the colorbar on the right side of the map. Clear differences in EMG amplitude between muscle regions can be observed; the dashed black lines outline those regions, identified through visual inspection [modified from [1], figure 7.4].

of physiological parameters. Travelling action potentials generated a high-amplitude EMG signal on the two sides of the innervation zone (B and C-D); the lower electrical activity in B than C-D is probably related to a thicker interposed tissue in the proximal portion of the thigh. For what concerns the differences between C and D, the most plausible interpretation is the selective recruitment of motor units in a specific muscle sub-portion: some authors, in fact, used this technique to identify inhomogeneities in motor unit recruitment in relation to level and direction of exerted force[2], fatigue[3] and adaptations occurring during the repetition of motor tasks or during pain condition[4]. This sort of analysis can also be useful in the field of musculoskeletal rehabilitation, as the within-muscle redistribution of activity is one of the key-points of the most recent pain-adaptation theory[5]. The possibility to selectively collect EMGs from a very localized skin portion, extracted by segmentation of a larger map, is also of particular interest in the case of body regions with many different muscles in a limited area. In these body areas, multi-electrode detection systems can be used to define the optimal placement for bipolar electrodes, that is the EMG technique commonly used in rehabilitation for the analysis of the motor performance. Even if both the amount and the quality of information obtained can be improved through high-density EMG techniques, if the aim is to record the interval of activity or a global EMG amplitude value of a muscle, couples of electrodes should be the first choice (if they are carefully placed, i.e. avoiding innervation zones and tendons, possibly in the muscle area the least sensible to crosstalk from other muscles). The longer set-up time and the more complex data processing required by high-density EMG are important limitation both in research and clinical settings. This problem is currently being addressed in laboratories working on more user-friendly devices and interfaces for the EMG detection and processing.

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Movement analysis plays a fundamental role supporting evaluation processes and rehabilitation medicine decisions, allowing:

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— Objective evaluation of serious disabilities and estimating functional rehabilitation potential.

— Control and monitoring the evolution of the patient being treated.

Motion analyzer systems can support therapists with analysis instrumentation that provides complete, accurate, and integrated data. The major movement disorders associated with neurological pathologies can be analyzed and used as indicators for both disability and pathology progression.

Ambulatory difficulties represent the most disabling problem for patients. However, posture behavior, muscle tone, procedures, motor coordination, can also provide useful biomechanical information included in the clinical assessment.

Specific analysis techniques can quantify any movement in detail: time measurements, joint kinematics, muscle activation patterns.

Using a motion analysis lab, walking irregularities can be identified, analyzed and corrected.

Before the intervention: Having examined the reports of the gait analysis, it is easier to decide the type of treatment: surgery, botulinic toxin, intrathecal baclofen pumps, orthesis, prosthesis, etc.

After the intervention: by comparing the analyses before and after treatment, results and improvements can be evaluated.

The main objective of physicians is to improve the quality of life of patients: the gait analysis lab has been created to help them attain this objective.

Kinematics

Optoelectronic TV cameras

Infrared video cameras follow the passive marker trajectories positioned in specific points of the body according to protocols that have been validated by the international scientific community.

Starting from the three-dimensional coordinates of the markers acquired, the system calculates the internal centers of

Figure 1.

rotation within each joint (shoulder, pelvis, hip, knee and ankle), outputting the changes in angle projected onto the three main planes of the body (frontal, sagittal and transversal).

Inertial sensors

Great relevance for the analysis of the movement is the availability of sensory devices capable of measuring its own movements (proprioceptive motion sensing), in the absence of external references. Inertial sensors, such as gyroscopes and accelerometers, are the most commonly used in wearable systems. The accelerometers measure linear acceleration components along directions determined by the physical structure of the device. Tri-axial accelerometers are now available, with sensitive directions that are two-by-two orthogonal. The gyroscopes respond to the component of the angular velocity oriented in the direction of a sensitive axis which is determined by the physical structure of the device itself.

Kinetics

Multi-axial force platforms record the 3 components of ground reaction force, (median, back-front, vertical), the center of Pressure (COP) coordinates and the torsion moment Mz.

Integrated with kinematics, the system also calculates moment and powers within the joints.

The transducer that converts an input mechanical force into an electrical output signal, can be piezoelectric or strain gauge both with its advantages and drawbacks.

Force plates must be distinguished from pressure measuring platforms that do not directly measure the applied force vector, although they can provide the coordinates of the center of pressure and the pressure patterns under the feet over time.

Società Italiana di Analisi del Movimento in Clinica

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The Società Italiana di Analisi del Movimento in Clinica (SIAMOC) was constituted on June 1999. Since then its activities have developed according to the original mission, i.e. promotion and education of the techniques and relevant clinical applications for the human movement analysis. This discipline has the scope of a) enhancing the overall assessment of patients with motor disorders, b) improving the efficacy of the treatments by means of a more careful quantitative assessment of the motor function, and c) quantifying the results of therapies and treatments.

Very uniquely, medical and engineering components are strictly integrated in the SIAMOC Society, and both contribute at creating a stimulating scientific environment, collaboration among groups, and professional competencies. The Society is open to collaboration with other scientific Societies, both national and international, and willing to activate initiatives of mutual benefit. The Society is affiliated with the peer-reviewed journal Gait & Posture, international reference for scientific article in the discipline. Members of our Society receive a subscription to the journal at the reduced rate as part of their annual membership. Each year the Society organizes in Italy a Congress, meetings, courses, and various seminars also on subareas of the discipline. In several occasions, awards are given to students and young researchers for their merits in original and innovative studies, both for methodological and clinical aspects. Whenever possible also specific scientific activities are financed by the Society.

Nearly 60 laboratories replied to a national survey about the instruments, the techniques and the patient populations dealt with. These are distributed over the entire national territory, and a large majority of these addresses both methodological issues and clinical assessments, single patient analyses as well as general hypotheses over population of patients. The most traditional instruments include stereophotogrammetric systems for the measure of marker positions, forceplates for the ground reaction force, electromyography for muscle activation signals, and baropodometry for the analysis of vertical loads on the plantar aspect of the foot. With these instruments, the kinematics and dynamics of the segments and the joints involved in the locomotion can be monitored with great details. Lower limb, but also trunk, foot, upper limb are investigated during activities of daily living or sport exercises. In addition, with these techniques, also posture and equilibrium are examined. All these measurements are

utilized for routine, quantitative evaluation of patients for clinical decision-making and treatment planning. Finally, it is important to emphasize that in both methodological and clinical areas, Italy has produced cutting-edge research, with a huge number of acknowledged original works in international meetings and peer-reviewed journals. In particular, this country has been leading the development of advanced protocols for the proper collection, processing and analysis of data in human movement.

For a deeper comprehension of the rationale for these measurements, a first set of clinical questions to be addressed for quantification and monitoring of motion can be as follow: How much is the motor performance affected by the neuromuscular or skeletal disease ? How much is the functional performance changing along time? Then, a second set of questions is more associated to the problem of modelling and the relevant potential capacity of predicting the result of pathologies, injuries, and treatments: How much can the pathological attitude overload the unaffected anatomical structures? How much can a local disease induce changes in other joints or structures? How can the adverse effects of an altered attitude be reduced by proper intervention? (orthoses, botox, surgery...).

Human motion analysis in the clinical context has demonstrated to be a fundamental tool in functional diagnosis, and is going to obtain an essential role in the clinical decision making process and in the selection of the most appropriate treatment option, as well as to acquire a central part in the design and assessment of rehabilitation programs.

The evaluation of muscle inhibition/inactivation

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Inhibition/inactivation of human skeletal muscles (also called arthrogenic muscle inhibition) is defined as the inability to maximally recruit motor units during a short maximal voluntary isometric contraction (Shield and Zhou 2004). Muscle inactivation is normally attributed to incomplete spatial recruitment (not all motor units are recruited) and/or submaximal discharge rate of active motor units. In vivo, it is possible to estimate the extent of inactivation by superimposing peripherally a short and powerful stimulation to the voluntary contraction (Merton 1954), while measuring the eventual extra-force produced by the current (see Fig. 1). Such extra-force is subsequently converted (normalized) to a percentage, which simply illustrates the extent of muscle activation, and in turn of inactivation.

As an example, for the quadriceps muscle, general estimates of inactivation are approximately 5-10% for able-bodied individuals (Park and Hopkins 2011), 20-30% for orthopaedic patients (Mizner et al. 2003), and 40-50% (and more) for neurological patients (Horstman et al. 2008). Depending on the characteristics of the stimuli and on the formula adopted to estimate the amount of inactivation, two techniques can be

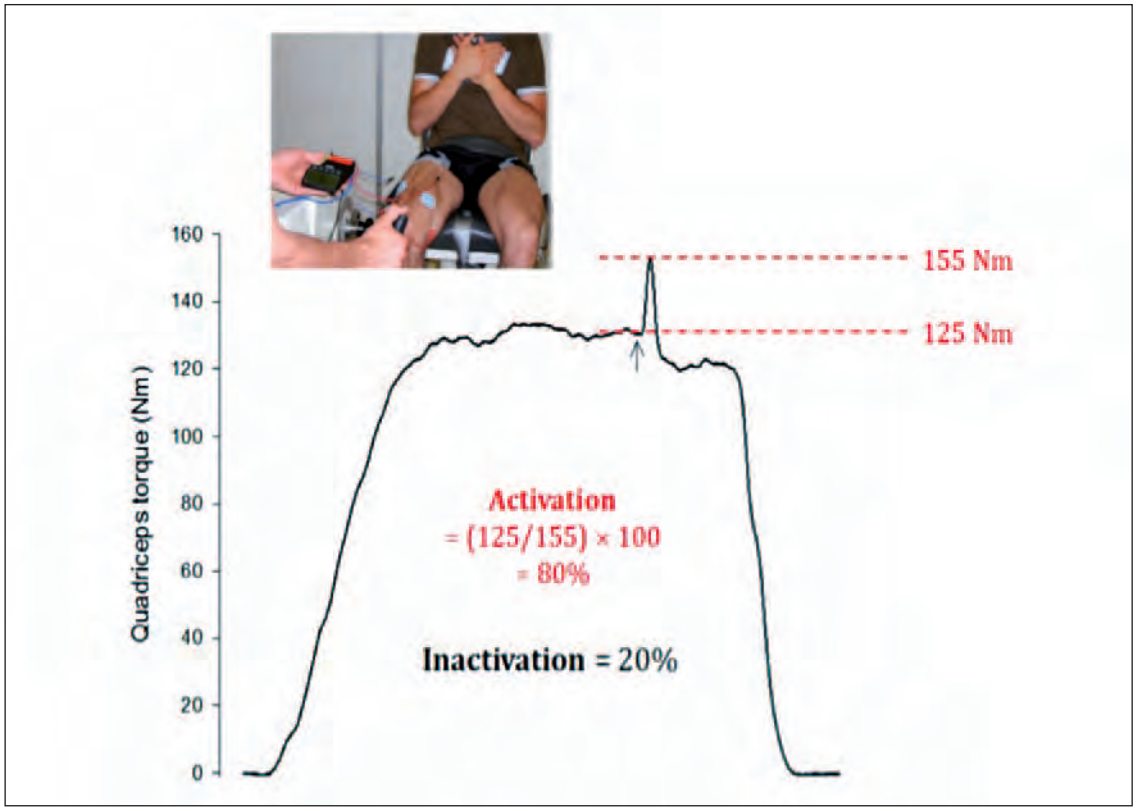

Figure 1.—Typical recordings of quadriceps torque during a maximal voluntary isometric contraction with a superimposed stimulation (arrow). The procedure for estimating the amount of inactivation is also depicted (according to the burst superimposed technique – see below).

Table I.—*Main differences between twitch interpolation and burst superimposed techniques.*

	Twitch interpolation	Burst superimposed
Stimulation site	Femoral nerve	Muscle belly
Stimulation type	Electrical (eventually magnetic)	Electrical
Stimulation unit	Constant-current (Digitimer DS7AH)	Constant-voltage (Grass S88X)
Stimulation intensity/voltage	Individual, supramaximal	Fixed at 125-135 V
Superimposed stimulation	Paired pulses at 100 Hz	100-ms train at 100 Hz
Resting stimulation	Paired pulses at 100 Hz	None
Estimation formula	Voluntary activation level 1-(superimposed/resting torque)x100	Central activation ratio (MVC/total torque)x100
Pros	More complete activation	Less discomfort
Cons	Quite « invasive »	Overestimation of inactivation
Common use	Europe and Australia	United States

MVC = maximal voluntary contraction.

distinguished: twitch interpolation vs. burst superimposed (see Table I).

In the last few years, muscle inactivation has been increasingly considered as the consequence, but also the cause, of specific neuromuscular or orthopaedic disorders, such as osteoarthritis (Palmieri-Smith and Thomas 2009). The longitudinal evaluation of muscle inactivation in clinical practice, and the eventual implementation of rehabilitation strategies aimed at restoring optimal muscle recruitment (e.g., imaginary strength training, contralateral strength training), have the potential for improving patient management of neuromuscular function.

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The use of isokinetic ergometer in clinical practice

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The isokinetic device is constituted by a lever that is connected to the limb of the subject we intend to examine. The speed of movement is predetermined by the operator and may be between 0 °/s (isometric condition) and 3-500 °/s (dynamic condition, concentric or eccentric mode) depending on the type and characteristics of the device used .

After a few movements of familiarization with the machine, the patient is asked to move the lever "with the maximum power and speed possibile".

The isokinetic devices are equipped with isokinetic force transducers (dynamometers) wich allow to calculate the torque expressed by a gropup of muscles in dynamic conditions during a movement performed at a specific constant speed.

It is also possible to record the Range of Motion (R.O.M.), using a position transducer. The computer thus provide a real-time series of parameters which need to be interpreted by the clinician.

The most important parameters to consider are: the peak torque (PT) and the work done (area under the curve torque / time) fig.1.

There is also the opportunity to obtain other parameters such as: the time required to reach the PT, the fatigue index when performing repetitive movements, and processing the data we can obtain the ratio between antagonist and antagonist muscle groups (knee flexor/extensors ratio), and also comparisons between contralateral limbs or with previous investigations.

