PW 32:
Functional assessment of muscle

PW32-399	**SCANNING ION CONDUCTANCE MICROSCOPY (SICM): A NEW TECHNIQUE TO INVESTIGATE THE DEVELOPMENT OF PATHOPHYSIOLOGICAL PHENOTYPE OF MEMBRANE SURFACE IN DYSTROPHIN-DEFICIENT MUSCLE CELLS?** COGNARD C[1], CONSTANTIN B[1], DUCLOHIER H[1], SEBILLE S[1] (1) IPBC 6187 Université de Poitiers/CNRS, Poitiers, FRANCE.
To contact the author:: christian.cognard@univ-poitiers.fr.	Since the cytoskeleton provides the cell with structure and shape, and participates in building specialized domains with specific functions, it will be interesting to compare the membrane surface topography in control muscle cells with the one of dystrophin-deficient cells. A glass nanopipette is filled with a physiological electrolyte and lowered through a Petri dish containing the same electrolyte and the living cells while the conductance between an electrode inside the pipette and a reference electrode in the bath is monitored. As the tip of the micropipette approaches the cell surface, the ion conductance decreases because the space through which ions can flow is decreased. The pipette is then scanned (in X-Y two dimensions) over the membrane while a feedback device raises and lowers the micropipette to keep the conductance constant. Thus, the path of the pipette tip follows the topography of the surface. A key feature of the technique is its scanning 'algorithm' which maintains constant the distance between the pipette tip and the sample. In our experiments membrane surfaces of myotubes from minidystrophin-expressing cell line (SolD) and from dystrophin-deficient cell line (SolC) in culture were scanned and the topographical images built and compared. An unexpected longitudinally grooved and complex surface was observed especially in dystrophin-expressing myotubes. This constitutes the first observations of cell surface in skeletal muscle preparations with this technique. Further experiments will be conducted to check if the membrane topography differences observed in the present preliminary experiments were directly related to absence/presence of dystrophin, and to elucidate the possible link with the normal/pathological function of the membrane embedded channels permeable to calcium which are reported to be involved in calcium homeostasis perturbation observed in dystrophin-deficiency related diseases like Duchenne muscular dystrophy.

PW 32-400	**ASSESSMENT OF MUSCLE CONTRACTION BY DIFFUSION TENSOR IMAGING** DEUX JF[1], BASSEZ G[2], MALZY P[3], PARAGIOS N[4], LUCIANI A[1], ROUDOT-THORAVAL F[5], VIGNAUD A[6], RAHMOUNI A[1] (1) Service d'Imagerie Médicale, CHU H. Mondor, APHP, Créteil, FRANCE. (2) INSERM U841-E10 (Institut Mondor de Recherche Biomédicale), Paris 12 University, Créteil, FRANCE. (3) Service d'Imagerie Médicale, CHU Lariboisière, Paris, FRANCE. (4) Ecole Centrale de Paris, Chatenay Malabris, FRANCE. (5) Centre d'Investigation Clinique, CHU H. Mondor, APHP, Créteil, FRANCE. (6) Siemens Medical division, Paris, FRANCE.
To contact the author:: guillaume.bassez@hmn.aphp.fr.	The goal of this study was to assess the changes of water diffusion during contraction and elongation of calf muscles using Diffusion Tensor (DT) MRI in normal volunteers. Twenty volunteers (mean age, 29 ± 4 years) underwent DT MRI examination of the right calf. Echo Planar Imaging sequence was performed at rest, during dorsal flexion and during plantar flexion. The 3 eigenvalues (λ1, λ2, and λ3), Apparent Diffusion Coefficient (ADC) and Fractional Anisotropy (FA) of the diffusion tensor were calculated for medial gastrocnemius (mGM) and tibialis anterior (TA). A fiber tractography was performed on both muscles. Non parametric Wilcoxon and Mann Whitney tests were used for statistical evaluation. At rest, λ1, λ2 and ADC of mGM were higher than their counterparts of TA ($P<0.01$). During dorsal flexion, the 3 eigenvalues and ADC of TA significantly increased ($P<005$) as their counterparts of mGM slightly decreased (P=NS). Opposite variations were detected during plantar flexion of the foot. Visual analysis evidenced a relationship between 3D representations of MRI fibers and physiological state of muscles. Contraction of calf muscles produces changes in DT parameters, which are related to the physiological state of the muscle.

