Ovidius University Annals, Series Physical Education and Sport / SCIENCE, MOVEMENT AND HEALTH
Vol. 11, ISSUE 2, 2011, Romania
Our JOURNAL is nationally acknowledged by C.N.C.S.I.S., being included in the B+ category publications, 2008-2011.
The journal is indexed in: Ebsco, SPORTDiscus, INDEX COPERNICUS JOURNAL MASTER LIST, DOAJ DIRECTORY OF OPEN ACCES JOURNALS, Caby, Gale Cengace Learning

THE EFFECTS OF ACUTE INHALED SALBUTAMOL ON POWER OUTPUT AND BLOOD LACTATE CONCENTRATION IN NONASTHMATIC ELITE KUNG FU ATHLETES

HAMID ARAZI[1], NAVID LOTFI[2], HOSEIN ROSTAMKHANI[3]

Abstract
Objective: The purpose of this study was to investigate the effects of inhaled Salbutamol on power output and blood lactate concentration in kung fu athletes. **Methods:** Seven elite Iranian kung fu athletes (age: 18.28±0.69 yr; height: 184.00±1.73 cm; weight: 69.84±7.78 kg; BMI: 23.25±1.45 kg.m^{-2}) with no history of asthma were participated in this study. Subjects performed a RAST test with and without salbutamol ingestion (400 µg) in a random, double blind, crossover design. Blood samples were collected at before test and at the end of the test. An independent t test was used to evaluate the differences in subjects characteristics between groups ($p<0.05$). **Results and Conclusion:** There were no difference in peak power, mean power, fatigue index and blood lactate concentration with Salbutamol compared with placebo ($p>0.05$). In conclusion, administering a single inhaled (400 µg) of the β_2-adrenergic agonist Salbutamol to healthy, elite anaerobic trained male athletes has no ergogenic effect. Further studies are necessary to clarify the mechanisms involved.
Key words: Salbutamol, Anaerobic performance, RAST test, Ergogenic effect.

Introduction

The ß$_2$-agonists such as Salbutamol are used, not only by asthmatic athletes to prevent exercise induced asthma, but also by non-asthmatic athletes as a potentially ergogenic agent. In sport many athletes use ß$_2$-agonists during sports competitions, claiming they need the treatment to prevent EIA (C. Goubault , M.C. Perault , E. Leleu et al. 2001). There are several investigations dealing with the effects of Salbutamol on performance as an ergogenic aid. M.A. van Baak , L.H. Mayer, R.E. Kempinski, F. Hartgens (2000) studied the effect of Salbutamol on muscle strength and endurance performance in nonasthmatic men. They reported that oral Salbutamol appears to be an effective ergogenic aid in nonasthmatic individuals not experiencing adverse side effects. K. Collomp, B. Le Panse, H. Portier (2005) investigated the effects of acute Salbutamol intake during a Wingate test. They reported that Salbutamol intake at a therapeutic dosage seemed to improve peak and mean power output in short-term supramaximal exercise, but further investigation of the mechanisms involved is needed. K. Collomp, R. Candau, F. Lasne, Z. Labsy, C. Préfaut, De Ceaurriz J (2000) in another study investigated the effects of short-term oral Salbutamol administration on exercise endurance and metabolism. They reported that compared with rest, exercise resulted in a significant increase in GH, cortisol, testosterone, T3, FFAs, and lactate and a decrease in C peptide after both treatments with higher exercise FFA levels and exhaustion GH concentrations after Salbutamol ($P < 0.05$). C. Goubault , M. C. Perault , E. Leleu et al (2001) studied effects of inhaled Salbutamol in exercising non-asthmatic athletes. They reported that inhaled Salbutamol, even in a high dose, did not have a significant effect on endurance performance in non-asthmatic athletes, although the bronchodilating effect of the drug at the beginning of exercise may have improved respiratory adaptation. K.F. Andersen, I.L. Kanstrup (2009) studied the effects of acute oral administration of 4 mg Salbutamol on exercise performance in non-asthmatic elite athletes and reported that after administering a single oral therapeutic dose (4 mg) of the β_2-adrenergic agonist Salbutamol to healthy, elite endurance trained male athletes, acute ergogenic effects were shown in terms of a reduced extent of EIAH as well as an increment in time to exhaustion during a constant-load test, which indicated a meaningful performance-enhancing effect in a race situation. I.B. Stewart, J.M. Labreche, Mckenzie, D.C (2002) indicated that acute formoterol administration has no ergogenic effect in nonasthmatic athletes. B.C. Sporer, A.W. Sheel, D.C. McKenzie (2008) studied the dose response of inhaled Salbutamol on exercise performance and urine concentrations. They reported that there was no significant effect of dose on completion time, mean power, or mean heart rate. S.L. McDowell, S.J. Fleck, W.W. Storms (1997) investigated the effects of salmeterol on power output in nonasthmatic athletes. They reported that there were no significant differences ($p>0.05$) between the placebo and salmeterol trials for peak power output, total work