Many studies have demonstrated the reliability and reproducibility of the data obtained with isokinetic dynamometers (Baltzopoulos e Brodie).

The isokinetic assessment can be considered useful to confirm the diagnosis and learn more about the functional abilities of the patient. In particular, the test provides a quantitative measure of the torque of a specific muscle group in dynamic conditions. The goal of the isokinetic assessment is to understand the ability of the patient to express force, power and endurance.

The isokinetic device allows to perform the same exercise at different speeds of movements so as to build the force/velocity relationship as torque/ angular velocity relationship.

For patients involved in a rehabilitation programme, a standard protocol provides 10-15 minutes of warming-up and stretching in preparation of the test. We test the uninjuried limb at first and then the injuried one using 4 consecutive movements at 90°/s (analysis of maximum force) and 20 consecutive movements at 180°/s (analysis of the endurance). This analysis is comparative between the injured and the contralateral healthy limb Fig. 2.

A deficit is considered when the differente between the two legs is more than 10%.

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Instrumental motion analysis in biomechanical disorders of the upper limb

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The computational approach to the motor system is a powerful analysis, in the field of neuroscience, which offers the opportunity to unify the experimental data in a theoretical framework. In the computational perspective, the motor behaviour is intended as the manifestation of an engineering system, whose basic task is to manage the relationships between motor commands and sensory feedbacks. This management is necessary for two reasons:

— it ensures that our movements achieve their goals;

— it enables us to learn by experience to make more accurate and effective movements.

As an example, Han et al. (1) developed a computational model for bilateral hand use in arm reaching movements to study the interactions between adaptive decision making and motor learning after motor cortex lesion (2). This model combines a biologically plausible neural model of the motor cortex with a non-neural model of reward-based decision making and physical therapy intervention. The model demonstrated that in the damaged cortex, during therapy, the supervised learning rules ensured that underrepresented directions of movement were "repopulated", thereby decreasing average reaching errors.

Based on a similar approach, the motion analysis of the upper limb allows, by means of optoelectronic or electromagnetic devices, to detect the biomechanical disorders of patients while performing rehabilitation exercises, functional tasks in real life, as well as controlled experimental paradigms.

The possibility to merge data from real patients into adequate theoretical frameworks gave the possibility, in the last years, to better comprehend the mechanism disrupted by peripheral as well as central lesions of the motor system.

On these basis, was demonstrated that after stroke:

— task related training are better than resistive training to improve scapular protraction, shoulder flexion, elbow extension and to reduce trunk flexion (3);

— kinematics parameters (i.e. hand peak velocity, time to peak, movement time) are reliable measures, with a minimal detectable change > 50% (4) (Figure 1);

— only trunk displacement discriminate for motor impairment (5).

Moreover it was possible to detect that a shoulder impingement usually induced an improvement of the anterior tipping and medial rotation of the scapula, with a consequent augmented activity of the upper and lower trapezius, while was reduced the upward rotation of the scapula and the activity of the serratus anterior (6) (Figure 2).

As original data, were presented the results from an innovative instrumental approach to study the behaviour of specific spinal modules (muscle synergies) after stroke. These spinal modules subserve normal motor behaviours by activating groups of muscles as individual units. The data collected and published at San Camillo Hospital Foundation (Venice), in collaboration with the Massachusetts Institute of Technology (Cambridge, MA), demonstrated that muscle synergies were stable after stroke being comparable between affected and non affected arms, as well as between patients and healthy subjects (7). More feasibly, the differences between arms' motor function after stroke, could rely on merging and fractionation phenomena of muscle synergies (8), that presumably could lead to a less adaptable motor behaviour.

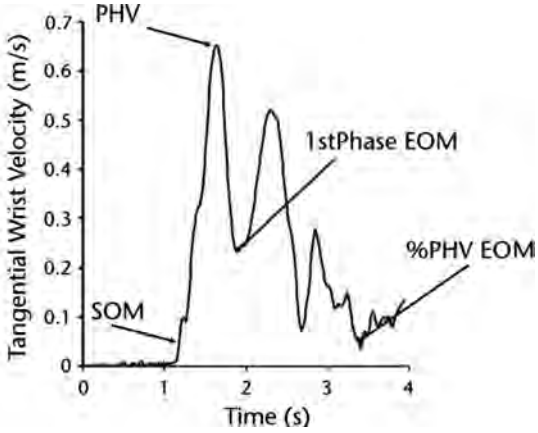

Figure 1.—Kinematics analysis of reaching movements in stroke patients (Velocity profile of the hand displayed along time, measured at wrist level. SOM: start of movement; PHV: peak of hand velocity; EOM: end of movement (From Wagner, 2008).

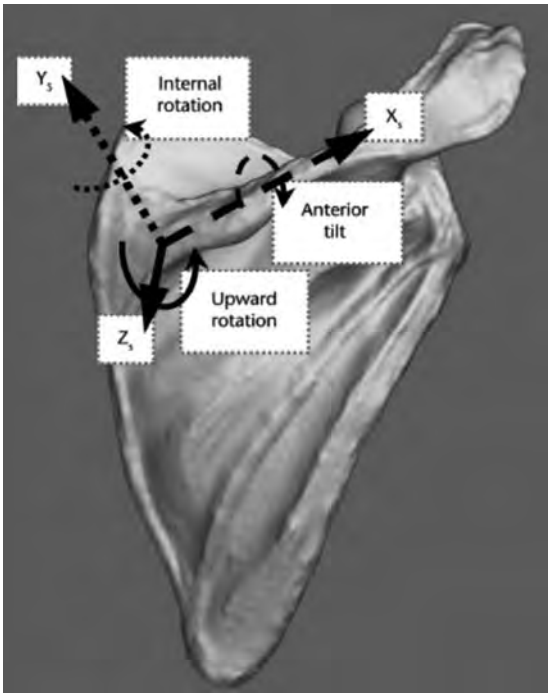

Figure 2.—Movement directions of the scapula [X_s: axis congruent with the spine of the scapula; Y_s: axis perpendicular to Xs; Z_s: axis perpendicular to the body of the scapula (From Crosbie, 2010)].

Future research for therapy based on muscle synergies disruption, were presented.

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TASI-2: Prevention of obstetric damage and applications of surface EMG on the analysis of pelvic floor muscles.

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Recent studies demonstrated that there is a significant correlation between anal sphincter damage during vaginal birth, with or without episiotomy, and subsequent development of anal incontinence in women. Mediolateral episiotomy is usually performed on the right side for convenience in cutting and suturing. Knowledge of the location of the innervation zones (IZs) could allow to choose the best side for performing episiotomy. Avoiding the incision of innervation zones during episiotomy would presumably reduce the incidence of anal incontinence. The aim of the TASI-2 project was to validate the methods developed in previous projects and to evaluate the effect of delivery related trauma on the external anal sphincter (EAS) muscle with surface electromyography (EMG). The total number of patients that participated to the study was 478. Nine clinical partners from five European Countries (Germany, Italy, Latvia, Slovenia, Ukraine) were involved in this multicenter study coordinated by LISiN. EMG measurements were performed with a disposable rectal probe including 16 silver electrodes. The study was divided in two experimental sessions (28th-34th gestational week and 6-8 weeks after delivery). 248 primiparae women concluded the experimental protocol. The drop-off of patients was about 50%, meaning

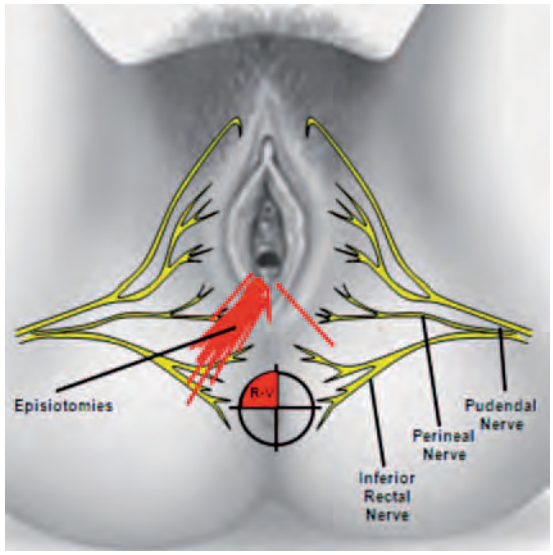

Figure 1.—Schematic representation of pudendal nerves and of the episiotomies which were performed within this study.

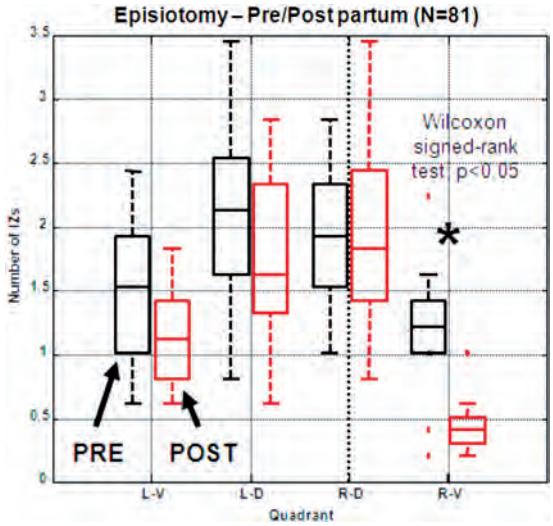

Figure 2.—Distribution of innervation zones before and after delivery for each of the four quadrants of women with Episiotomy. Median interquartiles and range are shown. Outliers are shown as red dots.

that about one patient out of two returned to the hospital for the second measurement after delivery. This drop-off could be explained due to the changes in behaviour of the patient due to the maternal duties.

The patients were asked to perform a maximal voluntary contraction (MVC) of the EAS for 10s. The innervation zones of single motor units were identified by means of a recently developed surface EMG decomposition algorithm. The gynaecologists involved in the study were asked to draw a picture of the episiotomy in a standard form (Fig. 1). Almost all episiotomies were performed on right side (just one on the left and two

in the midline). In women who underwent mediolateral right episiotomy (81 up to date), a statistically significant reduction (Wilcoxon signed-rank test, p = 0.017) was observed after delivery in the right ventral quadrant, corresponding to the side of episiotomy (Fig. 2), while women who had Caesarean section did not present any significant change in the innervation pattern. The results of the present study showed that women during the first or second trimester of pregnancy could have a fast and reliable clinical test which would provide indications on their sphincter innervation pattern. This information could help the obstetricians to choose which side is preferable for making episiotomy when necessary.

Motion analysis in cervical dystonia

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Dystonia is a neurological movement disorder characterized by involuntary muscle activity that produces spasms, slow repetitive movements or abnormal postures. Since the disorder can affect various body segments, dystonias are usually classified according to the anatomical distribution of symptoms in focal (localized to a specific body area), segmental (two or more adjacent segments), multifocal (two or more distant segments), hemidystonia (one side of the body) and generalized (multiple muscle groups throughout the body).[1] The most frequent focal dystonia is cervical dystonia (CD), also named spasmodic torticollis, that affects the neck and at times the shoulders. Most often it occurs in middle-aged people and women are affected about twice as frequently as men.[2]

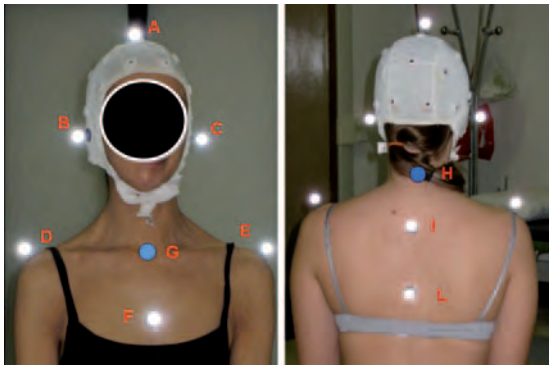

Figure 1.—Markers positioning for 3D reconstruction of head, trunk and shoulder girdle. Markers G and I are applied to locate the internal point corresponding to the centre of neck rotation.

A number of assessment tools have been developed, including the Toronto Western Spasmodic Torticollis Rating Scale (TWSTRS),[3] the Tsui scale[4] and the Cervical Dystonia Severity Scale (CDSS)[5]. Motion analysis protocols have also been applied in this field.[6-8] to get accurate and quantitative kinematic data, needed to evaluate objectively the effectiveness of interventions (drugs, surgery, exercise therapy) as well as the course of the disease.

In our laboratory, we developed an original protocol for kinematic assessment of involuntary movements and postures in patients with CD, which uses an optoelectronic system SMART e-90 with five infrared cameras (BTS, Milan) and 10 reflective markers applied as shown in figure 1. Compared to the abovementioned published protocols, it has the advantage of allowing also the assessment of involuntary shoulder girdle movements in addition to neck motions. After the positioning of markers, the protocol of assessment comprises two static tests (subjects are asked to stay seated motionless with spontaneous posture or looking at a point at eye level) and six dynamic tests (subjects are asked to smoothly move their head and neck to full flexion, extension, right and left lateral flexion, right and left rotation). The reliability of measures have been established in a sample of 20 healthy young individuals (10 men and 10 women, age 23.5±2.04) who performed two assessments 4 weeks apart.

We applied the protocol to measure changes obtained by an intervention that combines botulinum toxin and physiotherapy in 7 patients with CD (4 men and 3 women). After botulinum toxin injection, subjects were treated three times a week for a total of 10 sessions of physiotherapy. Treatment consisted mainly in gentle mobilisation, relaxation and stretching and strengthening exercises. Subjects were asked also to perform daily tailored exercises at their home. Outcome measures comprised kinematic data as well as the TWSTRS, the CDSS and the Tsui scale and were collected before the botulinum injection and after the end of physiotherapy. Results showed significant improvements in the TWSTRS and the Tsui scores ($p<0.05$) and an increase of maximal head and neck extension ($p<0.05$). Moreover, involuntary flexion movements during lateral flexion and rotation were significantly reduced ($p<0.05$, see figure 2). These preliminary data support the use of motion analysis for assessing the efficacy of available treatments for CD.

