

**Dynamic 31P MR spectroscopy using MR ergometers**  
(Project number: 66p3)

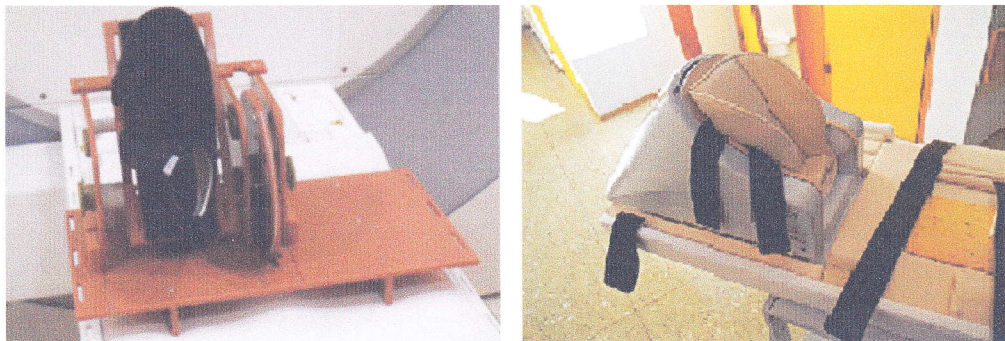
*Final Report*

In order to directly compare the data on oxidative muscle metabolism acquired in our institutions at different MR systems using two types of ergometers, we aimed to define a universal examination and evaluation protocol. *In vivo* measurements using two different ergometers on three whole-body systems working at 3 and 7 Tesla magnetic fields and consecutive data evaluations were performed within this project. MR measurements at 3T, equipped with a home-built ergometer, were performed at the MR Unit of the Institute for Clinical and Experimental Medicine (IKEM) in Prague; the MR measurements at 3T and 7T, equipped with a commercial ergometer, were done at the High Field MR Centre, Medical University of Vienna.

Following the approval of the ethics committees in Prague and Vienna and making some modifications in the project due to reduced expenses the first exchange of information between Vienna and Prague (April and July 2013) served for the discussion about the ongoing development of the unified examination protocol and for the measurements of first volunteers. The workload calibration curve was calculated to equally set the load on the weight-based mechanic ergometer used in Prague and on the air pressure-based pneumatic ergometer used in Vienna. Figure 1 depicts the ergometers used in this project. Several different loads were used in each subject to test the dependency of the designed protocol on the used workload.

In the summer months of 2013, examinations of the same volunteers were performed in the second institution and few additional volunteers were examined in IKEM. These were measured in Vienna during the visit in August, 2013. Unfortunately, soon after, a defect on the MR compatible ergometer was discovered what postponed future measurements and visits.

Data acquired during all previous measurements were independently and individually processed at both sites. This analysis showed an urgent need for unified evaluation protocol, which was consequently designed and used to re-analyze all measured data.



**Figure 1.** Home-built mechanic ergometer constructed in the IKEM institute which uses counterweights to set workload is depicted on the left. The commercially available pneumatic ergometer of the Vienna MR institute which uses compressed air to set workload is depicted on the right.



Workload	7.5 kg ~ 1.2 bar			11 kg ~ 1.8 bar			2.4 bar	
Tomograph	Prague 3T	Vienna 3T	Vienna 7T	Prague 3T	Vienna 3T	Vienna 7T	Vienna 3T	Vienna 7T
PCr conc. [mM]	39.2±0.3*	32.0±0.3	32.5±0.3	39.3±0.4*	32.7±0.3	31.2±0.3	32.1±0.3	30.4±0.2
PCr drop [%]	18±10	12±5	11±5	31±15	19±9	20±8	27±12	25±12
$\tau_{\text{PCr}}$ [s]	35±15	34±8	29±5	48±11	34±10	32±7	33±9	32±8
$V_{\text{PCr}}$ [mM/s]	0.22±0.11*	0.11±0.05	0.12±0.05	0.26±0.14	0.18±0.07	0.21±0.09	0.25±0.05	0.23±0.07
$Q_{\text{max}}$ [mM/s]	0.46±0.15*	0.26±0.09	0.30±0.10	0.44±0.17	0.38±0.10	0.38±0.06	0.40±0.17	0.36±0.17
pH	7.06±0.01	7.08±0.01	7.07±0.02	7.04±0.03	7.05±0.04	7.06±0.03	7.06±0.02	7.04±0.03

**Table 1.** The comparison of dynamic parameters measured in volunteers in Prague and Vienna. The data are given as mean  $\pm$  standard deviation. \* depicts the statistically significant differences ( $p < 0.05$ ) between the measurements at 3T with different ergometers. The 2.4 bar measurements were performed only in Vienna due to limited maximum load of the Prague ergometer.

Very good agreement between the 3T and the 7T data on oxidative muscle metabolism acquired using the same ergometer was found (Table 1), proving independence of the designed protocol on the magnetic field strength used. This was true for all three workloads tested. The differences found between the results from Prague and Vienna (3T) can be contributed to differences in measured PCr concentration values. The cause of this is the difference in sensitivity volumes of the used coils due to slightly different diameters and geometry. The *in vivo* sensitivity maps measurement of the used coils was added to the protocol during the last volunteers' examinations in Vienna (November, 2013) and consecutive examination of the same volunteers in Prague.

The project was concluded with the final volunteer measurements at 3T MR system and data analysis during the last visit in Prague (December, 2013). This visit also served for the intensive discussion and preparation of the manuscript, which is planned for the submission to scientific journal (Journal of Magnetic Resonance Imaging) in due time. Further on, the preliminary results of the study are to be presented at the joint MR related international conference (International Society of Magnetic Resonance in Medicine & European Society of Magnetic Resonance in Medicine and Biology) in Milan in 2014.

Besides the scientific output of protocol unification allowing dynamic 31P MRS multi-centric studies, our project proved the usability of sharing measurement time on mid-size instrumentation in international projects.

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**Scientific output (List of presentations at local and international conferences)**

1. Abstract submitted to the joint annual meeting of the ISMRM & ESMRMB in Milan in 2014
2. Manuscript in preparation to Current Contents indexed int. journal J Magn Reson Imaging

**List of Participants of respective project visits (no students were traveling):**

Vienna to Prague (15.-17.04.2013)

1. Ladislav Valkovič
2. Marek Chmelík
3. Martin Krššák

Prague to Vienna (08.-10.07.2013)

1. Monika Dezortová
2. Milan Hájek

Prague to Vienna (18.-20.08.2013)

1. Monika Dezortová
2. Andrea Gálisová
3. Petr Šedivý
4. Miloslav Drobný

Prague to Vienna (25.-27.11.2013)

1. Monika Dezortová
2. Milan Hájek
3. Petr Šedivý
4. Vít Herynek

Vienna to Prague (04.-07.12.2013)

1. Ladislav Valkovič
2. Wolfgang Bogner
3. Monika Kipfelsberger

**Funding of the project:**

- a) AKTION funding according to the project proposal: 3420,- Eur + 43.000,- CZK
- b) Additional institutional supports (especially measurement time fee):
  - Vienna - cca 18.000,- Eur
  - Prague - cca 66.000,- CZK