[1]Assistant professor, Department of Exercise Physiology, Faculty of Physical Education and sport sciences, University of Guilan, Rasht, IRAN
[2]MSc, Islamic Azad University, Ghorveh Branch, Kurdistan, IRAN
[3]PhD candidates, Islamic Azad University, Abhar Branch, Zanjan, IRAN
email: h_arazi2003@yahoo.com
Received 15.01.2011 / Accepted 20.04.2011

performed during the 30-second test, percent fatigue, and time to peak power. J.F. Signorile, T.A. Kaplan, B. Applegate, A.C. Perry (1992) studied the effects of acute inhalation of the bronchodilator, albuterol on power output and reported significant ergogenic effect of the bronchodilator on short-term power output independent of impact on respiratory smooth muscle, with no effect on cardiac response.

Anaerobic power is important in anaerobic sports such as kung fu and wrestling. Having high level of anaerobic power helps to these athletes for perform explosive techniques. Lactate increased during the sport has a negative effect on enzymes function and glycolysis process in energy production. Materials that can be used to increase power production and reduce lactate concentration can be improved performance in anaerobic sports. In often studied have been investigated the effects of Salbutamol intake on endurance performance and few study have been done on anaerobic power. Although in these studies subjects weren't of anaerobic sports (K. Collomp, B. Le Panse, H. Portier, 2005, B.C. Sporer, A.W. Sheel, D.C. McKenzie, 2008, I.B. Stewart, J.M. Labreche, D.C. Mckenzie, 2002, J.F. Signorile, T.A. Kaplan, B. Applegate, A.C. Perry, 1992). Also, because of prevalence use of $ß_2$-agonists such as Salbutamol in many athlete (such as Kung fu athlete) without knowledge of real effects of this drugs, the purpose of this study was to investigate the effects of acute inhaled Salbutamol on power output and blood lactate concentration in nonasthmatic elite kung fu athletes.

Methods

Subjects

Seven kung fu athletes with no history of asthma were recruited from the Kurdistan clubs and served as subjects in this study. They all had at least 5 years training experience and were top kung fu athletes of Iran competitors in national competitions. None were smokers and none had a history of atopy or of asthma or other cardio respiratory disorders. Before participating, subjects' parents were informed of the potential risks and gave their written informed consent to participate their children in this study, which was consistent with the human subject policy of the Guilan research center.