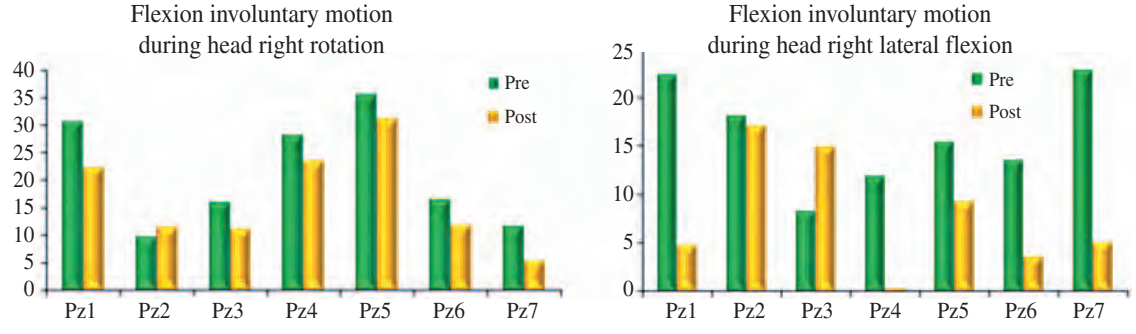

Figure 2.—Involuntary head flexion movement during active head rotation (left) and active head lateral flexion (right) to the right side, before (pre) and after (post) intervention in the 7 patients with cervical dystonia enrolled (Data in degrees).

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The spatial relationship between myofascial trigger points and the innervation zone in upper trapezius

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Myofascial pain syndrome is a common cause of pain in clinical practice. It is character- ized by the myofascial trigger point (MTrP), an exquisitely tender point in a taut band of muscle. Mechanical stimulation of the MTrP by palpation produces the phenomenon of referred pain that is felt at a distance from the point of stimulation. Electrophysiological studies indicated that an abnormal electrical activity in the innervation zone (IZ) is detectable in the myofascial trigger point region. This phenomenon has been described as endplate noise (EPN) due to an excessive release of acetylcholine and, together with sensitized sensory nerve fibers, constitutes the basis for MTrPs pathophysiology. Thus it is suggested that MTrPs should be located in the vicinity of IZ. The purpose of this work is to describe the location of MTrPs and the IZ in the upper trapezius.

Seventy-one subjects were screened to identify MTrPs in the upper trapezius. Twenty-four patients with neck pain and MTrPs (21 active MTrPs and 3 latent MTrPs) together with 24 healthy subjects with latent MTrPs were enrolled. During an isometric contraction of the upper trapezius electromyographyc signals (sEMG) were detected using an electrode matrix (13 rows x 5 columns). Subsequently a physiotherapist examined the enrolled subject's trapezius to confirm the presence of MTrPs and to establish their location. IZ locations were identified through visual analysis of sEMG signals. Both IZ and MTrPs locations were described by anatomical coordinate system (ACS). The ACS consisted in four quadrants obtained with a line between the spinal process of the seventh vertebrae and the acromial angle (X), and a second line perpendicular to the first one and passing through its midpoint (Y). Forty-eight subjects were included in the analysis: 18 patients with neck pain and active MTrPs, 6 patients with neck pain and latent

Table I.—*Summarised results. Column two indicates patient group. H. healthy group; NP. neck pain group. Column three indicates MTrP status: A. active MTrP; L; latent MTrP. Columns four and five indicates the MTrP location according to the ACS. Column six indicates the distance between the MTrP and the IZ.*

Subject	Group	MTrPs	X (mm)	Y (mm)	TrP-IZ (mm)
1	H	L	-1	-1	10
2	NP	A	-1	-1.5	2
3	NP	L	-0.6	-1.5	10.5
4	NP	A	-2.4	-1.6	4
5	H	L	-1.2	0	0
6	NP	A	-1.8	-1.3	14
7	H	L	-1.9	-0.8	3
8	H	L	-2	-0.6	16
9	H	L	-1.7	-0.3	14.5
10	NP	A	-2.5	-0.7	17.5
11	NP	A	-2.3	-1.2	11
12	NP	A	-1.3	-1.3	1
13	NP	A	-1.6	-0.6	9
14	NP	A	-2.7	-1.4	10
15	NP	A	-1.4	-1.4	12
16	NP	A	-2.2	-0.3	18
17	H	L	-2.1	-0.5	19.5
18*	NP	A	-0.9	-2.1	-
19	H	L	-0.1	-1.5	6.5
20	NP	L	-1.8	-1.3	6
21	H	L	-2.9	-1.4	9
22	H	L	-1.6	-0.3	9
23	H	L	-3.1	0	7
24	NP	L	-1.7	-0.1	16.5
25	H	L	-1.5	0	11
26	H	L	-2.7	-0.6	16
27	H	L	-1.1	-0.6	3
28	H	L	-2	-0.4	14
29	H	L	-2.7	-0.7	19
30	H	L	-2.9	-1	20
31	H	L	-0.7	-0.5	0.5
32	NP	A	-2.2	0	10
33*	H	L	-1.4	-1.7	-
34	H	L	-1.4	-0.6	10
35	H	L	-1.4	-0.7	2.5
36	H	L	-2.7	-0.5	12.5
37	H	L	-2.1	0	13
38	H	L	-2	0.1	8
39	NP	A	-2.9	-0.7	17
40	H	L	-2.6	0	14
41	H	L	-1.5	-1.4	12
42	NP	A	-2.3	0.5	11
43	NP	A	-2.2	-0.6	15
44	NP	L	-1.4	-1.5	10.5
45	NP	A	-1.9	-1.5	8
46	NP	A	-0.5	0	1
47	NP	L	-1.5	-0.4	1
48	NP	A	-2.1	-0.6	16
49	NP	L	-2.7	0.5	20
50	NP	A	-1	-0.9	6
51*	NP	A	-2	-1.9	—
52*	NP	A	-1.8	-1.9	—
Mean±SD					10.4±5.8

*Subjects who showed an MTrP located outside the matrix were excluded from the analysis.

MTrPs and 24 healthy subjects with latent MTrPs. According to the ACS 45 subjects showed aMTrP medially located respect to the Y-axis and all the MTrPs were included in the 3rd quadrant (bottom left quadrant) except 3 included in 2nd quadrant (top left quadrant) (Table. 1). No statistically significant difference was found for X (P=0.6) values and Y (P=0.1) values between active and latent MTrPs. The IZ was successfully detected in all subjects for each of the matrix columns and it was not larger than 8 mm (i.e. the inter-electrode distance). Typically the IZ was located medially respect the Y-axis, not more distant then 2.4 cm from Y-axis, and in an area that extends from 2nd to the 3rd quadrant. It was partially included in the 1st and 4th quadrant only exceptionally (i.e. 7 out 48 subjects). The mean distance between MTrP and IZ (TrP-IZ) was 10.4 ± 5.8 mm with no statistically significant difference between active and latent MTrP (P=0.6). MTrPs and the IZ are not overlapped but closely located in well-defined areas. Our ACS can be useful for clinicians to retrieve those locations. Further research is needed to confirm this finding in other muscles.

Gait disorders in adults with motor impairments

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A straightforward classification of gait disorders, which is a useful guide for an observational gait analysis, is based on the sign observed in each sub-phase of gait cycle. However, the same sign may be either a deficit or a compensation and may be due to multiple different causes: for example, a step length reduction may result from decreased ankle power production at terminal stance, decreased hip power production at preswing or initial swing, increased leg deceleration at terminal swing, and more.[1]

Other classification systems have been developed[2] according to sensorimotor levels in order to assess contributors to gait disorders. Low sensorimotor level deficits comprise peripheral sensory and motor dysfunctions, that give rise to a number of typical gait patterns, including compensatory strategies. Middle level disorders indicate a dysfunction of centrally selected postural and locomotor responses, e.g. spasticity, parkinsonism or ataxia. At the higher level, deficits are more non-specific and possibly are also influenced by cognitive dysfunctions. The pathophysiology of these gait disorders, however, is poorly understood and a number of overlapping terms have been proposed. Thomson[3] suggested that high level gait disorders can best be described in terms of failure in the organization of the two basic elements of walking: equilibrium (the maintenance of balance in a continuously changing upright posture) and locomotion (initiation and maintenance of rhythmic stepping).

The instrumental gait analysis is often useful for understanding the pathophysiology of the disorder and therefore suggesting targeted interventions. Consider for example the energy cost of hemiplegic gait. It is well known that in non-disabled individuals the walking economy is the lowest at self-selected walking speed, that ranges from 1.2 to 1.4 m/s.[4] Post-stroke patients usually walk much slowly and spend much more energy than healthy controls. A question is: do hemiparetic people consume more energy than controls because they walk slowly? Chen[5] compared hemiparetic and healthy subjects at matched speeds, and found that energy cost was higher in the disabled subjects, so the slowness of walking may not be the unique cause of the increased oxygen consumption. However, the slowness of walking may contribute in selected patients to increased cost of gait? Reisman[6] asked hemiparetic subjects to walk on a treadmill at different speeds (free, 20% lower than free, fastest possible speed and 2 speeds between free and fastest speeds). Results showed that walking economy improved when speed was above the free walking speed, but the effect was significant only in patients who walked more slowly. A treadmill training that forces slowly walking patients to walk at faster than self-selected speed (which may be viewed as a constraint-induced movement therapy for lower extremity) might be a useful treatment strategy in these cases.

The freezing of gait (FOG) in Parkinson's disease is a further example of how motion analysis start providing new insights into a still mysterious clinical phenomenon.[7] The finding that FOG-patients show a sequence effect (step to step reduction in amplitude) before FOG episodes suggests an underlying disrupted pattern generation.[8] However, other mechanisms might be impaired movement automaticity (in dual-task conditions FOG episodes are enhanced)[9], impaired coupling of postural adjustments with stepping (the typical knee trembling during FOG episodes is similar to alternating, repeated anticipatory postural adjustments)[10] or perceptual deficits (in FOG patients the step length reduction depends on the width of the upcoming doorway).[11]

Attempts to attenuate the disorder through exercise therapy should consider these findings. Preliminary data (N=6 patients) from our laboratory (figure 1) indicate that one week of

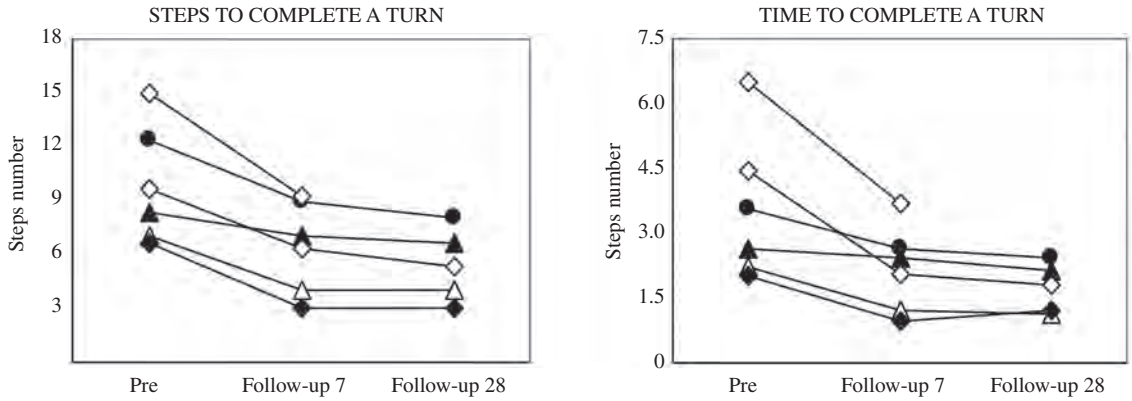

Figure 1.—Steps number (left) and time (right) needed to complete a 360° turn while walking before treatment (pre) and 7 (follow-up 7) and 28 (follow-up 28) days after the end of training (N=6 subjects with Parkinson's disease and Freezing of Gait episodes; one participants did not perform the second follow-up).

intensive FOG-targeted training with five consecutive 60 minutes sessions is effective at follow-up at 7 and 28 days ($p<0.05$) in reducing both the step numbers and the time needed to complete a 360° turn while walking, a task that is known to trigger FOG episodes.

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The gait of children with motor disorders

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In children with motor disorders is common practice to evaluate the function path through observational analysis carried out on a path of at least 10 meters, using a normal camera. Typically, you make a registration in the frontal plane and the sagittal plane. The evaluation of the deambulatory function is facilitated through the use of an observational scale of gait.

For several years, many centers are equipped with the necessary instrumentation to perform the instrumental analysis of the gait. It offers some advantages but also suffers from some limitations. The benefits include the ability to provide the clinician with objective data quantifying various parameters of the path, detecting even phenomena of very mild entity or phenomena that are so fast as to be invisible to the human eye. The limits instead are represented by the fact that the laboratory analysis of the movement is not the optimal setting to assess the child's spontaneous way. In addition, gait analysis is an assessment procedure that is often long and costly both from child and health care system points of view. However, in some cases, the integration between the two analysis of the function path has become the most effective means to direct the clinician in treatment decisions and for the evaluation of their effectiveness.

In our clinical experience instrumental analysis of the way it is used mainly in children with cerebral palsy with the aim of defining the objectives and verify the results of functional surgery, as well as inoculum of botulinum toxin and, in particular, to verify the effectiveness of orthoses used. In our laboratory we use the instrumental analysis of the way with and without orthoses applied in order to identify the parameters on which the orthoses actually act, verifying the correspondence between the results obtained and the expected objectives.

Although orthoses are commonly used to improve motor skills of children with cerebral palsy, to date there is still no solid scientific evidence that prove its effectiveness. From some research (1) it emerged that children who were prescribed orthoses have not experienced substantial improvements when compared to peers with the same disease.

Questioning the results of these studies, we wondered if the reason for this lack of improvement is due to brace themselves but rather to the difficulties encountered by the prescriber to analyze the specific case history of the patient.

It is important to specify that the prescription of the most appropriate orthosis requires the clinician a detailed analysis of the motor pattern and strategies adopted spontaneously by the child during walking.

To make an effective prescription, pathophysiology and pathological elements in biomechanics kinematics of each type of ambulation must be carefully weighed and placed in relation with the biomechanical characteristics of the orthosis that you have. The clinician should try to integrate their goals, in terms of improving the kinematics and kinetics of the way, with the functional needs of priority expressed by the child and family. This integration must take into account also the technical and economic constraints.