PW32-401	**EFFECT OF MATURATION ON THE RELATIONSHIP BETWEEN MUSCLE SIZE AND FORCE PRODUCTION** TONSON A[1], RATEL S[2], LE FUR Y[1], COZZONE P[1], BENDAHAN D[1] (1) Center for Magnetic Resonance in Biology and Medicine (CRMBM), UMR CNRS 6612, MARSEILLE, FRANCE. (2) Laboratory of Exercise Biology (BAPS), EA 3533, AUBIERE, FRANCE.
To contact the author:: david.bendahan@univmed.fr.	The purpose of this investigation was to determine whether maturation affects the relationship between muscle size and maximal strength and to investigate the reasons accounting for the discrepancies among previous studies. **Methods:** Maximal isometric handgrip force (F_{max}) and forearm muscles size were measured in 14 pre-pubertal boys (11.3 ± 0.8 y.o.), 16 adolescents (13.3 ± 1.4 y.o.) and 16 men (35.4 ± 6.4 y.o.). MRI was used to measure anatomical maximal cross-sectional area (MCSA) and muscle volume (V_M). V_M was compared with anthropometric measurements of muscle volume (V_L). **Results:** F_{max} was linearly correlated with V_M (r^2=0.90), V_L (r^2=0.85) and MCSA (r^2=0.87). The F_{max}/V_M ratio did not differ between groups. By contrast, F_{max}/V_L and F_{max}/MCSA were significantly higher in adults than in children and adolescents. Additionally, V_M was strongly correlated to V_L (r^2=0.90). This relationship demonstrated that, when compared to MRI, anthropometric measurements lead to a systematic overestimation of muscle volume which was significantly larger in children and adolescents than in adults (43.1 %, 38.5 % and 20.5 % $p < 0.05$ respectively). **Conclusion:** Our results showed that the maximal isometric strength which can be exerted by the forearm human muscles is proportional to its size whatever the age. During growth V_M was the best index of muscle size. We suggest that the previously reported increased ability to produce maximal strength from childhood to adulthood could be explained by systematic bias introduced by the method used in order to characterize muscle size and not by physiological or neural changes.

PW32-402

A NEW EXPERIMENTAL SETUP FOR INVESTIGATING SKELETAL MUSCLE FUNCTION STRICTLY NON-INVASIVELY IN RAT USING NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY AND IMAGING

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Introduction. Magnetic resonance (MR) techniques have proven their ability to investigate skeletal muscle function in situ. However, in animal research, the benefit provided by MR techniques in terms of non-invasiveness is lost because of the utilization of invasive procedures for inducing muscular contractions (via nerve stimulation) and for measuring force output (via attachment of a transducer to the muscle tendon). Required surgical preparation thus prohibits repeated investigations on the same animal. We have developed a new experimental setup allowing strictly non-invasive MR investigations of muscle function in contracting rat gastrocnemius muscle. In this study, we have compared its performance with that of a traditional invasive setup.

Methods. The new setup integrates four non-invasive systems allowing prolonged anesthesia with control of the animal's body temperature, transcutaneous electrical stimulation of the gastrocnemius muscle, force measurement with a dedicated ergometer, and two MR probes for 31-phosphorus spectroscopy and proton imaging. Muscle function was investigated in 20 rats through a fatiguing stimulation protocol, either with this new setup (n = 10 rats) or with a traditional setup (n = 10).

Results. Muscle functional MR imaging demonstrated that transcutaneous stimulation specifically activated the gastrocnemius muscle. During the stimulation period, changes in isometric force production and energy metabolism (intramuscular pH and phosphorylated compounds) were similar for both setups.

Conclusion. The non-invasive setup is then suitable for investigating skeletal muscle function in situ, allowing mechanical performance, energy metabolism, anatomy and physiology to be accessed strictly non-invasively in contracting rat gastrocnemius muscle. This non-invasive alternative makes surgical preparations obsolete and represents a major advance for the future investigations of skeletal muscle function in animal models. Longitudinal studies become readily feasible and each rat can serve as its own control, thus reducing inter-individual variability, workload and costs, hence opening up new perspectives in various research areas including pharmaceutical research.

