PROJECT "SOSPESI 2"

Report on the results of the second phase

February 2015

Introduction

C.A.M.P. and the University of Milan Bicocca collaborated on the research project "SOSPESI"*, regarding the likelihood of developing the inert suspension syndrome for workers and climbers that use a harness.

Research Team

The project "SOSPESI" is led by a group of researchers at the Clinical Physiology and Sport Centre of the University of Milan Bicocca (www.fisiologiaclinica.medicina.unimib.it).

Summary of the first phase of the project

The first phase of the project focused on a thorough analysis of the causes and symptoms of syncope due to passive suspension by performing a series of experiments on 40 people, through innovative and non-invasive techniques never used previously for the analysis of this medical problem.
The results of the first stage can be summarised as follows:

- the average time of suspension, of immobile persons with a harness for rope access, was 29 minutes (maximum and minimum time is 60 and 10 minutes, respectively). Please note that the time refers to the use of a working suspension harness: the suspension time following a fall on a normal harness would be lower;
- no relationship has been found between suspension time, age and level of training of volunteers. Even highly skilled and trained people can have harness syncope;
- suspension time decreases with the increase in ambient temperature.
- arterial pressure and heart rate increase throughout the suspension period and decrease immediately when it ends.

** The other sponsors of the research project are: "Servizi e Sistemi", "Geoneer Group".*

Thorough data analysis of the first phase of the project useful for the second phase

The specific risk for those who use the harness for work (or for leisure purposes) is the syncopal event even in the absence of a trauma. The project SOSPESI revealed a syncopal event in 4 participants in the project on 40 (10 %). Harness syncope, if not countered with prompt interruption of suspension and the positioning of the unconscious person in the horizontal position, can lead to irreversible organ damage from hypoxia (lack of oxygen to tissues). If the condition persists, it leads to the death of the unconscious and inert person in the harness.
The evidence from the project SISPESI suggests that it is necessary to choose the harness based the work performed, but also on the possibility of experiencing a syncopal event.
Among the variables analysed, we carried out a non-invasive assessment of oxidative metabolism of the muscle using the NIRS (near infrared spectroscopy) method and by putting a probe on the vastus lateralis muscle of the femoral quadriceps.

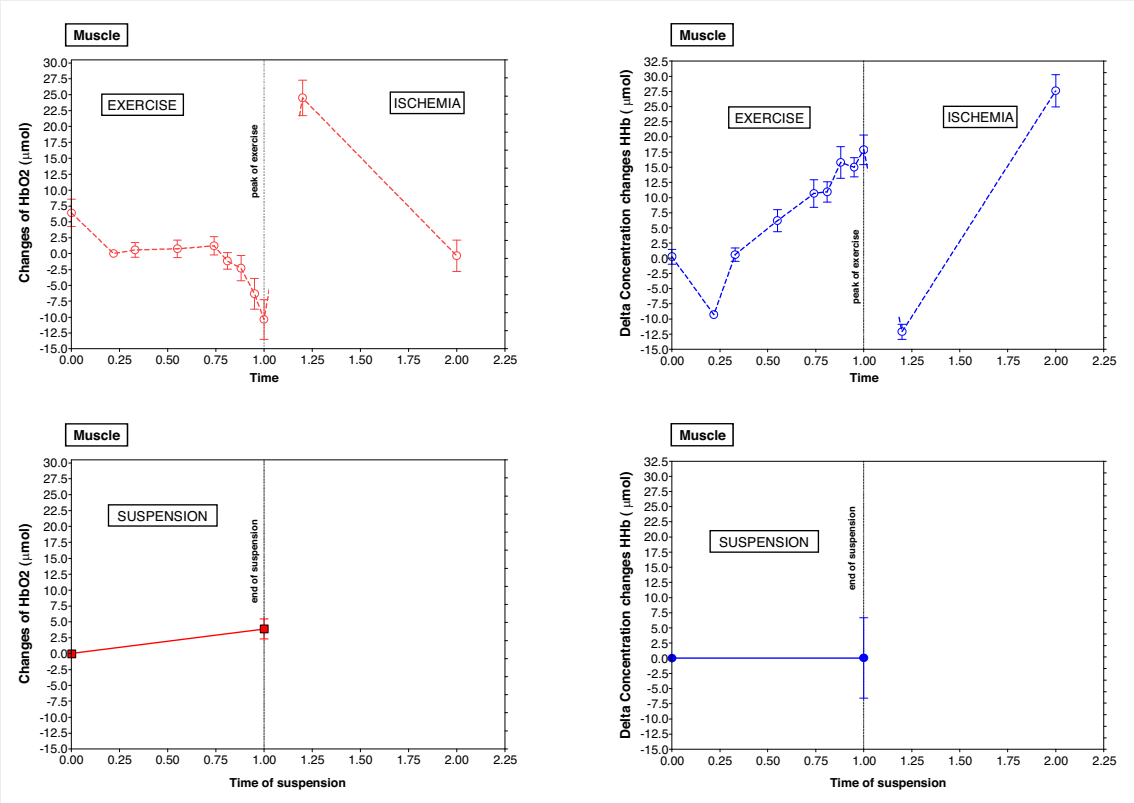
Figure 1: passive suspension test.