We therefore conducted a study to assess the effectiveness of orthoses, investigating the correlation between the golas of clinical interest identified by the professional to whom you want to meet through the use of a specific orthoses, and the real fulfillment of both objectives achieved through the application of the orthosis.

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ORAL COMMUNICATIONS

Investigation of EMG changes during low-load fatiguing contractions of the trapezius muscle

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Background and aim. Surface EMG techniques have been extensively used to assess muscle fatigue, usually in high-level contractions when the pool of recruited motor units (MUs) is constant [1]. Maximal efforts are unusual in daily living activities, and fatigue assessment during sub-maximal contractions can be affected by MU recruitment. The aim of this study was to investigate the adaptations of the neuromuscular system occurring during low-load contractions.
Materials and methods. Twelve healthy subjects performed an isometric shoulder elevation at 5% of their maximal voluntary contraction (MVC) for 20 minutes. Surface EMG from the right trapezius muscle was collected using a 64-channel electrode grid (13 rows X 5 columns, one missing electrode; Fig. 1A). Amplitude (RMS) and conduction velocity (CV) have been estimated for each row from differential signals (10-second long epochs). The changes over time for both variables and the correlation between them have been analyzed (Spearman test). Furthermore, the barycentre of the amplitude distribution in the cranio-caudal direction has been calculated, and its displacement over time has been tested. Significance has been set at $p = 0.05$.
Results. A significant increase over time was detected in 50.0% of the channels for CV and 66.0% for RMS. A direct correlation between CV and RMS was observed in 80.4% of the channels (Figure 1B). The barycentre significantly shifted over time in 11 subjects out of 12 (cranially in six, caudally in five).
Discussion. The direct correlation between CV and RMS suggests a MU recruitment and de-recruitment strategy. The increase over time of both variables suggests the recruitment of fresh MUs with fatigue [2], even if concurrent decrease of CV in some active MUs might have occurred [3]. The shift of the barycentre over time can be related to the recruitment of MUs localized in a specific muscle sub-portion [4].
Conclusion. The variations in time of EMG variables during sub-maximal contractions are different from those observed during high-force conditions (i.e. decrease of CV and increase of RMS, [1]). The analysis of the spatial distribution of surface EMG amplitude discloses neuromuscular adaptation to fatigue in different muscle sub-portions.

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Evaluation of the efficacy of a nintendo wii exercise protocol for balance disorders. A pilot study in patients with multiple sclerosis.

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Background and aims. Balance disorders are common in subjects with multiple sclerosis (MS) leading to impaired balance and increased risk of falls. Although the Nintendo Wii is designed and used in play, its use is becoming common in rehabilitation settings. The aim of the study is to evaluate the efficacy of an exercise protocol, through the use of the Wii bal-

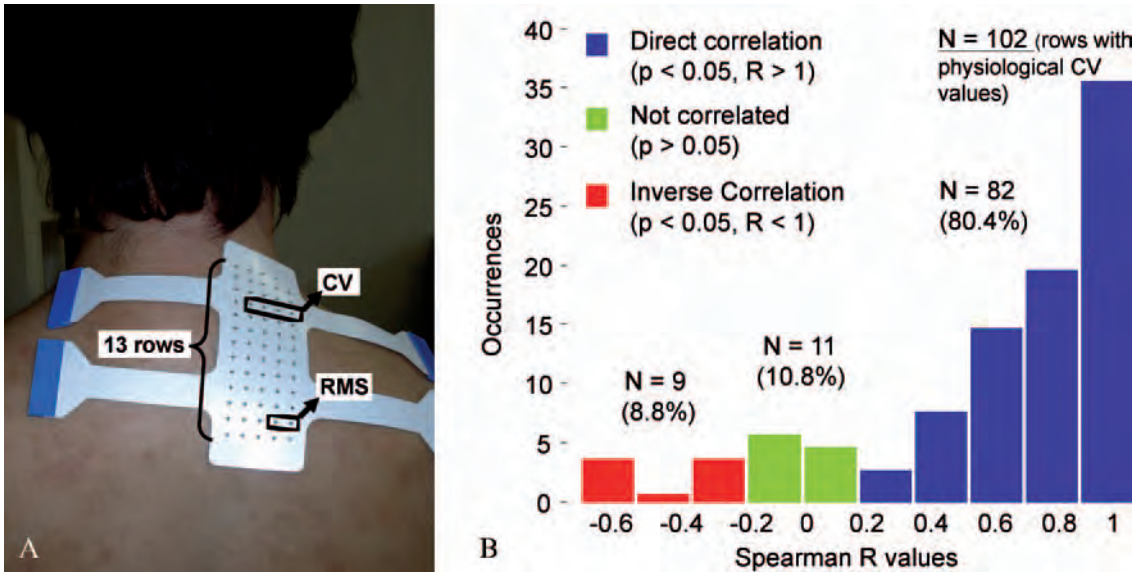

Figure 1.—A) Position of the electrode grid; CV and RMS have been calculated for each row. B) Correlations of RMS and CV; each occurrence is the Spearman R value that describes the dependence between RMS and CV within one row.

Table I.—*Demographic and clinical characteristics at baseline.*

	E (n = 9) Mean Rank	C (n = 8) Mean Rank	P Value
Age	7.22	11.00	0.139*
Height (cm)	7.11	11.13	0.114*
Years of disease	8.00	10.13	0.423*
EDSS	9.61	8.31	0.606*
Total BBS	9.00	9.00	1.000*
Gender (M/F)	1/8	2/6	0.453°

E: Experimental group; C: Control group; M: male; F: Female; BBS: Berg Balance Score; EDSS: Expanded Disability Status Scale.
* = Mann-Whitney Test. ° = Chi square Test.

Table II.—*Significant differences between groups.*

	E (n = 9) Mean Rank	C (n = 8) Mean Rank	P Value*
BBS14 monopodalic	11.56	6.13	0.027
BBS TOT	12.28	5.31	0.002
NO FB H ellipse (cm)	6.44	11.88	0.027

E: Experimental group; C: Control group; BBS: Berg Balance Score
* = Mann-Whitney Test
NO FB H ellipse = antero-posterior distance of the ellipse without visual feedback.

ance board (WBB) and the software "Physiofun balance Training", in subjects with MS with mild balance deficits.
Materials and methods. MS patients with balance disorders were selected among those related to the Rehabilitation Center of USL 3 of Pistoia. Seventeen subjects were selected and randomized into two groups: experimental group (E - 9 subjects), the control group (C - 8 subjects) (Table 1). Participants were assessed at baseline (T0) and end (T1) through the Berg Balance Score (BBS) and by measuring the oscillations of the center of pressure (COP) under static conditions supporting both feet for 30", as detected by the platform. The E group received a rehabilitation treatment with the WBB (10 sessions, 45 min each). The C group has received recommendations about strategies to avoid running into situations that could put them at risk of falling and could alter their balance. The statistical analysis was performed to evaluate the differences T0-T1 between the two groups in the BBS score and in stabilometric parameters obtained from the test on the platform.
Results. The E group showed significant improvement for the following measures: BBS total score; BBS - item 14 and antero-posterior distance of the ellipse without visual feedback (Table 2). All other values of the items were not significant.
Discussion. Considering the large number of limitations, this pilot study should serve as a basis for future studies, with the aim to further validate these new approaches to rehabilitation.
Conclusion. The WBB (in combination with specific software), can be considered as an indicative tool for balance training in subjects with MS with mild deficits of postural stability, that can be used in a clinical setting and at home.

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A brief period of Action Observation significantly reduces the preparation time of finger flexion in healthy subjects

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Background and aim. Action Observation (AO) is an emerging tool in motor rehabilitation and some evidence exists about its effectiveness in individuals who had a stroke (ref) or with Parkinson's disease (ref). This technique relies on a robust neurophysiologic rationale, i.e. the mirror neurons system. However, the positive effect of AO might be due, to some extent, to a better comprehension of cognitive features of the motor task and consequent enhancement of the cognitive phase of motor learning, rather than to direct facilitation of motor output. This study was aimed at verifying whether a brief period of AO results in a decrease of the

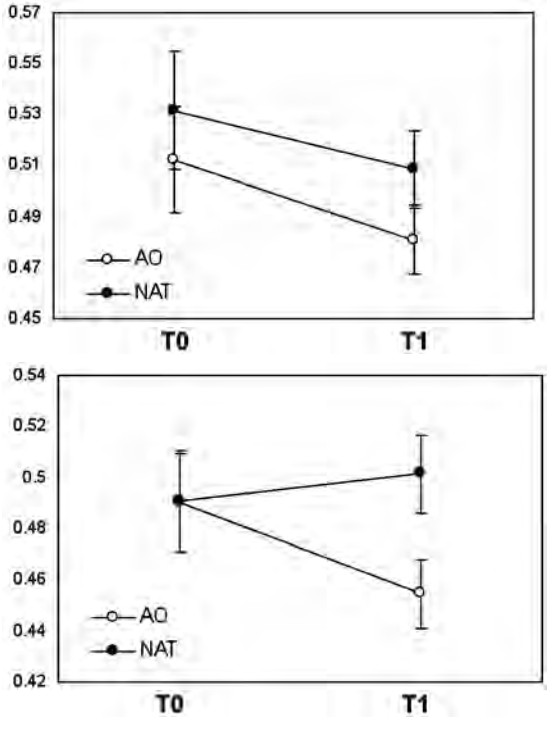

Figure 1.

preparation time, which is considered an indicator of central control processes.
Methods. *Subjects*. 26 healthy young participants (age 32±11, range 20-63, 17 male). *Procedure*. Preparation time of finger flexion were assessed during two separate sessions, with 2-3 days delay, before (T0) and after (T1) watching a 4 minutes movie representing animal life (NAT movie) or hand/fingers movements and actions (AO movie). The movie observed during the first session (NAT or AO) was randomized among participants. Preparation time test consisted in a 4-choice reaction time test (4RT), in which 50 consecutive visual stimuli (the image of a hand with one of the last four fingernails randomly lighting up) were presented on a computer screen and subjects were asked to press a keyboard button as fast as possible with the finger matching the lighted fingernail. Both right (RH) and left hand (LH) were assessed with a random order. *Data analysis*. The average 4RT at T0 and T1 was calculated for both hands and for each finger. Paired t-tests were used for all comparisons.
Results. A significant decrease in 4RT was found after the observation of AO movie in both the RH (p=0.013) and the LH (p=0.024), but not after the vision of NAT movie. When considering each finger separately, changes in 4RT were significant in both hands at the 3rd (RH, p=0.004; LH, p=0.035) and 4th fingers (RH, p=0.007; LH, p=0.017), and in the LH also at the 2nd finger (p=0.033). However, changes after the vision of AO movie were significantly higher than changes after the vision of NAT movie for right hand only (p=0.032).
Conclusions. Though a learning effect exists, for the left hand in particular, data presented suggest that AO significantly reduces preparation time for finger flexion. This effect can non be due to enhancement of cognitive phase of motor learning, since actions observed were unrelated to the measured motor task

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Gait analysis in subject with chronic stroke: correlation between gait patterns and clinical assessment.

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Background. From a study developed at Usl 11 (2009), we have inquired which are the two possible proximal gait pattern (hip hiking and circumduction) (1) in the subject with chronic stroke, that guarantees the best motion performance and we have relieved that the circumduction have the best results for the speed.(2)
Objective of the study. Define the main kinematic characteristics of two proximal patterns (hip hiking and circumduction) and their relationship with the measures of impairment, of functional limit and disability.
Materials and methods. Through the gait analysis we have tested 22 subjects with chronic stroke: 12 subjects with prevailing proximal pattern of hip hiking, 10 with prevailing circumduction (Tab. 1) We have relieved that the degree of impairment (ROM, strength, spasticity) of functional limit (Short Physical Performance Battery), disability (Barthel Index BI, Barthel Index Locomotion BIL) and compared the two groups. With a gait analysis we have collected information about swing, length stride, step and cadence.
Results. In the hip biking it's significant the balance deficit (P=0,008); in articular range, the most significant data are the excessive extension of the knee (P=0,019), the reduction of abduction of hip (P=0,044) and the limit in the internal rotation of hip (P=0,075). Less significant are information about the BI differences and most significant is the difference about BIL (O=0,010) for the circumduction. From the gait analysis data the two groups uses opposite strategies for the affected side and for unaffected side (Fig 1).

Table I.—*General characteristics of subjects (n. 22).*

	Hip hiking n.=12 (mean±er. st)	Circumduction n.=10 (mean±er. st)	P
Age (month)	60.83±0.79	57.00±0.81	NS
Distance events Index (months)	52.33±4.72	55.10±3.92	NS
Hemiplegic side			
Right	4	3	
Left	8	7	
Type of stroke			
Ischemic	7	7	
Hemorrhagic	5	3	
Sex			
Men	8	7	
Females	4	3	
Subjects who use assistive	10	4	

E: Experimental group; C: Control group; M: male; F: Female; BBS: Berg Balance Score; EDSS: Expanded Disability Status Scale.
* = Mann-Whitney Test. ° = Chi square Test.

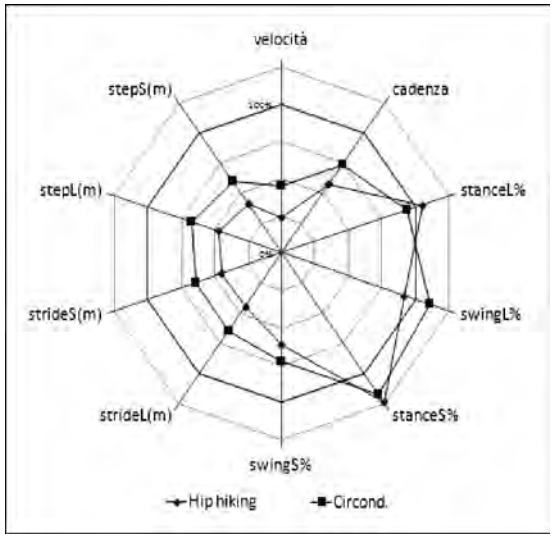

Figure 1.—Spatio-temporal characteristics measured with gait analysis.