Testing procedures

Crossover design was used in this study. Approximately 10 minutes before the testing, the subjects took either 400 µg inhaled administered Salbutamol or placebo (no active medication) (I.B. Stewart, J.M. Labreche, D.C. Mckenzie, 2002). Anaerobic power was measured by the RAST test. The Running-based Anaerobic Sprint Test (RAST) was developed at the University of Wolverhampton (United Kingdom) to test an athlete's anaerobic performance. RAST is similar to the Wingate Anaerobic 30 cycle Test (WANT) in that it provides measurements of power and fatigue index. This test was chosen primarily due to its validity and reliability in relation to the Wingate test and also, because this test requires minimal equipment and training of the assessors and because of its specialty for field based anaerobic activities that are of a repetitive nature. It is easy to perform, provides scores that are easily reproduced and can be used to successfully estimate anaerobic capacity (E. Zacharogiannis, G. Paradisis, S. Tziortzis, 2004). In order to carry out a correct and precise testing process, the subjects stood 70 cm in the back of the starting line (on each side) and the apparatus would let the timer start after the subject passed in front of the first photocell. It was also decided that if in any of the cases the subject's best record was achieved after the second repetition, the test process should be finished and the subject was allowed to have another opportunity to participate in the test. To avoid these unwanted cases, subjects were asked to do each repetition at maximum power and avoid dividing energy between the six repetitions. Also, in order to increase the subjects' motivation, the record of each repetition was announced loudly and there were special rewards for three individuals who could achieve the best record, in addition to the payment in consideration of all the participants (E. Zacharogiannis, G. Paradisis, S. Tziortzis, 2004). Blood samples were collected from unpreferred hand mid-fingertips two times (1) immediately prior to the RAST test (pre-lac), (2) five minutes after the RAST test (5lac) (K.H. Letafatkar, M.H. Alizadeh, M.R. Kordi, 2009). For the purpose of estimating blood lactate concentration using a lactate analyzer (Lactate Scout-SensLab-Germany).

Statistical methods

All descriptive data are expressed as means ± SD. An independent t test was used to evaluate the differences in subjects characteristics between groups ($p<0.05$). Statistical analysis was conducted using SPSS 16.0 for Windows.

Results

Subjects' data and body composition are shown in Table 1. Results are shown in Table 2 and Table 3. None of the subjects experienced side-effects of any kind. (table 1)

Regarding the RAST test (Table 2), there were no statistically significant changes between Salbutamol and placebo in peak power ($P = 0.30$), mean power ($P = 0.79$) and fatigue index ($P=0.96$). Lactate plasma concentration of the subjects, as well as power parameters were also unchanged ($P = 0.64$) (Table 2).

Discussion and Conclusion

This is the first study to report the acute effects on performance in elite athletes of anaerobic sports without asthma after a single, inhaled administered therapeutic dose of Salbutamol.

It is well documented that inhaled β_2-adrenergic agonists, despite the dosage or the medication involved, do not have any performance enhancing effects in healthy subjects (B.C. Sporer, A.W. Sheel, D.C. McKenzie, 2008, C. Goubault, M.C. Perault, E. Leleu E. et al 2001, W.H. Meeuwisse, D.C. Mckenzie, S.R. Hopkins, 1992). But, some studies have demonstrated a statistically significant effect of a single inhaled therapeutic dose of Salbutamol (K. Collomp, B. Le Panse, Portier H, 2005, K. Collomp, R. Candau, F. Lasne, Z. Labsy, C. Préfaut, De Ceaurriz J, 2000, M.A. van Baak, L.H. Mayer, R.E. Kempinski, F. Hartgens, 2000, J.F. Signorile, T.A. Kaplan, B. Applegate, A.C. Perry, 1992).

Many studies have previously shown an improvement performance in healthy male athletes after administered Salbutamol, but the subjects were not highly trained (K. Collomp, B. Le Panse, Portier H, 2005, K. Collomp, R. Candau, F. Lasne, Z. Labsy, C. Préfaut, De Ceaurriz J, 2000, K.F. Andersen, I.L. Kanstrup, 2009, J.F. Signorile, T.A. Kaplan, B. Applegate., A.C. Perry (1992) and M.A. van Baak , L.H. Mayer, R.E. Kempinski, F. Hartgens, 2000).

Theoretically, it is unlikely that the bronchodilatory action of Salbutamol and other β_2-agonists has an ergogenic effect in healthy non-athletes, because bronchoconstriction is not a performance limiting factor (K.F. Andersen, I.L. Kanstrup, 2009).