PW32-403	**DEVELOPMENT OF MUSCULAR STRENGTH IN SARCOPENIA : COMPARING THREE DIFFERENT TRAINING METHODOLOGIES** IODICE P[1], DI TANO G[1], DORIA C[1], SAGGINI A[2], SAGGINI R[1] (1) Dept. Basic and Applied Medical Science, "G. dAnnunzio" University, Chieti, ITALY. (2) La Sapienza University, Roma, ITALY.
To contact the author:: pierpaolo_iodice@yahoo.it.	Aging is characterised by a gradual decrease in muscle mass and muscle strength which contributes to a decline in physical functions, increase disability, frailty, and loss of independence. Age related loss of muscle mass is referred to as sarcopenia (Argiles JM et al., Adv Gerontol.18:39-54,2006). Regular training programs are a concrete means to prevent and/or reduce functional decline due to aging (ACSM, Med Sci Sports Exerc.1998 Jun;30(6):992-1008), although the optimum regime specific for older adults remains unclear. Twenty-eight subjects (12♂ and 16♀) of 75±10 years old with a diagnosis of grade 3 Sarcopenia (CDC) were randomly assigned to three different training programs, 3 day/wk for 12 wk, high intensity local vibrational program (intensity: 300hz), endurance program (intensity: 60-70% HRmax) and resistance program (intensity:60-80%Fmax, 10-12 repetitions for 3sets). Before and after the training programs a muscle samples were collected from vastus lateralis muscle by biopsy. These were used to analyse the specific tension development of single fibers. At the same time, the Isometric lower limb force was measured by dynamometer. The Myoton-2 equipment was used to describe the viscoelastic parameters of the skeletal muscles: the frequency of damped mechanical oscillation of the muscle tissue (Hz), logarithmic decrement of the oscillations (Θ) and stiffness (Nm^{-1}) of the muscle tissue. As follow-up the subjects was tested 3 months after protocol end. Our results indicate that resistance and vibrational training increase muscular strength($p<0.05$). This improvement was maintained at 3 months. This study shows increase of muscular elasticity and muscular tension. Variation in muscular stiffness is not significant. The relation between strength, the viscoelastics parameters and the specific tension of fibers have been analysed. In conclusion, different training programs cause specific adaptation in muscles in the elderly. Resistance and vibrational programs seem to have better results in counteracting muscles decline due to aging.

PW32-404	**CELLULAR AND MOLECULAR MODIFICATIONS INDUCED BY THREE SPECIFIC TRAINING IN AGED HUMAN SKELETAL MUSCLE** PIETRANGELO T[1], PUGLIELLI C[1], BOSCO G[1], TONIOLO L[2], REGGIANI C[2], BELLOMO RG[3], DI PANCRAZIO L[3], FANÒ G[1] (1) Dept. Basic and Applied Medical Science, Interuniversity Institute of Myology,University G. d'Annunzio, Chieti, ITALY. (2) Dept. of Human Anatomy and Physiology, Interuniversity Institute of Myology, University of Padova, Padova, ITALY. (3) Dept. Basic and Applied Medical Science, University G. d'Annunzio, Chieti, ITALY.
To contact the author:: tiziana@unich.it.	Sarcopenia is a scientific term indicating the physiological reduction of skeletal muscle mass and strength in older people. Sarcopenia has a multifactorial origin linked to: oxidative damage of fibers (Fulle et al, Exp. Gerontol 40:189, 2005), mitochondrial damage (Brunk UT et al, Eur J Biochem, 269(8):1996-2002, 2002) reduced levels of GH, IGF-1, steroids and reduced myogenesis (Beccafico et al., ANNALS 1100:345-352, 2007). The physical activity is able to slow down and/or revert this condition (Taaffe DR et al, Clin Physiol 16:381- 391, 1996). We analysed the effects of three different physical activity programs (endurance training, resistance training and local vibrational energy) on vastus lateralis biopsy derived by 65-85 years old people, before and after the training. From these muscle fragments we analysed: (i) the specific tension development of single fibers and the expression of myosin heavy chain proteins; (ii) the transcriptional profile and (iii) the regenerative capacity of satellite cells. The single fiber strength development do not change with any training protocol. Considering the gene expression profiles, each physical activity share a stimulation of a specific metabolic pathway; both endurance and vibrational training increase the aerobic metabolism while the resistance training stimulates the creatine metabolism. All the training, in a different manner, stimulate the expression of sarcomeric and cytoskeletal proteins and in particular the vibrational training stimulates proteins linked to Z-line. Moreover, the endurance training induces the expression of protein for neuronal chemotaxis. We studied also the behavior of satellite stem cells after the specific training and their contribution to regeneration process and fiber trophism. In conclusion, our results suggest that all our training counteract Sarcopenia progression and each of them are able to stimulate a specific molecular signaling. The effects are specific because it exists coherence between exercise typology and stimulated metabolism.