Discussion. Who uses the hip biking has more difficulties of balance and strength, because of the reduced propulsion mechanisms, which induces to a more proximal compensation (pelvis and trunk). This shows that the hip biking is a hard-working strategy. The ROM data shows that the degree of hip impairment is significant to choose the compensatory pattern.
Conclusions. The study of locomotion patterns gives important data for the physiotherapist for the plan of a gait-oriented training (for example in the hip hiking it's important improve the balance and the motion range of the hip at frontal and transversal level). The results give important prognostic data about the complication of motion pattern. Further studies are necessary.

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Rehabilitative ultrasound imaging of the supraspinatus muscle: intrarater and interrater reliability of thickness and cross sectional area.

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Objective. To examine intrarater and interrater reliability of thickness and cross sectional area (CSA) measurement of the supraspinatus muscle using rehabilitative ultrasound imaging (RUSI).
Background. Ultrasound imaging related to musculoskeletal rehabilitation (RUSI) is a tool with a rapid development in the last 30 years.[5] A consensus statement that distinguishes RUSI from diagnostic musculoskeletal USI was defined. [4] RUSI has been used to assess and measure muscles architecture, different muscles in appendicular and axial skeleton has been studied.[2,3] Reliability of RUSI for the supraspinatus muscle thickness and CSA has not been documented.
Methods. Twenty-five asymptomatic subjects (11 female, 14 male) were recruited. During each session B-mode ultrasound images of left and right supraspinatus muscles were acquired twice by each operator. Measurements of supraspinatus thickness and CSA were conducted off-line using region of interest (ROI) techniques. Intrarater and interrater reliability were examined using intraclass correlation coefficient (ICC) and Bland and Altman plot.[1]
Results. The intrarater reliability for the thickness was very high showing an ICC $_{1,1}$ of 0.91 (95% CI: 0.84 to 0.95) for rater 1 and 0.92 (95% CI: 0.86 to 0.95) for rater 2. Intrarater reliability for the CSA was high showing an ICC $_{1,1}$ of 0.90 (95% CI: 0.82 to 0.94) for rater 1 and 0.85 (95% CI: 0.74 to 0.90) for rater 2. Interrater reliability for the thickness was high with an ICC $_{3,1}$ of 0.86 (95% CI: 0.77 to 0.92). For the CSA the interrater reliability was moderate with an ICC $_{3,1}$ of 0.70 (95% CI: 0.52 to 0.82).
Discussion. Supraspinatus is a muscle with a great involvement in the physical therapist practice, validate RUSI for the evaluation of morphological parameters support the use in clinical and research situations. Future research could use a similar measurement protocol to investigate supraspinatus morphology in pathological subjects
Conclusion. Thickness and CSA of supraspinatus muscle can be measured reliably with RUSI.

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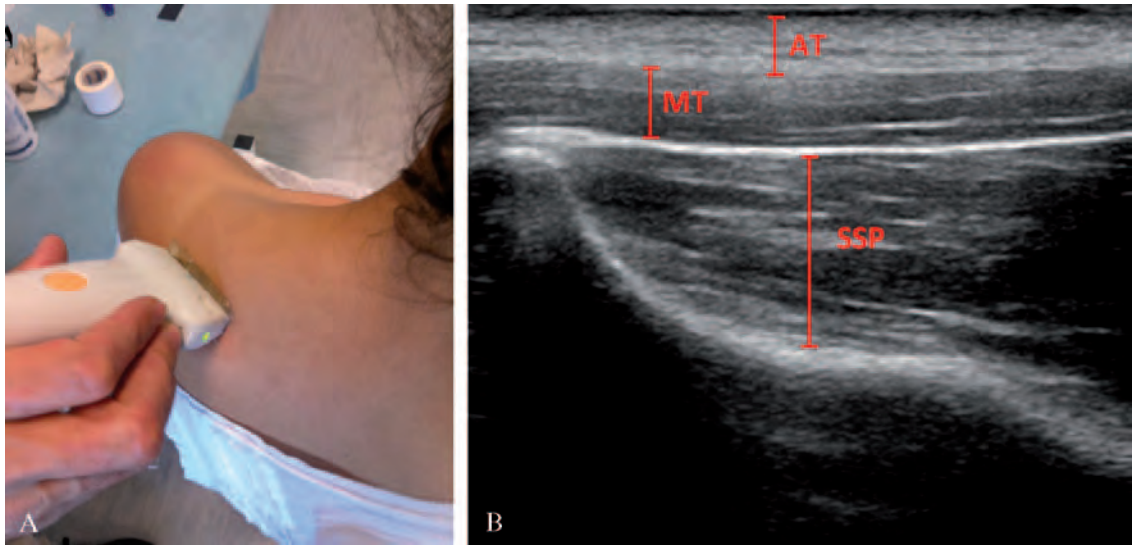

Figure 1.—A) Position of trasducer for imaging of supraspinatus muscle thickness. B) Respective ultrasound image. (AT= Adipose tissue, MT = Middle trapezius, SSP = Supraspinatus).

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uTUG: a smartphone application to instrument the TUG test

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Background and aim. The Timed Up and Go (TUG) is one of the most used clinical tests to assess mobility. An instrumented Timed Up and Go (iTUG) makes use of a measurement system (e.g. an accelerometer [1]) to compute a set of parameters able to more subtly investigate balance and gait. We present here a novel Smartphone (SP) application, called ***uTUG***, that makes use of the accelerometer and gyroscope sensors embedded in the SP to instrument the TUG test. The application performs signal processing, computes a set of significant parameters and sends them to a remote server.
Materials and methods. We implemented the *uTUG* application on an Android SP to keep all the advantages in terms of high-performance computation and the availability of an open platform; the validity of the embedded sensors has been proven in a previous work [2]. A number of state-of-the-art parameters [3][4], was used to characterize gait and transitions; cadence was computed by identifying the heel strikes [2]. *uTUG* has a friendly interface with only a "Start/Stop" button. At the "Start" the application starts collecting sensors data. At the end of the TUG test, by pressing the Stop button, all the parameters are calculated and stored in the SP. The application also include the possibility to "guide" the subject in the TUG test: the application automatically detects when the subject is sitting quietly, at the beginning and at the end of the test, and provides him/her an audio cue acting as a start/stop trigger command.
Results. We performed 49 TUG (49 subjects, 59±16 years) wearing the SP (Motorola Droid 2) on the lower back by means of an off-the-shelf case belt. We compared parameters values calculated by the *uTUG* application and by the MATLAB implementation of the algorithms (Table 1).
Discussion. The results show that *uTUG* application provides the same results of the MATLAB algorithms. Further, the thresholds used for the automatic start/stop audio cue are effective, at least for healthy subjects involved in this study.
Conclusions. *uTUG* application makes it possible to instrument the TUG test and calculate its significant parameters by only using a commercial Smartphone. The transmission of raw data and test results to a remote server can be considered useful for an automatic creation of a database of TUG data.

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Movement and linguistic negation: effects of action verbs on the kinematics of grasping gestures

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Background. Listening to action related sentences activates a left fronto-parieto-temporal network [1,2]. This network is mostly the same as the mirror neuron system that is activated during action observation. The neural representation of negative action related sentences induces a relatively weaker activation of the action representation system involved in embodied language representation, compared to the effects of listening to affirmative action-related sentences [3].
Aim and scope. The objective of the study was to investigate the effects of linguistic negation on a reach and grasp movement (proximal, experiment1) or an isolated grasping movement (distal, experiment2) (figure1), comparing the different effects of hand-related action verbs (e.g. "I sew"), with those ones by listening to armrelated action verbs ("I beat"), or abstract verbs ("I wish"). These sentences were listened in affirmative and negative form.

Table I.—*Maximum overall computation time of the smartphone: 1 second; it depends on the Smartphone CPU and instantaneous memory loading*

Parameter	MA Values Mean Value (Standard-Deviation)	(MA – uTUG) Values Mean Value (Standard-Deviation)
Total Duration [s]	18,68 (3,66)	0 (0)
Sit to Stand Duration [s]	1,36 (0,32)	0 (0)
RMS Acc. AP Sit to Stand [m/s2]	1,87 (0,56)	7,9074e-10 (4,8401e-09)
RMS Acc. ML Sit to Stand [m/s2]	0,58 (0,18)	2,4180e-08 (1,3924e-08)
Max Acc. AP Stand to Sit [m/s2]	1,23 (1,32)	3,4044e-08 (7,5138e-08)
Gait Duration [s]	13,50 (3,03)	0 (0)
Mean Cadence [s]	0,57 (0,06)	0 (0)
Cadence Standard Deviation [s]	0,05 (0,03)	0 (0)
Cadence Coefficient of Variation [%]	8,59 (5,33)	0 (0)

MA: MATLAB algorithms implementation; uTUG: uTUG algorithms implementation; Acc. = Acceleration; AP = Antero-Posterior; ML = Medio-Lateral; RMS = Root Mean Square;

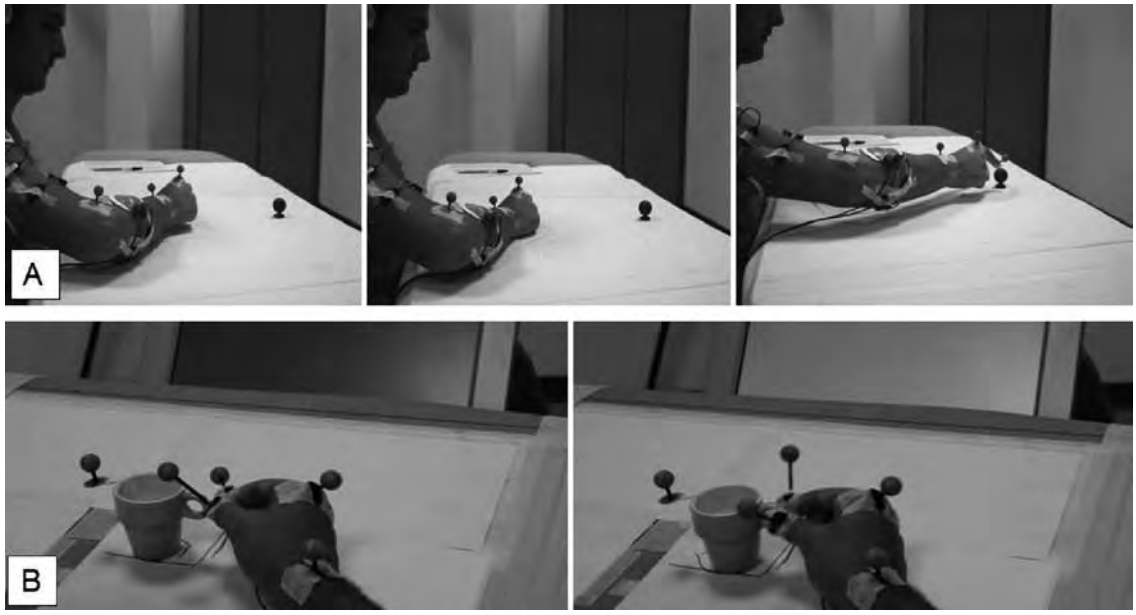

Figure 1.—Reach and grasp (A) and isolated grasp (B) movement.

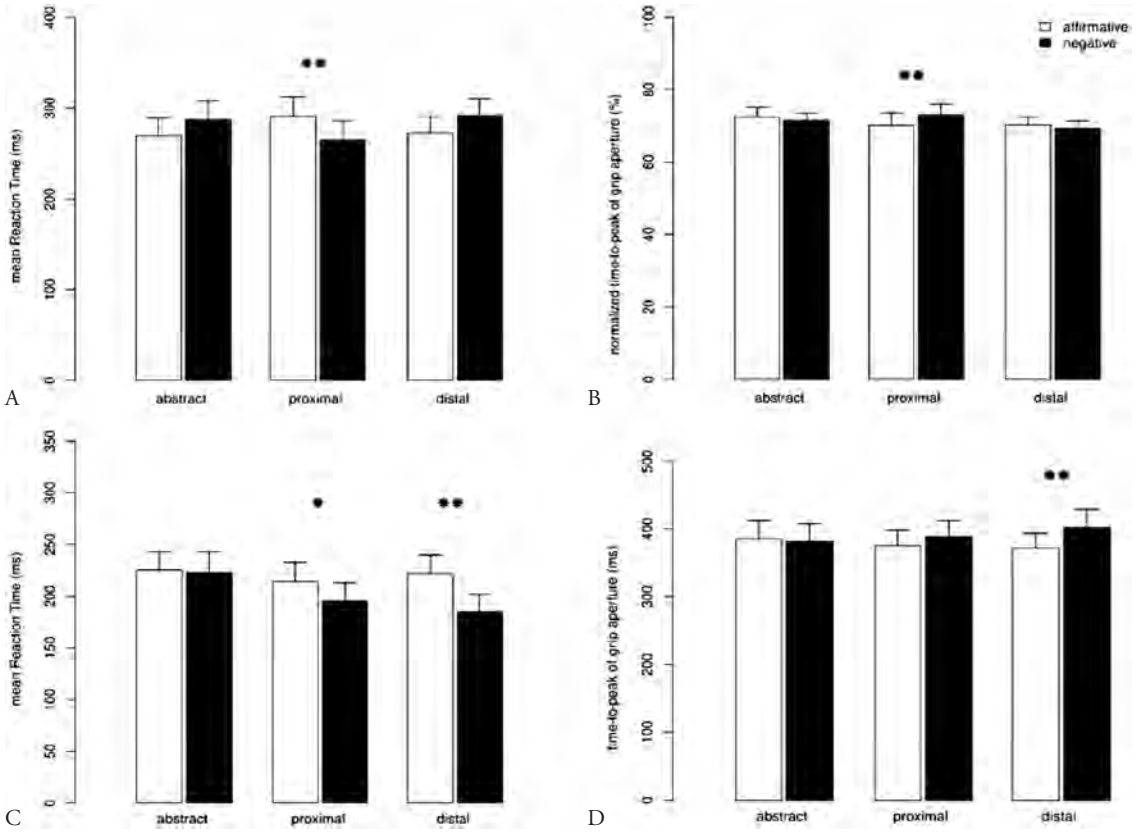

Figure 2.—A and B: results from experiment 1; C and D: results from experiment 2.