The differences of mean power, peak power between groups after administration of Salbutamol was not significant. This result is in agreement with S.L. McDowell, S.J. Fleck, W.W. Storms (1997) who reported that there were no significant differences ($p > 0.05$) between the placebo and salmeterol trials for peak power output, total work performed during the 30-second test, percent fatigue, and time to peak power.

This result also, is in agreement with I.B. Stewart, J.M. Labreche, D.C. Mckenzie, (2002). But this result does not correspond with K. Collomp, B. Le Panse, H. Portier (2005) who reported that Salbutamol intake at a therapeutic dosage seemed to improve peak and mean power output in short-term supramaximal exercise.

The present study also does not corresponds with the results of M.A. van Baak, L.H. Mayer, R.E. Kempinski F. Hartgens (2000), K. Collomp, R. Candau, F. Lasne, Z. Labsy, C. Préfaut, De Ceaurriz J (2000) and K.F. Andersen, I.L. Kanstrup (2009) which suggested that Salbutamol appears to be an effective ergogenic aid in nonasthmatic individuals. This result maybe is because of test's protocol, subject's age (young vs. adult), subjects' experience (elite vs. novice) and nature of subjects' sports (anaerobic vs. aerobic sports). Also Signorile JF, Kaplan TA, B. Applegate, A.C. Perry (1992) reported a significant improvement in peak power in recreational athletes (positive result of an acute inhaled).

Subsequent studies measuring anaerobic power output in elite endurance athletes (W.H. Meeuwisse, D.C. Mckenzie, S.R. Hopkins, Rpad J.D, 1992, I.B. Stewart, J.M. Labreche, Mckenzie, D.C, 2002), including the present, have failed to identify any significant effect. When comparing therapeutic doses, formoterol has a similar maximum bronchodilatory effect, but the duration of the effect is approximately double that of salbutamol (E. Y. Dermon, Pauwels R. A, 1992, A. Wallin, T. Sandstrom, Rosehall L, 1993, I.B. Stewart, J.M. Labreche, D.C. Mckenzie, 2002). Despite the dosage or the medication involved, acute, inhaled administration of $ß_2$-agonists has been shown repeatedly to have no aerobic or anaerobic performance-enhancing effect in a population of elite athletes (W.H. Meeuwisse, D.C. Mckenzie, Hopkins S.R, 1992, K. Larsson, Hjemdahl P, 1989, M. Sandsund, M. Sue-Chu, R. E. Reinertsen, J. Helgerud, B. Holand, L. Bjermer, 2000, I.B. Stewart, J.M. Labreche, Mckenzie, D.C, 2002). It is unlikely that the bronchodilatory action of $ß_2$-agonists has an ergogenic effect, because in nonasthmatics bronchodilation is not a performance-limiting factor (I.B. Stewart, J.M. Labreche, D.C. Mckenzie, 2002).

The high level of rest blood lactate concentration in subjects (15-19 mmol/l) is due to exposed them in competition season (2 - 12 mmol/l in other studies). Transient increase of lactate levels (lactatemia) with or without metabolic acidosis has been seldom reported as a complication of ß-adrenergic agents administered during an asthma attack or for preterm labor therapy (G. Stratakos, J. Kalomenidis, C. Routsi, S. Papiris, C. Roussos, 2003). G. Rodrigo and C. Rodrigo (2005) reported that high lactate concentrations can develop during the first hours of inhaled beta agonist treatment. Although, this increase is may be due to subjects' trying to generate higher power. But, on the other hand with increase anaerobic power of subjects, lactate production decreases. However, we did not find any statistically significant changes in blood lactate concentration.This result does not correspond with other studies, who have found increased blood lactate concentration after administration of Salbutamol during exercise (G. Rodrigo and C. Rodrigo 2005). This result is due to that subjects in these studies weren't elite athletes. This result is in agreement with K.F. Andersen, I.L. Kanstrup (2009) who showed no statistically significant differences between the two testing conditions. After he RAST test, lactate had little increased. This may be because the lower increase of lactate in elite and trained subject.In conclusion, administering a single inhaled (400 μg) of the β_2-adrenergic agonist Salbutamol to healthy, elite anaerobic trained male athletes has no ergogenic effect. Further studies are necessary to clarify the mechanisms involved.