PW32-405	**ASSESSMENT OF GRIP STRENGTH USING PRECISION DYNAMOMETRY** HOGREL JY[1], LI K[2], DUCHENE J[2], HEWSON D[2] (1) Institut de Myologie, Paris, FRANCE. (2) Institut Charles Delaunay - Université de Technologie de Troyes, Troyes, FRANCE.
To contact the author:: jy.hogrel@institut-myologie.org.	Grip dynamometry is an important and easy-gathered method to evaluate hand function. Reliable and valid evaluation of grip strength depends on the quantified measurements and standardised testing procedures. A major drawback of all commercially available grip handles is that they are not adapted to weak patients, particularly during therapeutic trials. To this end, the Myogrip was designed for the assessment of grip strength of weak patients suffering from various neuromuscular disorders such as muscle dystrophies. The device was built around a precision force sensor (full scale: 89 daN; accuracy: 0.05 daN; sensitivity: 0.01 daN). The Myogrip can complete several functions: real time display, maximal force recording, wireless communication with a computer, RS232 or BNC connections. The handle size is finely adjustable. Several works are undergone using the Myogrip, aiming at: - testing the effect of elbow positioning and grip handle size on maximal grip strength - comparing the Myogrip with the gold standard (represented by the Jamar) and another available device (Martin Vigorimeter) - developing a normative database on 450 subjects aged from 5 to 80 years - assessing the reproducibility and repeatability of the measure on 120 subjects - proposing a predictive model of grip strength to compute patient deficit - testing the validity of the Myogrip for the evaluation of weak patients Prelimlinary results showed no effect of elbow positioning. However when the elbow is fully extended, patient evaluation was more reproducible, probably due to less possibility of compensation and better patient maintaining by the evaluator. A significant effect of grip handle size was observed. Results obtained with Myogrip and Jamar were highly correlated (0.93). Test-retest reliability of all grip devices was excellent (ICC higher than 0.96). The Myogrip is a new device devoted to the measure of weak patients. Its validation is ongoing and preliminary results show excellent reliability.

PW32-406	**QUALITY ASSURANCE AND METROLOGY STANDARDS IN FUNCTIONAL EVALUATION OF NEUROMUSCULAR DISORDERS** OLLIVIER G[1], TOUITA KABBAJ A[1], CANAL A[1], ROQUES S[1], HOGREL JY[1] (1) Institut de Myologie, Paris, FRANCE.
To contact the author:: g.ollivier@institut-myologie.org.	Many techniques and methods exist to evaluate the functional capacity of patients suffering from neuromuscular disorders. Because each evaluator/physiotherapist (PT) has different skills and because each trial centre has different tools and practices, it is essential to standardize techniques and methods for the functional assessment of patients, particularly for multicentric studies, in order to improve the reproducibility and consistency of results. At the Institute of Myology, the Neuromuscular Physiology and Evaluation Lab, composed of 6 persons including 3 Physiotherapists, is developing a quality system based on the international standard ISO/CEI 17025 "General requirements concerning the competence of the laboratories of calibrations and tests". The aim of this process is: - to guarantee the reproducibility and robustness of the results delivered - to reinforce our credibility with investigators, industrial partners and drug companies The first section concerns the management of the laboratory. Main requirements are: - to understand study objectives fully and adapt functional evaluations in consultation with investigators - to manage all the documents linked to a clinical trial according to formal procedures - to improve communication and follow-up with investigators by meetings, contracts and questionnaires - to detect all variations from correct procedures in order to improve the system The second section concerns measurement and metrology to ensure: - competence of the personnel by training and checking the reproducibility within- and between-PTs - proper control of equipment (functioning and calibration) - respect of evaluation procedures - metrological quality of equipment (compliance with national standards) - development and validation of new methods ISO 17025 is an industrial standard which needs some adaptations to be transferred to clinical settings. We plan to be accredited at the end of the year 2008 by the COFRAC (French Committee of accreditation). For scientific, ethical and financial reasons, it is fundamental to apply formal and rigorous methodology to ensure the quality of measurements. Quality assurance and metrology standards help towards reaching this goal.