Materials and methods. A total of forty-two volunteer subjects took part in Experiment 1 and 2. Subjects had to listen to 60 sentences, varying in terms of linguistic content (proximal, distal and abstract verbs), and polarity (affirmative or negative); at the end of each sentence, at the appearance of a visual stimulus, they had to reach and grasp a ball (exp.1) or either grasp and hold a cup or rotate a screw (exp.2). An ELITE system (BTS,Milan) and reflective markers were used to collect kinematic data.
Results. Statistically significant differences were found for reaction time (exp. 1 and 2; figure 2: A,C), time to acceleration peak (exp.2) and time to maximal finger aperture (exp. 1 and 2; figure 2: B,D). The differences were found only in the movements corresponding to the linguistic content heard, and these differences were correlated to polarity.
Discussion and conclusion. Listening to sentences describing actions made by the same body part used for simultaneous movement, causes a worsening of the quality of the movement, while a motor facilitation is found when listening to the same verbs in negative form. The presence of negation seems to block the mental simulation of the described action, reducing the computational load for the fronto-parietal system, thus leaving the fronto-parietal network more free to support the execution of the movement.

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Sincerity of effort: isokinetic evaluation of knee extension.

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Background and Objective. To ensure the validity of findings derived from measurement of muscle strength it is essential that the patient exerts maximal effort. Despite the widespread use of methods aimed to detect the sincerity of patients' effort in clinical assessment, none of them has demonstrated satisfactory levels of reliability and absolute discriminative capacity[1,2]. The aim of this study was to find a reliable method to evaluate the sincerity of the muscular maximal effort performed in a dynamometric isokinetic test of knee flexion/extension.
Material and methods. A standardized method, the coefficient of variation of the peak torque (CV), and 3 new indices were analyzed: 1) the average coefficient of variation calculated on the complete peak torque curve (ACV); 2) the slope of the regression line in an endurance test (SRL); 3) the correlation coefficient of the peak torques in the same endurance test (CCE). Sensitivity and specificity were calculated for each index by ROC curves. Twenty healthy subjects underwent assessment in two different trials, maximal (MX) and 50% submaximal (SMX), with a rest between of 20 minutes. Each trial consisted of 4 strength tests of 3 repetitions at angular speed of 30, 180, 30, and 180°/s, plus 1 endurance test of 15 repetitions at 240°/s of knee extension.
Results. All 4 indices showed high sensitivity and specificity; however, best results were obtained with the SRL (Table 1).
Discussion. The use of standardized CV has been questioned[2], and there is little agreement on its best cut-off value[3]. In this study we introduced the use of isokinetic endurance test-related methods, based on the observation that it would be more difficult for a patient to simulate physiological decrease of performance with a higher number of repetitions[4]. Statistical analysis showed that SRL had better sensitivity and specificity than CV, whose threshold seemed to be speed-related.
Conclusions. Among all the variables considered, the best index discriminating between maximal and submaximal effort was the SRL. This index showed very high sensitivity (100%) and specificity (95%), and we hope in the future it will be calculated by commercial software.

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TABLE I.—*Value of sensitivity and specificity obtained from ROC curve analysis. Grey cells indicate the best global result. Cut-off values are expressed as: % of variability for CV and ACV; slope of regression line for SRL; reliability coefficient for CCE.*

	CV 30°/sec	CV 180°/sec	ACV 30°/sec	ACV 180°/sec	SRL	CCE
Repetitions	3	3	3	3	15	15
Cut-off value	14%	8.8%	14%	10.5%	-1.2	0.7
Sensitivity	100%	75%	90%	90%	100%	90%
Specificity	70%	95%	75%	100%	95%	90%

POSTERS

Observational gait analysis

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Background. The Observational Gait Analysis (OGA) is the most applied technique in clinical practice for gait analysis, because it delivers a synthetic overview of patient's movement pattern. It is affordable, fast, and can be performed everywhere. Nevertheless, it has often been criticized for its presumed little objectivity.
Objective. The purpose of this work is to search for major error sources, and, at the same time, for reliable and shared practices used to perform OGA, in field literature.
Materials and methods. The articles that we took into account were found on the following websites: Pub Med, Cochrane Library, and Dare. The keywords we chose are: movement disorders/diagnosis, reproducibility of results, gait disorders, neurologic/diagnosis, observation/methods. We did not apply any restriction concerning population characteristics and year of publication. Our search resulted in 22 relevant articles.
Results. Major error sources in performing OGA are: the considerable amount of variables for analysis [9], poor skills of the observer [2,4], the limits of visual perception, the complexity of movements in the different body segments [9], and the exclusive use of frontal plane as an observation plane [5]. There is evidence of the usefulness of delivering to the observers relevant, unified, written instructions for performing the analysis, of a visual analogue scale, and of the reduced amount of information the observers have to treat [7, 8, 9]. And there is also evidence that, in order to guarantee high levels of reliability, a high level of skill by the observer should be required [1]. Moreover, the video recording, allowing the observation of one variable at a time, is vital to obtain good levels of reliability for complex observations [2-7].
Conclusions. The OGA has a ultimate role within the decisional process in the rehabilitation field [1-9], although a universally shared performance method still does not exist. The way the analysis is carried out, together with the amount and type of variables under analysis, should apparently impact accuracy.

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Effetto del taping neuromuscolare applicato sul muscoli vasto mediale e vasto laterale sulla performance ciclistica di soggetti sani

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Introduzione e scopo. Il taping neuromuscolare è una tecnica relativamente recente ampiamente utilizzata sia in ambito clinico che in ambito sportivo come supporto al trattamento riabilitativo. La tecnica consiste in un confezionamento di un particolare bendaggio adesivo elastico eseguito sulla cute sovrastante il ventre muscolare. Il meccanismo neurofisiologico che viene ipotizzato dagli autori consiste nella stimolazione dei meccanocettori cutanei a lento adattamento di tipo I. Esistono diversi studi in letteratura che ne indagano numerosi aspetti e campi di applicazione. Tuttavia i risultati non sono chiari anche se una recente metanalisi evidenzia un effetto facilitante sull'azione muscolare (Williams S, 2012). Questo studio è stato condotto allo scopo di valutare se l'applicazione sul vasto laterale e vasto mediale di questa tecnica modifichi la performance ciclistica durante uno sforzo massimale di 30 sec. eseguito da soggetti sani su un cicloergometro.
Metodo. Il campione era composto da 37 partecipanti di cui 33 uomini e 4 donne. Questi sono stati suddivisi in due gruppi: uno di studio (18 soggetti) al quale è stato confezionato un tape con il corretto tensionamento e un gruppo di controllo (19 soggetti) al quale è stato confezionato un bendaggio privo di tensionamento. Durante la prova sono stati valutati parametri quali: potenza e velocità massima e media, Watt/Kg e calorie consumate di ogni soggetto. Sono state registrate 4 performance a distanza di 24 ore una dall'altra: T0 al baseline senza nastratura, T1 immediatamente dopo l'applicazione, T2 a 24 ore dall'applicazione e infine T3 a 24 ore dalla rimozione del taping.
Risultati. Si sono rilevate differenze statisticamente significative nell'intero campione tra i dati raccolti al baseline e quelli a 24 ore dall'applicazione del taping adesivo elastico, in particolare nei parametri quali distanza percorsa, velocità massima e media, potenza massima e media e potenza rapportata al peso corporeo. Inoltre si è registrata un'interazione significativa fase x gruppo, che sottolineava un maggiore sviluppo di potenza massimale del gruppo 1 rispetto al gruppo 2.
Conclusioni. Questo studio mostra un miglioramento della performance ciclistica con il bendaggio neuromuscolare mantenuto per 24 ore ed evidenzia una maggior efficacia facilitante del taping applicato con tensione rispetto a quello senza. Ciò incoraggia il suo utilizzo in ambito sportivo e la pianificazione di ulteriori studi per verificarne l'applicabilità in ambito clinico.

Instrumental evaluation of effect of manual therapy on the pain by acupressure on pelvic floor in subjects affected by vulvodynia or vulvar vestibulitis

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Background and aim. Vulvar vestibulitis and vulvodynia are conditions that cause pain and burning in the vulvar area, also are chronic conditions. In such cases it is often also involved the muscular system of the pelvic floor, that occurs in the condition of overactive resulting in contractures and pain at rest and acupressure. Manual therapy can be a useful strategy to reduce these conditions, but the outcome is difficult to quantify "pain acupressure." This study aims to present the use of a new strategy for the instrumental assessment of this outcome.
Materials and Methods. *Study design*: observational pilot study. *Subjects*: 15 patients with vulvodynia or vulvar vestibulitis, all patients has had neither childbirth and pregnancy. All patients receiving drug therapy for the symptoms. *Interventions*: all subjects received weekly sessions of manual therapy

Figure 1.—Instrument used for the observational study (produced by EB Neuro SpA). It may be noted the balloon of the size of 2 x 0.5 cm applied to the finger of the operator.

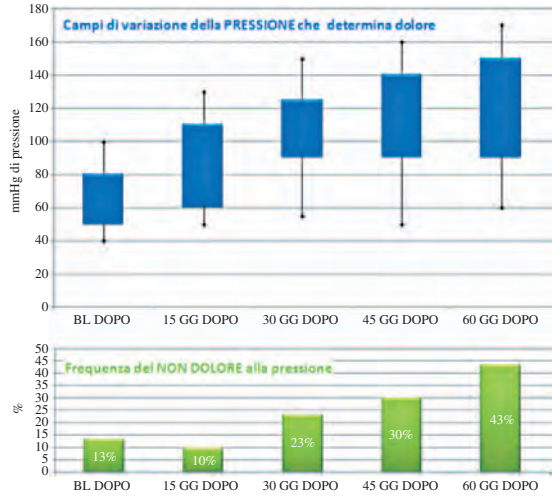

Figure 2.—A) fields of variation of the threshold for evocation of pain acupressure. B) frequency of the condition of "no pain acupressure" in the sample examined.

applied to the levator ani muscle, which surrounds the vaginal canal and that is palpable on the right and left side 3 cm. after the vaginal entrance. All patients were also instructed to self-treatment. *Measurements:* a tool is used by a balloon made of 2 x 0.5 cm., located on the operator's finger and connected to a manometer (Figure 1); is measured the pressure at which the evocation of pain resulting from the acupressure beam left and right elevator of the anus. For each patient are collected, before and after each session of manual therapy, 5 measurements: at baseline and after 15, 30, 45, 60 days.

Results. There was a statistically significant increase ($T=0$, $p<0.05$) the mean threshold for evocation of pain both within the individual acupressure session, both during the 5 measurements (64±17.7 mmHg at baseline to 121±33 mmHg to 60 days). Also increased the percentage of subjects with the condition of "no pain acupressure" (from 13% to 43%).

Discussion. The pain acupressure seems to be a sensitive treatment outcome of manual therapy. It would be useful to investigate the association between increase in the threshold of evocation of pain acupressure and other outocomes, such as the pain at rest and the quality of life.

Conclusions. Manual therapy applied to the elevator of the anus of patients with vulvodynia or vulvar vestibulitis seems to lead to an improvement or resolution of pain evoked with acupressure. Further studies are needed to evaluate the measurement characteristics of the instrument adopted.

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Surface electromyography activity of Masseter, Orbicularis Oris and Submental muscles during swallowing in healthy subjects

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Background and objective. Surface electromyography (sEMG) studies on swallowing have not yet reached clear and standardized patterns regarding timing and intensity of activation. This study analysed duration and the intensity of sEMG activation of masseter, orbicularis oris and submental muscles during swallowing of saliva, water, semi-liquid and solid bolus.

Material and methods. Twenty-five healthy subjects were recruited among physiotherapy students of San Raffaele University in Milan. Age ranged between 18 and 25 years, with ten males and fifteen females. Pairs of standard bipolar electrodes were positioned for each muscle (Figure 1); sEMG record made use of an 8 channel Telemg BTS (Milan) with pre-amplification and wireless transmission. Acquisition frequency was set at 1000 hz, low and high pass filter from 50 to 250 hz. Duration was recorded by visual assessment of sEMG curve (Figure 2); intensity data were normalised and computed as percentage of the maximal isometric contractions. Statistical analysis included Kolmogoro-Smirnow test for normality, and the analysis of variance. P value was set at 0,05 with a Bonferroni correction at 0,01.

Results. The study reported 246 valid swallowing trials, with the following results: the duration of orbicularis oris is lower with water then semi-liquid and solid; the duration of submental muscles is higher with solid than the other concistencies; the intensity of masseter is higher with solid compared to the other concistencies; the intensity of orbicularis oris is lower with saliva compared to the other consistencies; the intensity of submental muscles is higher with solid in compari-

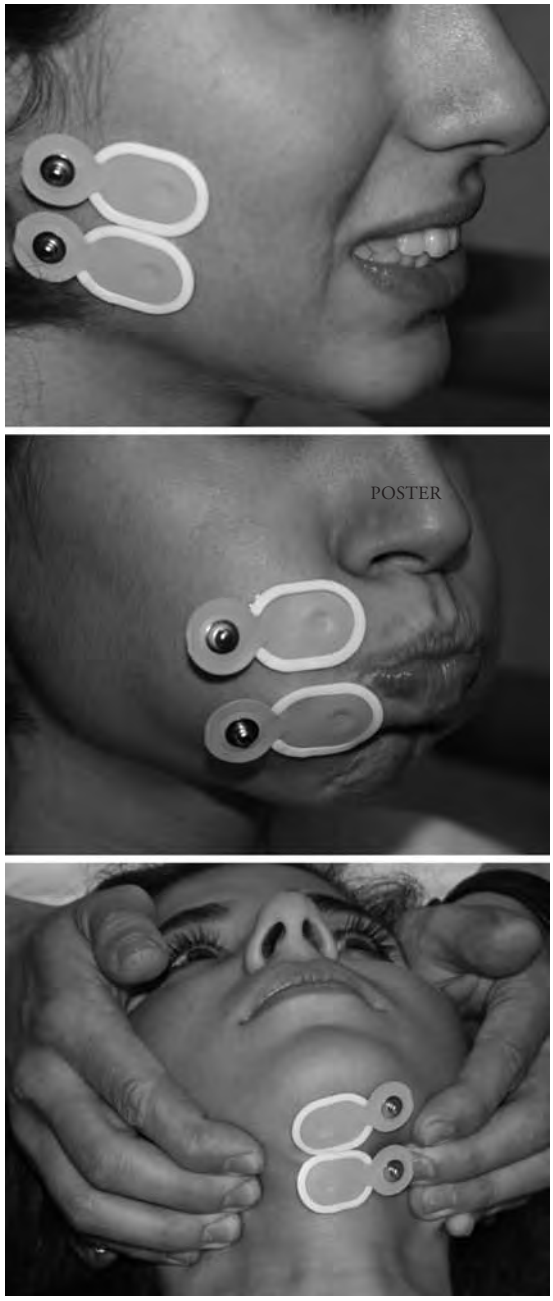

Figure 1.