The harness syncope appears to be linked to a phenomenon of accumulation of blood in areas under the diaphragm (abdomen and lower limbs) and therefore it seemed important to check whether the leg loop of the harness performs a compressive action that prevents the venous return of blood to the heart.

The graph below (average values and standard deviation of the 40 participants in the first phase of the research project) compares changes in oxygenation of the vastus lateralis muscle during:

1) a maximal running exercise on tapis roulant;
2) ischemia (reduction of blood inflow) produced with a sleeve positioned at the base of the thigh under a pressure of about 300 mmHg;
3) the condition of passive harness suspension.

Please note that, during the maximal exercise, the muscle increases oxygen extraction from the muscle: the red dashed line decreases (oxygenated hemoglobin), concurrently with an increase in the blue dashed line (deoxygenated hemoglobin).
During the exercise, the muscle uses oxygen to support muscle contraction and when it is unable to further increase the extraction of oxygen, in spite of an increase in workload, a condition muscle exhaustion by hypoxia occurs and the test ends due to the inability of the person to keep running.
Tissue hypoxia is evident during ischemia, a condition in which the influx of arterial blood to the muscle and the return of venous blood toward the heart are blocked.
During suspension, there is no request for extraction of oxygen to the muscle and not even phenomena comparable to ischemia: continuous red and blue lines and without significant changes.
The leg loop does not obstruct the venous return, but the orthostatic and inert position in the harness involves the failure of the return of blood toward the heart.



The first phase of the study also found that the inert person, if it was possible to witness the event (condition recreated during the laboratory experimental set) must be rescued with immediate descent to earth and can be positioned with the legs higher than the torso to allow the restoration of physiological cardiovascular conditions.
This photo displays the individual who was suspended the longest (54 minutes) at the end of the suspension, ended due to high values of systolic hypertension. The photograph shows that, by using the most comfortable type of harness available, the extended passive suspension may have a very important impact on the lower limbs. The photograph also shows the position they should put the injured party in once s/he is back on the ground.

Figure 2: conditions of the teste after a inert suspension test of the duration of one hour. This photo shows the right position of the rescued person after the suspension.

When it is possible to bring the person quickly to the ground it is not recommended to carry out rescue operations with the harness on because they can waste precious time, especially if these are performed by untrained staff: the main priority should be to bring the injured party to the ground.
According to the research project SOSPESI, the harness should be comfortable and safe not only for use, but also in the event of having to evacuate an unconscious person.

Purpose of the second phase

The purpose of the second phase of the project was to find a possible correlation between the type of harness and the negative consequences of suspension, evaluating possible variables in the construction of the harness that might improve or worsen suspension conditions.

Participants

13 healthy individuals (9 men and 4 women) participated in the second phase, aged between 24 and 70 years of age, weight ranging between 49 and 94 kg, height ranging from 160 to 191 cm.
Five persons were also part of the 40 people who had taken part in the first phase of the project. Five people are habitual harness users.

Methodology

Type of test

27 active suspension tests were carried out (photo 3), comparing the following harness models:

- CAMP Safety Golden Top Evo Alu ref.094102 (abbreviated GTE) (photo 4);
- CAMP Safety Access Sit + Access Chest ref.196201 +196202 (abbreviated ACC) (photo 5);
- Harness prototype with improvements in comfort at inguinal, dorsal, lumbar and latero-cervical level with possibility of adjusting the position of suspension from activity at rest (abbreviated PRO).

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Figure 3: active suspension test.
Figure 4: CAMP Safety Golden Top Evo Alu ref.094102.
Figure 5: Safety Access Sit + Access Chest ref.196201+196202.

Type of comparison

- Number of comparative tests between GTE / ACC / PRO: 12
- Number of comparative tests between GTE / PRO: 9
- Number of comparative tests between GTE / ACC: 1
- Number of GTE only tests: 2
- Number of ACC only tests: 2
- Number of PRO only tests: 1

Test temperature

- Number of tests conducted at room temperature (between 18 and 23°C): 12
- Number of tests conducted at low temperature (< 18°C): 12

Results

Average cardiovascular parameters observed

- Average systolic blood pressure (mmHg):
  GTE: 127
  ACC: 125
  PRO: 124

- Average diastolic blood pressure (mmHg):
  GTE: 76
  ACC: 77
  PRP: 78

There are no significant changes in blood pressure between suspensions performed with the different harness models.