PW32-407	**ASSESSMENT OF FLEXION AND EXTENSION TORQUES OF WRIST AND ANKLE USING SPECIFIC DYNAMOMETERS** HOGREL JY[1] (1) Institut de Myologie, Paris, FRANCE.
To contact the author:: jy.hogrel@institut-myologie.org.	Evaluation of wrist and ankle flexion and extension has rarely been considered in neuromuscular disorders, particularly because their assessment is difficult using classical methods, either by hand-held dynamometry or by quantified muscle testing. This work aimed to develop two different dynamometers to study these muscle functions. The wrist device allows the measurement of the torque generated around the wrist joint during voluntary isometric contractions in the flexion/extension directions. The wrist dynamometer is built around a static torque sensor presenting a full scale (nominal torque) of 25 Nm, an accuracy of 0.05 Nm and a sensitivity of 0.0025 Nm. The ankle device was designed to measure strength of ankle flexion and extension using two different settings. The device is made of a foot plate under which two precision load cells are fixed. From each load cell is attached an extremity of a strap. This strap is then tighten over the fifth metacarpal joint (for ankle flexion) or over the knee (for ankle extension). The full scale is 200 daN; the accuracy is 0.1 daN and the sensitivity is 0.01 daN. Force values (in N) are converted into torque values (Nm) by measuring the lever arm. Fatigue assessment during static contractions and timed tests are also possible with both dynamometers because they can be connected to a computer. The work was firstly devoted to test the technical validity and the reliability of both instruments. At the present time maximal voluntary contractions of wrist and ankle flexion and extension were measured on 250 subjects aged from 5 to 80 years to build normative data. Repeatability and reproducibility were tested on 60 subjects. Wrist flexion and extension and ankle flexion presented excellent intraclass correlation coefficients (ICC higher than 0.9) whereas ankle extension presented lower ICC (about 0.7). Both devices were also tested in some very weak patients suffering from various neuromuscular disorders and demonstrated their ability to detect small contractions and their good reproducibility.

PW32-408	**GAIT ANALYSIS OF NEUROMUSCULAR PATIENTS USING ACCELEROMETRY** HOGREL JY[1], CANAL A[1], BARREY E[2], OLLIVIER G[1] (1) Institut de Myologie, Paris, FRANCE. (2) LEPHE-INRA - Genopole, Evry, FRANCE.
To contact the author:: jy.hogrel@institut-myologie.org.	Quality of gait is a fundamental outcome measurement for the follow-up of neuromuscular patients either during the natural history of their disorder or during a therapeutic trial. Precise gait analysis can be performed using kinematic systems in lab conditions. Unless very useful, the measurement and analysis procedures are long and complex and not always suitable for clinical routine depending on the patients. Accelerometry can bring much useful information on gait without many constraints for the patient or the medical staff. This has been considered in the present work during six-minute walk tests (6MWT). The gait analysis system used in this study (Locometrix-2™) includes three accelerometers in a small (20 x 40 x 80 mm) and light (50 g) box and a data logger. The apparatus is incorporated into a semi-elastic belt, which is fastened around the subject's waist, close to the centre of gravity. Signals were recorded with a sampling frequency of 100 Hz. The recorded signals were transferred to a computer and analyzed by a specific software. Several gait variables were computed on a sample of 10 s of stationary gait: walking velocity, stride frequency and length, symmetry and regularity indexes, mechanical power and high frequency shocks. As a pilot study, the measurements were performed on 12 patients suffering from acid maltase deficiency during 6MWT. Their results were compared to normative data available from more than 400 healthy subjects and show deep modifications of their gait depending on the severity of their disorder. Accelerometry is a very simple tool to assess gait quality. Measurements will also be considered at home in further studies.