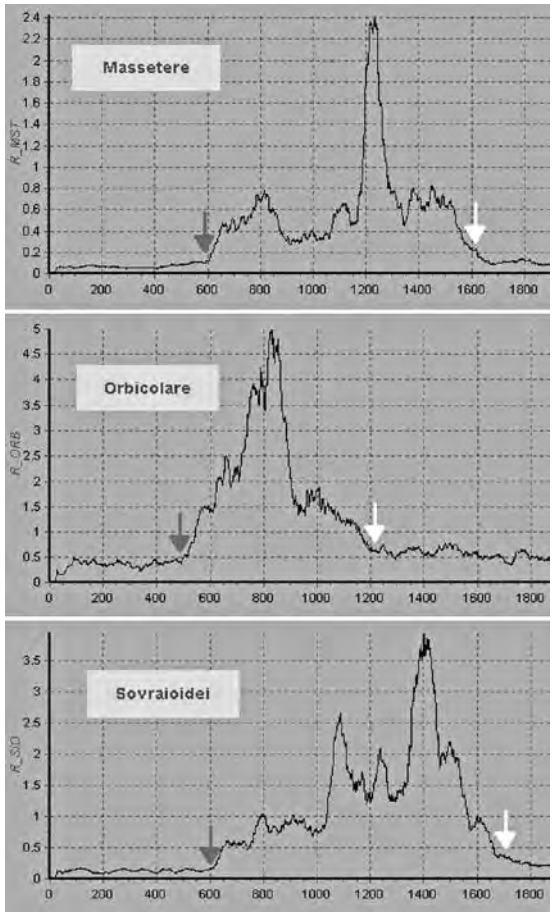

Figure 2.

son with the other consistencies, and with water compared to semil-iquid.

Discussion and conclusions. Duration of orbicularis oris and submental muscles' increases with bolus viscosity, whereas masseter's duration does not vary significantly; sEMG intensity of masseter and submental muscles increases together with viscosity whereas orbicularis oris' together with volume. These data confirm, even from a sEMG point of view, the different role of muscles during single swallowing: anterior containment for orbicularis oris, mandible fixation for the masseter, hyoid elevation for submental muscles. sEMG could be a valid support for evaluating functional deficit of swallowing and plan proper intervention aimed at muscle training and diet selection.

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Orthotic effects of a modified sole on gait in healthy subjects and in people with multiple sclerosis

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Gait, Multiple Sclerosis, Orthotic devices

Background. Many orthoses have been studied in order to improve ambulatory ability and quality of life in people with Multiple Sclerosis (MS) and impaired walking1. The aim of this study was to evaluate the orthotic effects of a modified sole (Figure 1) on walking mechanics in healthy subjects and in people with MS.

Methods. Four subjects with MS and 13 healthy subjects performed three gait trials with flat shoes and subsequently other three trials wearing the modified sole to allow the intra-subject comparison of the two walking conditions. By defining critical gait events (1st strike, toe strike, heel off, toe off, maximal hip flexion, maximal hip extension, femur vertically aligned during stance, femur vertically aligned during swing) the kinematics of the lower limb joints and time-distance parameters including gait speed, cadence, step length, and toe clearance were measured. The comparison of the two walking conditions in healthy subjects was performed using Wilcoxon's test. Regarding the data obtained from the people with MS, a descriptive analysis was performed due to the small sample size.

Results. Regarding healthy subjects, when wearing the modified sole an increased plantar flexion was found during the gait cycle. In the experimental condition, the knee was more flexed during the maximal hip extension instant (+33.84%) while there was a decrease in knee flexion when the femur was vertically aligned during swing (-8.3%). Shorter step length (-2.98%), lower speed (-9.36%), and higher toe clearance (+9.76%) were found with the modified sole. All the reported results are statistically significant ($p < 0.05$). When wearing the modified sole an increased plantar flexion and a decrease in speed and step length was found in subjects with MS. In one person an important increase in the maximal knee flexion was noted in the experimental condition.

Conclusions. The modified sole alters the walking mechanics of both healthy subjects people with MS. This study suggests that in people with MS a greater knee flexion can be induced by the experimental condition. Further studies with larger sample size are needed in order to conclude with more certainty on the effects of the modified sole.

Figure 1.

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Validity and reliability of the balance board nintendo Wii for stabilometric assessment. Pilot study

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Background. The number of studies that refer to the usage Nintendo Wii or Wii Balance Board (WBB) in the rehabilitation process is increasing but still limited. [1] Saposnik et al. evaluated the feasibility, safety and efficacy of VR rehabilitation using the Nintendo Wii gaming system [2]. Clark et al. demonstrated the convergent validity and the clinical utility of the WBB compared to a laboratori-grade force platform, which is considered the gold standard measure of balance. The results suggest that the WBB could be considered as a valid portable low-cost tool for assessing standing balance [3]. In comparison with platforms, the Nintendo Wii Balance Board is an inexpensive interface that has widespread availability.

Objectives. Objective of the research is to validate the WBB platform a stabilometric platform.

Tools and methods: A WBB platform was used with the following additional components:

— Wii Remote , Sensor Bar, Balance Board , Physio Fun

— Sistemi PRO-KIN [4]

To estimate the psychological and physical state of patients 2 evaluation scales were used: visual analogical scale (VAS) and SF36 (Daily lifestyle).

Participants: The sample, made up of 50 people, underwent to 3 evaluations carried out throughout WBB, WBB Physio Fun and Pro-kin.

Participant's requirements

— 18-65 aged people

— Scale Vas = 0

— SF36 > 80

Statistical analysis: To determine the relationship between discrete quantitative, variables represented by the values of the axes of abscissa and ordinate, it was used the Pearson correlation analysis and calculated the correlation coefficient (r) to measure the degree of linear relationship. This coefficient always takes values between -1 (varying inversely related) and 1 (directly related variables).

Results. According to the results, obtained by correction of the values of the abscissa and the ordinate of the three assessments, it is clear that there is a moderate correlation between the WBB / WBB Physio Fun and the platform Pro-Kin. In particular the following values were obtained: xphysio / XPro-kin r = 0.34952; xWBB / XPro-kin r = 0.29681; yphysio / yxpro-kin r = 0.431754; yWBB / ypro-kin r = 0.602113.

Conclusons. The work has shown that there is a moderate correlation between the value of the axis of abscissa and ordinate of the assessments made. Surely it is essential to continue the work by increasing thesample number.

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Figure 2.

Motor performance assessment in children with duchenne muscular dystropy

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Background and objective. Muscular Dystrophy (DMD) is an X-linked recessive disease that leads to severe progressive disability and death in the 20's[1]. The North Star Ambulatory Assessment (NSAA), the 6 minutes walking test (6MWT)[2,3] and the quantitative muscle test (QMT, never used before for longitudinal muscle strength assessment) have been used to assess patient's motor ability. The aim of the study is to monitor quantitative muscular strength, functional scales changes (NSAA, 6MWT) and their correlations in the natural course of the pathology in patients with Duchenne Muscular Dystrophy.
Materials and methods. 28 children with Duchenne Muscular Dystrophy between 5 and 12 years old (8.4 ±1.6) have been assessed for one year every three months with NSAA, 6MWT, and by Kin Com dynamometer. 13 healthy children age matched to patients (9.5 ±2.8) have been assessed using the Kin Com dynamometer at baseline and 12th month. Patients have also been assessed after 24 months. Knee flexors and extensors were evaluated both using isokinetic and isometric contractions, elbow flexors and extensors only isometrically.
Results. Random fluctuation of strength measures has been calculated as the 20% of annual change. Strength measures were significantly lower in patients if compared to healthy subjects both at baseline and 12th month. Knee extension strength worsened more than knee flexion and upper limb strength improved during the year of assessment. At the age of 7,5 years an inversion of strength improvement of lower limb trend seems to happen. Functional scores keep lowering. Referring to patients, correlations between isometric and isokinetic knee extension and NSAA and Gowers were found at baseline and 24 months. After 12 months and body mass gain, these correlations decrease.
Conclusions. Considering strength and functional measures scores trend in patients we conclude that the decline of functional measures could be associated also to other factors than muscular strength such as body mass increase. In fact, strength deterioration is different depending on muscle groups. Considering that knee extensors worsen more than other muscles tested, we hypothesize that the more a muscle is loaded the more rapidly it worsens if compared to less loaded muscles.[4]

Figure 1.

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The Subjective Visual Vertical: comparisons between two alternative methods of assessment and age-related differences.

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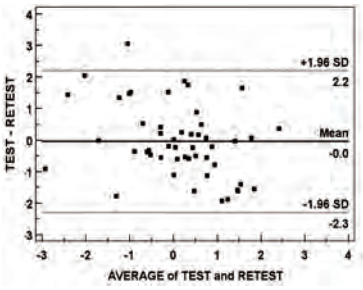
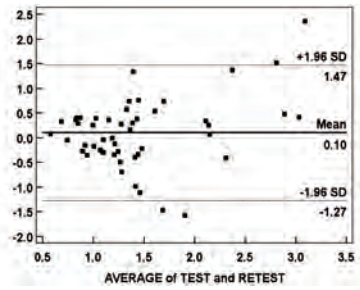
Background and aim. Verticality representation is impaired in some neurogical and vestibular disorders and may be assessed by measuring the subjective verticals, i.e., the individual's perception of verticality through different sensory channels, which include the haptic vertical (SHV), the postural vertical (SPV) and the visual vertical (SVV).[1] The latter is most frequently assessed, usually asking to subjects, in complete darkness, to





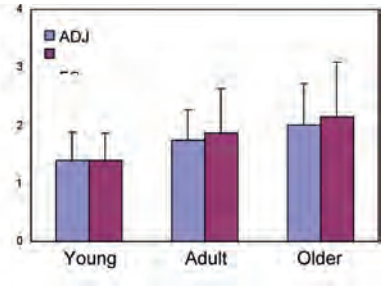


Figure 1.—LoA for Bias value. Figure 2.—LoA for Threshold values. Figure 3.—Age-related differences for Bias.

adjust the position of a luminous bar which is tilted at a random angular offset in the coronal plane (adjustment method, ADJm). Recently, the alternative method of Two-Alternative Forced Choice (FCm) was applied in this field. [2] In the FC method, simuli are presented for a brief period on a computer screen, tilted from vertical selecting at random from a predetermined set of values of appropriate range; the observer is then forced to categorise each stimulus in one of two classes, i.e. as tilted clockwise (CW) or counter clockwise (CCW). This study was aimed at comparing results obtained in healthy subjects with the two methods.

Method. *Subjects.* In 57 healthy individuals the SVV was assessed with both methods. Participants were classified as young (N=24, age 23.7±4.2), adult (N=16, 49.3±8.2) or older (N=17, 75.7±5.4). The assessment with ADJm was repeated 2-3 days later in order to assess reliability. In the ADJm, 10 trials were performed, with randomised initial tilting of the bar of 1, 2, 4, 8 or 12° from vertical, both CW and CCW. For each trial, subjects were asked to instruct the examiner how to rotate the bar in order to reach the vertical position. The test was performed twice, varying the length of the bar (35 cm or 70 cm). In the FCm, 120 stimuli were consecutively presented for 250 ms, with variable tilting from vertical (1°-32°, CW or CCW) and a 90" interval after the 40th and the 80th stimulus. For both methods, environmental cues were carefully eliminated. *Data Analysis*. The bias (B) and the threshold (T) in SVV were estimated. Reliability of ADJ measures was estimated through calculation of the Intraclass Correlation Coefficients (ICC) and Bland-Altman's Limits of Agreements. Age-related differences and differences between methods and gender were analysed, using non parametric tests for T, since T measures were not-normally distributed.

Results. Test-retest reliability of ADJ measures was fair (ICC: <0.60, LoA: 2° and 1,5°, for B and T, respectively; fig. 1-2). No differences were found between the two methods, neither for B nor for T. In the ADJm, the bar length was irrelevant to results, whereas the its initial position significantly affected the SVV, leading to biases toward the same side which were significantly higher in trials with the bar placed in the most tilted position. The SVV did not significantly differ between genders (Figure 3). A significant positive correlation was found with age for T (rho=0,376, p<0,001) but not for B. Accordingly, age-related differences were found for T among age groups, with values significantly higher in the older group compared to adult and young groups.

Conclusions. SVV measures obtained with the ADJm and FCm are comparable. Should the FCm be found reliable, it might be preferable since in the ADJm some artifacts may affect the reliability and the measure varies with the initial value of the test stimulus. Age-related differences suggest the presence of mild impairment in verticality perception with ageing.

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pERhl: a personal health lab in your pockets

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Background and aim of the study. Mobility problems, ranging from frequent accidental falls to difficulty standing up or walking, affect millions of Europeans both young and old. Injuries caused by falls range from mild scrapes and bruises to serious complications requiring long term treatment with an high impact in the quality of life of the subjects. The *pERsonal health lab* (*pERhl*) project funded by the Emilia Romagna Region aims to build a novel system for the assessment of motor function in the aged: the definition of a fall-risk profile [1,2] is the ultimate goal of the project.