- Average heart rate (beats/min):
  GTE: 89
  ACC: 91
  PRO: 74

There is a statistically significant difference between the PRO harness and the GTE and ACC models, compatible with lower cardiovascular stress.

Average duration of suspension

- Suspension time prior to interruption due to inability to continue
  GTE: 46 min
  ACC: 45 min
  PRO: 53 min

Note the increase in the average suspension time for the PRO harness.

Comfort parameters (subjective)

Parameters measured based on the report of the user, expressed as a percentage of the number of reports with respect to the test total.

- Thoracic Cage Expansion Limitation at rest
  GTE 10%
  ACC 42%
  PRO 37%

- Posterior dorso-lumbar discomfort
  GTE 50%
  ACC 0%
  PRO 0%

- Lateral dorso-lumbar discomfort
  GTE 30%
  ACC 0%
  PRO 0%

- Inguinal discomfort
  GTE 60%
  ACC 100%
  PRO 12%

- Latero-cervical discomfort
  GTE 0%
  ACC 42%
  PRO 12%

- General PRO comparison with GTE and ACC
  More comfortable in passive suspension 62%
  More comfortable during activity 100%
  More convenient at dorso-lumbar level 75%
  More comfortable in lateral movement 12%

Overall evaluation of the prototype

- Strengths: comfort at rest, lumbar support comfortable at rest, the better support of the lower limbs (90° position) both at rest and during exercise, improved symptoms at inguinal level, lighter.

- Weak points: limited torsion and laterality tasks, improvable inguinal level symptoms.

Conclusions relating to the second phase of the project

As described above, the orthostatic and inert position in the harness is the root cause of the failed return of blood to the heart, and therefore of the syncope. The leg loop is not obstructive to venous return.

However, comfort in the harness is an important factor in precipitating events triggered in people subject to syncopal event. It is believed that the choice of harness (on the basis of the tests of different types, different room temperatures, in conditions of passive suspension) the following points should be comfortable:

- inguinal: distribution of the weight of the lower limbs on wide and padded leg loops,
- lumbar: with the possibility of support in this area.
- dorsal: shoulder straps and support band that do not restrict the physiological excursion of respiratory muscles,
- latero-cervical: shoulder straps that do not create compression in the loggia latero-cervical space on the neck where the carotid vessels start, both during activity and under syncope condition.

The ability to adjust the harness depending on the individual bodily size is an important requirement in the choice of the type.

The second phase of the project, with the comparison between existing harnesses and a new prototype, contributed to providing important elements for the development of a new harness for suspended work, called "GT" consisting of a low part (GT Chest) and a pectoral part (GT Chest). Photo 6.

Figure 6: new GT Sit + GT Chest harness.

New solutions were found during product development improving comfort, especially in the light of the medical aspects mentioned above:

- new construction of the leg loop connection with the harness, in favour of better inguinal comfort;
- form and structure of the modified belt, in order to maintain good dorsal support without compromising the movement of the respiratory muscles;
- the shape of the pectoral padding proven to minimise contact with the carotid blood vessels.

Feasible solutions for lumbar paddings and additional adjustments are being researched, which may further improve comfort but without causing damage to the freedom of movement at work.

Summary comment on the entire "SOSPESI" project

Ensuing from what emerged from the SOSPESI project and from interviews with healthcare and non-health professionals after informative events carried out (conference in Lecco, Trento, Ancona, Rome, Lake Louise, Barcelona), two important actions in the communication with harness users are considered a priority.

1) The awareness of the worker of the fact that the harness with the anchoring and connection system is "the place of work".
   It clearly emerges that the workplace must be safe and comfortable to allow activity to be performed effectively and over prolonged periods.
   A few hours a day do not lead to health problems, but the aggregate hours over a working life can cause permanent damage to health.

2) It is necessary to consider the harness not only in terms of the work performed, but also in terms of the possibility of experiencing a syncopal event.
   Unfortunately, we detected an unawareness on the part of workers, sometimes disturbing, in the choice of harness and the possibility of being rescued with types of harnesses in some cases suitable for technical/work gestures but deleterious in the case of inert suspension.

We therefore urge harness workers to be constantly updated on technical improvements to harnesses.
The development and marketing of harnesses is also important for making choices that also take into account these two important points that emerged from the study.

Conclusively, it is important to ensure all operators in the sector ar informed of problems relating to inert suspension syndrome, in order to raise awareness on the risks and precautions to be taken.
This especially in relation to the general awareness of the absolute necessity of planning, and of training working teams in order to ensure effective and quick rescue in the event of inert suspension.
Quick rescue is undoubtedly the best way to limit consequences after a fall or a syncopal event after prolonged suspension.

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