PW32-409	**MEASUREMENT OF BODY HEIGHT IN PERSONS WITH NEUROMUSCULAR DISEASES** ZUPAN A[1], BALANTIC Z[2], CERU B[3] (1) Institute for rehabilitation of the Republic of Slovenia, Ljubljana, SLOVENIA. (2) Faculty of organizational sciences, Kranj, SLOVENIA. (3) Institute for rehabilitation of the Republic of Slovenia, Ljubljana, SLOVENIA.
To contact the author:: anton.zupan@guest.arnes.si.	Information about a person's body height is needed for calculating numerous formulas such as for vital capacity. Classical method of measuring body height (client in standing position) is not usable in wheelchair-bound persons with neuro-muscular diseases (NMD), particularly not in those with physical deformations. We tried to find a new method of measuring and predicting body height on the basis of measuring certain body parameters – segments in upper and lower limbs. We chose 12 body segments, which were considered to be measured easily in persons with physical deformities. First we conducted a pilot study on 18 healthy persons, whose body heights were measured by classical method. Subsequently the study was performed in 60 persons with NMD, whose body heights were measured with a tailor's tape measure in lying position and we were trying to consider all physical deformations, above all scoliosis and flexor contractures in hips, knees and ankles. A good correlation between the chosen parameters and the body heights was found in healthy and also in persons with NMD. Statistical analysis proved that by measuring one of the newly defined parameters we can assess the body height with 0,63 reliability rate. The study has proven that by measuring the newly defined parameters the body height can be well assessed. We made a mathematical model to help us to define the body height, by using at least three chosen body parameters, those three, which correlate best with the body height and which, considering the specific physical disability and the present body deformities, can be measured most easily and objectively.

PW32-410	REHABILITATION PROGRAMS FOR PERSONS WITH NEUROMUSCULAR DISEASES IN SLOVENIA. ZUPAN A[1], PRAZNIKAR A[1], SARDOC M[2] (1) Institute for rehabilitation of the Republic of Slovenia, Ljubljana, SLOVENIA. (2) Muscular Dystrophy Association of Slovenia, Ljubljana, SLOVENIA.
To contact the author:: anton.zupan@guest.arnes.si.	Neuromuscular diseases are inherited, chronic, degenerative and progressive. The main characteristics of neuromuscular diseases are: muscular weakness, contractures, scoliosis, respiratory insufficiency, cardiac affection, nutrition disturbances, dependence on the help of others, possible social isolation and physiological problems. Appropriate rehabilitation programs should influence all mentioned characteristics. A special unit for rehabilitation of patients with neuromuscular diseases within the Institute for rehabilitation of the Republic of Slovenia was established in 1993 at the initiative of the Muscular Dystrophy Association of Slovenia. The main aim of this establishment was to try to guide the patient and his family through the course of the disease. The article described the work of the mentioned unit. Different clinical rehabilitation programs for persons with neuromuscular diseases are presented and some research results of the unit are mentioned.