Materials and methods. The pERhl system is assembles two components (Figure 1): a wireless inertial Sensing Unit (SU), including triaxial accelerometer, gyroscope, and magnetometer, and an Android application (uPerhl); the SU sends the sensors data to uPerhl through a Bluetooth connection. The SU was designed to be small and lightweight in order to be easily worn. uPerhl is used to acquire and store the data with an easy-to-use interface. The pERhl protocol is currently composed of six tests: *functional reach*, *timed up and go*, *repeated sit to stand*, *assessment of postural sway in quiet standing and after a laying-to-standing transition*, and the *six minutes walking test*. These tests are already used in a clinical screening protocol for fall prevention and are instrumented wearing the SU on the lower back by means of an elastic belt.

Results. The pERhl system is currently used in an experimental protocol at the geriatric ward of the Civil Hospital of Modena (Italy). Algorithms have been implemented in MATLAB for each test to compute a set of parameters defined in literature to characterize and evaluate motor performance [3,4].

Discussion. A personal health record (PHR) has been designed that contains: the results of the clinical tests; the information collected during the clinical examinations; the parameters obtained with the instrumented tests; and the raw signals re-

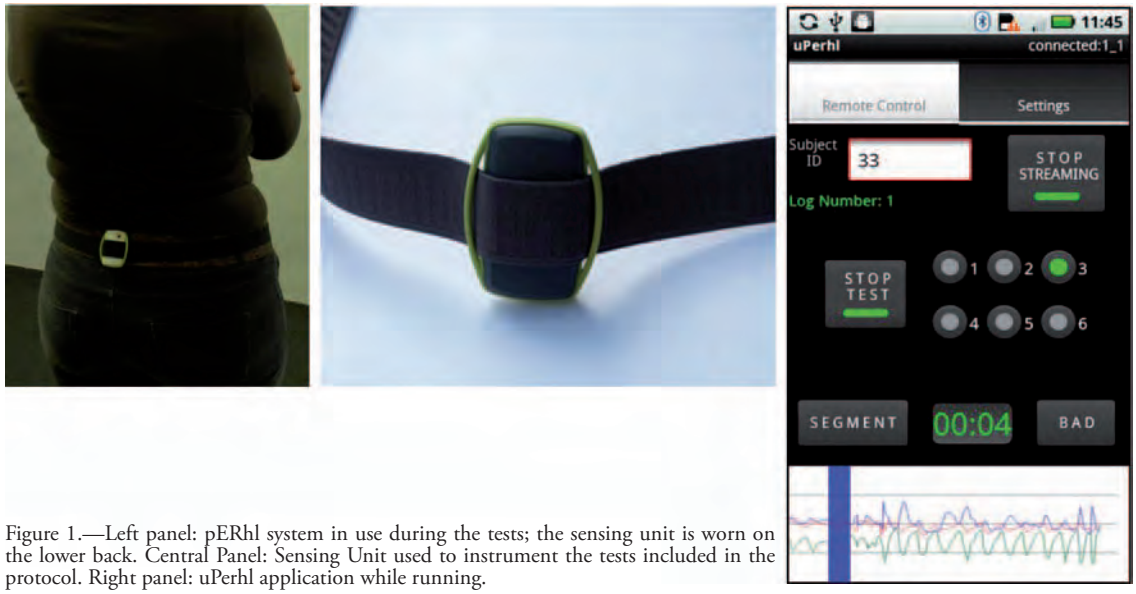

Figure 1.—Left panel: pERhl system in use during the tests; the sensing unit is worn on the lower back. Central Panel: Sensing Unit used to instrument the tests included in the protocol. Right panel: uPerhl application while running.

corded with the inertial sensor. Data mining techniques will be used on the PHR database to define a fall risk model that will be tailored on the specific and unique user's profile.
Conclusions. The combined use of a wireless SU, to capture inertial data, and a Smartphone, for the data processing, make it possible to obtain a pocket size mobile movement analysis lab.

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Starting to walk or taking a step: study of anticipatory postural adjustments

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Background. Previous studies showed that the latency and the duration of the Anticipatory Postural Adjustment (APA) are greater in complex motor tasks than in simple [1,2]. This could be due to the fact that since planning for a complex task is more elaborate, it would require more planning time.
Aim and scope. The purpose of this study is to observe whether differences can be found in the APAs' when the subject is given motor orders requiring equal kinematics but two different space-time references.
Materials and methods. 15 healthy subjects aged between 20 and 24 years were recruited. Subjects stood barefoot on a force platform, with the feet parallel, 20 cm apart.
Each subject performed, starting with the right leg, a total of eight trials, four for each of the two types of tasks, which consisted in performing "one stride" (step, task 1) and "walk to the end of platform" (walk, task 2). Were measured: 1) the kinematics of the gestures in terms of length, velocity and acceleration of the first step using an optoelectronic system (ELITE, BTS, Milan); 2) the displacement of the CoP using a force platform (Kistler); 3) the EMG of the medius gluteus, medial gastrocnemius and anterior tibialis muscles bilaterally. An inter-task t-test for paired samples or a Wilcoxon Signed Ranks was performed.

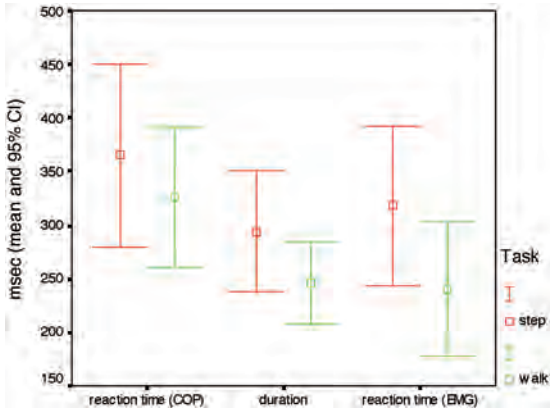

Figure 1.

Table I.

	Task 1 (step)	Task 2 (walk)	p-value
COP peak velocity (m/sec)	0.21±0.08	0.23±0.07	0.038
COP peak acceleration (m/sec^2)	1.53±0.65	1.73±0.61	0.007

Results. The kinematic variables showed no differences between the two tasks. The latency and duration of APAs' were greater in the first task (figure 1); CoP speed and acceleration were higher in the second task (table1).
Discussion. Taking into account the information that the literature provides us [3], we can speculate that these differences could origin from these circumstances:
— during one stride the Central Nervous System needs to predict the final APAs
— a step involves a dual-task programming compared to walking, which involves the programming of a single task (i.e. the subject must think beyond that to start the task, even to stop immediately after the execution of first step).
Conclusions. The single step seems to require a greater motor planning when compared to walking.

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Identificazione delle fasi del cammino nella Gait Analysis: confronto fra tre metodi

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Introduzione e scopo. L'analisi computerizzata del cammino (Gait Analysis) fornisce al clinico informazioni dettagliate in grado di individuare e quantificare anomalie non sempre rilevabili con la semplice osservazione clinica. Per ottenere informazioni accurate e precise occorre però identificare le fasi del passo per ciascun piede, così da normalizzare correttamente al ciclo del cammino tutti i dati cinematici e cinetici misurati. Valutare il grado di concordanza, nell'identificazione delle fasi del passo, fra tre metodi: A) metodo che utilizza i valori della forza di reazione del suolo rilevati con piattaforma dinamometrica; B) metodo che utilizza i valori di pressione rilevati in vari punti della pianta del piede mediante particolari sensori (Foot-Switches, FS); C) metodo che utilizza i dati cinematici rilevati mediante sistema optoelettronico. Il metodo A) è stato considerato il *gold-standard*, rispetto al quale stimare la validità degli altri due metodi.
Metodo. In 10 soggetti giovani sani, 5 uomini e 5 donne, di età 20-35 anni (media 24,2±4,2) è stata effettuata l'analisi computerizzata del cammino mediante sistema optoelettronico SMART-E90 (BTS, Milano) con disposizione dei markers secondo il protocollo Davis, due piattaforme dinamometriche (Kistler e AMTI) e tre FS posti sulla pianta del piede (tallone, base V° metatarso, falange distale alluce). In tutti i soggetti venivano registrati tre trial di cammino a velocità libera e tre trial di cammino lento con cadenza di 92 passi/minuto dettata da un metronomo. Per ogni trial venivano identificati bilateralmente il contatto iniziale (Heel Strike, HS) e il distacco delle dita (Toe Off, TO), in maniera indipendente utilizzando i dati cinematici, i dati dei FS e quelli delle piattaforme di forza. Questi ultimi sono stati considerati il *gold standard* rispetto al quale è stato stimato con metodo Bland-Altman il grado di concordanza degli altri due metodi.

Table II.—*Limits of Agreement secondo il metodo Bland-Altman delle misurazioni effetuate.*

	C vs P	FS vs P	FSc vs P
HS Dx 1	17,84	20,60	12,74
TO Dx	27,75	26,95	20,70
HS Sx 1	24,72	25,39	17,28
TO Sx	26,73	28,95	21,02

Risultati. Quando si uniforma la frequenza di campionamento a 60 Hz, il metodo che fornisce misure maggiormente in accordo con il *gold standard* è quello che utilizza i dati dei FS, per il quale l'errore in più o in meno atteso nel 95% delle osservazioni rispetto al *gold standard* è inferiore all'intervallo di un frame (17 ms). Il metodo basato sulla cinematica porta ad un errore leggermente maggiore, ma ancora del tutto accettabile.
Conclusioni. I dati presentati mostrano che sia l'analisi visiva dei dati cinematici, sia in misura ancora maggiore l'applicazione di FS, sono metodi validi per identificare in maniera sufficientemente accurata inizio e fine dell'appoggio durante il cammino in piano in soggetti sani. Ulteriori ricerche sono necessarie per verificare la validità dei due metodi nello studio del cammino patologico o per l'identificazione di altri eventi del ciclo, importanti per definire le diverse subfasi della deambulazione.

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Development of the italian version of the physical therapy patient satisfaction questionnaire. Cross-cultural adaptation, reliability, and validity

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Background and purpose. Patient's satisfaction is an important measure for evaluating interventions in health care. No translated form of satisfaction questionnaire for physical therapy treatment has been validated to date in Italian population.
Methods. The Italian version of the Physical Therapy Patient Satisfaction Questionnaire (PTPSQ-I) was developed through forward-backward translation, final review, and pre-final version. The reliability was measured by internal consistency (Cronbach α) and test-retest repeatability at 7 days (Intra-class Coefficient Correlation). The concurrent validity was measured by comparing the PTPSQ-I with the Visual Analogue Scale (VAS) and with a 5-points Likert-type Scale evaluating the Global Perceived Effect (GPE) for the physical therapy treatment. Moreover, an acceptability analysis and a factor analysis were conducted.
Results. The process for obtaining a shared version of the PTPSQ-I required three months. 109 inpatients and 354 outpatients filled in the PPS-I and 108 took the re-test. The high number of 'I do not know' answers for some items suggested

the opportunity to exclude them from the PTPSQ-I, leading to the definition of a reduced version, named PTPSQ-I(15). The PTPSQ-I(15) scale (sum of the scores on the 15 items) showed high internal consistency (α=0.9289) and good test-retest reliability (ICC=0.938). Concurrent validity was moderate for the GPE (r=0.33812, p<0.001), but not significant for the VAS (r=0.356, p=0.0188).
The possible existence of more satisfaction dimensions was investigated using factor analysis, which evidenced the suitability of 2-factors structure (explaining together the 65% of the total variance). The estimated factors were interpreted as related to the perceived "competence" and "courtesy".
Discussion. The Physical Therapy Patient Satisfaction Questionnaire, translated into Italian in its full version, did not have sufficient psychometric properties to be used to evaluate patient satisfaction with physical therapy in different Italian health care facilities. This situation suggested the opportunity to develop the PTPSQ-I(15) version, adapted to the Italian cultural and social context. The PTPSQ-I(15) version showed to be easily understood and self-administrable, requiring only few minutes to be completed.
Conclusion. The PTPSQ-I(15) showed satisfactory psychometric properties and its use can be recommended within Italian-speaking population, both for inpatient and for outpatient subjects.

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Italian-language version of the Physical Therapy Outpatient Satisfaction Survey: cross-cultural adaptation and psychometric analysis.

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Background and Purpose. Patients' satisfaction is a relevant outcome measure for health care providers. To date, no satisfaction questionnaire for outpatient physical therapy has been validated within Italian population.
Methods. The Italian version of the Physical Therapy Outpatient Satisfaction Survey (PTOPS-I) was obtained through forward-backward translation, final review, and pre-final version. Following the original proposal, the items were partitioned into four domains. The reliability of the questionnaire (and of the considered domains) was measured by internal consistency and test-retest stability at 7 days. Factor analysis was also used to verify the construct validity. The concurrent validity was measured by comparing the PTOPS-I scale with a 5-points Likert-type Scale assessing the Global Perceived Effect (GPE) of the treatment and with the Visual Analogue Scale (VAS).
Results. The development of a shared version of the PTOPS-I required three months, including the administration of the pre-final version to 50 subjects. 354 outpatients filled in the PTOPS-I, and 56 took the re-test after one week. Factor analysis confirmed the partition of the items into four blocks, identified as *Enhancers* (good experiences during the treatment), *Detractors* (perceptions regarding professional behaviors), *Location*, and *Cost*. The internal consistency (Cronbach's alpha) was 0.758 for *Enhancers*, 0.847 for *Detractors*, *0.885* for *Location*, and 0.706 for *Cost*. The test-retest stability (Intra-class Correlation Coefficients) was 0.769 for *Enhancers*, 0.893 for *Detractors*, 0.862 for *Location*, and 0.862 for *Cost*. Concurrent validity (Pearson Correlation) with GPE was significant for all the domains but not for *Location*. Irrelevant or not significant correlations were observed with VAS.
Discussion. The PTOPS-I showed a good level of acceptability and required few minutes for the compilation. The satisfaction of the patients was mostly related to the relationship with his/her physical therapist (confidence, dialogue, respect of the privacy) as found from the correlation between global score and sub-totals, which indicated the most correlation with *Detractors*. The lowest level of satisfaction was found on the *Cost* domain.
Conclusions. The PTOPS-I showed good psychometric properties. Its use can be suggested for Italian-speaking population, for outpatients who receive physical therapy, both in public and in private facilities.

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