PW32-411	**DYNAMIC, MULTI-PARAMETER NMR IMAGING QUANTIFICATION IN HUMAN CALF AT REST AND IN CONDITIONS OF REACTIVE HYPEREMIA** LOUREIRO DE SOUSA P[1], VIGNAUD A[2], CARLIER PG[1] (1) Laboratoire de RMN AIM - CEA Institut de Myologie, Paris, FRANCE. (2) Siemens Medical Solutions, Saint-Denis, FRANCE.
To contact the author:: p.loureiro@institut-myologie.org.	NMRI (Nuclear Magnetic Resonance Imaging) investigations have attempted to exploit the Blood-Oxygen-Level-Dependent (BOLD) contrast in the skeletal muscle as an estimator of physiological parameters. However, beside changes in hemoglobin saturation, which induce changes in apparent T_2 and T_2*, other mechanisms are involved in the BOLD contrast. For instance, it has been shown that BOLD contrast depends both on perfusion and on vascular filling during reactive hyperemia (RH) in human skeletal muscle [1]. To improve understanding of the origins of BOLD signal changes during RH, interleaved multi-parameter measurements have been used [2]. Such experiments have confirmed T_2* and T_2 changes, with no significant alteration in T_1 and M_0 [2]. In the present work we investigated the feasibility of simultaneous measurement of NMR parameters (T_1, T_2 and M_0). Experimental data were acquired on a 3.0 T whole body scanner (Siemens TimTrio, Erlangen, Germany). Multiple parameters were obtained in human calf using the IR TrueFISP [3] sequence. Image resolution = 2.3 x 2.3 mm^2, slice thickness = 8.0 mm. Dynamic multi-parameter measurements were performed in healthy volunteers who underwent a three phase protocol: rest (10 min), ischemia of the calf (5-10 min), reactive hyperemia (15 min). Time resolution for these multiparametric measurements was ~12 s. At rest, T_1 and T_2 maps showed excellent agreement with those obtained from standard methods. In all volunteers parameter time-courses showed a complex pattern, with concomitant changes in T_1, T_2 and M_0, whose origins need to be disentangled. The ability to monitor dynamically and simultaneously the main parameters of the NMR signal might help to define indices that reflect muscle oxygenation more closely than does standard BOLD contrast. [1] Duteil et al, MRM 55, 450-4 (2006) [2] Klarhöfer et al, Proc. ISMRM 3800 (2007) [3] Schmitt et. al., MRM 51, 661-7 (2004)

PW32-412	**INFLUENCE OF WORKLOAD ON HUMAN CALF MUSCLE FOLLOWING AEROBIC EXERCISE:PERFUSION AND BOLD ASSESSMENT** MONNET A[1], WARY C[1], WUYAM B[2], VERGES S[2], DUTEIL S[1], CARLIER PG[1] (1) Laboratoire de RMN, AIM - CEA, Institut de Myologie, Paris, FRANCE. (2) CHU, Université Joseph Fourier, Grenoble, FRANCE.
To contact the author:: a.monnet@institut-myologie.org.	**Introduction:** NMR is a powerful tool to assess musculo-skeletal perfusion and metabolism non-invasively and with a high time resolution. Blood oxygen level dependent (BOLD) NMR imaging readily provides contrast which depends on oxygenation but also on perfusion and other intricate factors. Arterial spin labelled (ASL) NMR imaging maps skeletal muscle perfusion, while 31P NMR spectroscopy monitors high energy phosphates metabolism. When combined in a single protocol, multiparametric functional NMR can provide new insight into muscle regulatory mechanisms, into time course of muscle recovery after dynamic aerobic exercise in healthy and diseased muscle. **Methods:** To explore the time course of muscle recovery from aerobic exercise, and in particular the "luxury perfusion", we studied exercise and recovery in 5 healthy volunteers who performed 10 min bouts of single leg plantar flexion at 4 graded workloads on a custom-built ergometer, while lying in a 4T magnet. Perfusion data with positive and negative ASL were acquired in the calf muscle during and after aerobic exercises and BOLD signal was directly measured from the mean of the same images. In the meantime, phosphorous spectra were acquired to evaluate phosphocreatine inorganic phosphate and pH changes. Muscle cell oxygenation was concomitantly explored by deoxymyoglobin proton NMR spectroscopy. **Results:** Recovery perfusion profiles were significantly prolonged with increasing workload ($p<0.05$), time x perfusion integrals and time of peak perfusion were linearly dependent on PCr depletion ($R^2=0.86$). In contrast, BOLD curves were not significantly different at different loads. **Conclusion:** Our results illustrate how mpf-NMR can investigate non-invasively control mechanisms between energy demand and microvascular perfusion adaptations in exercising muscles. They confirm that BOLD contrast is not a suitable substitute for perfusion assessment. However, it may be taken in combination with other variables, such as perfusion and intracellular oxygenation, to improve understanding of the physiology of exercising muscle.