Acknowledgements

We like to thank Mr. Naser Mafakheri and Mr. Pedram Cheraghi (coaches) and Mr. Hadi Rohani (statistical adviser) for their cooperation in this study.

References

ANDERSEN, K.F., KANSTRUP, I.L., 2009, *Effects of acute oral administration of 4 mg Salbutamol on exercise performance in non-asthmatic elite athletes*. JEPonline. 12(1): 36-49.

ARAZI, H; ASGHARI, E; LOTFI, N, 2009, *The effect of a single session of preparatory and specific exercises in kung fu athletes on some hematological variables*. J of Sport and Exercise Physiology. 2 (1): 235-240.

COLLOMP, K., LE PANSE B., PORTIER, H., 2005, *Effects of Acute Salbutamol Intake During a Wingate Test. Int J Sports Med.* 26: 513-517.

DERMON, E.Y., PAUWELS, R.A., 1992, *Time course and duration of bronchodilating effect of inhaled formoterol, a potent and long acting sympathomimetic*. *Thorax.* 47: 30-33.

GOUBAULT, C., PERAULT, M.C., LELEU, E., BOUQUET, S., LEGROS, P., VANDEL, B., DENJEAN, A., 2001, *Effects of inhaled Salbutamol in exercising non-asthmatic athletes*. Thorax. Sep; 56(9):675-679.

HODGES, A.N.H., LYNN, B.M., KOEHLE, M.S., MCKENZIE, D.C., 2005, *Effects of inhaled bronchodilators and corticosteroids on exercise induced arterial hypoxaemia in trained male athletes*. Br J Sports Med. 39:917-920.

HOPKINS, W.G., SCHABORT, E.J., Hawley, J.A., 2001, *Reliability of power in physical performance tests*. Sports Med. 31(3):211-34.

LARSSON, K., HJEMDAHLE, P., 1989, *Cardiovascular and hypokalaemic effects of inhaled salbutamol, fenoterol, and isoprenaline*. Thorax. 44:767-768

COLLOMP, K., CANDAU, R., LANSE, F., LABSY, Z., PREFAUT, C., DE CEAURRIZ, J., 2000, *Effects of short-term oral Salbutamol administration on exercise endurance and metabolism.* J Appl Physiol. 89: 430-436.

LE PANSE B., COLLOMP, K., PORTIER H. A.M. LECOP, C. JAFFRE, H. BEAUPIED, O. Richard, L. BENHAMOU, J. De CEAURRIZ, D. COURTEIX., 2005, *Effects of short term salbutamol ingestion during a Wingate test.* Int J Sports Med. 26:518 523.

LETAFATKAR, K.H; ALIZADEH, M.H; KORDI, M.R., 2009, *The effect of exhausting exercise induced fatigue on the double-leg balance of elite male athletes.* Journal of Social Sciences. 5 (4): 445-451.

LUND, T., PEDERSEN, L., LARSSEN, B., BACKER V., 2009, *Prevalence of asthma-like symptoms, asthma and its treatment in elite athletes.* Scand J Med Sci Sports. 19:174-178.

MCDOWELL, S.L., FLECK, S.J., STORMS, W.W., 1997, *The effects of salmeterol on power output in nonasthmatic athletes.* J Allergy Clin Immunol. 99(4):443-

MCKENZIE, D.C., RHODES, E.C., STIRLING, D.R., WILEY, J.P., DUNWOODY, D.W., FILSINGER, I.B., JANG, F., STENS, A., 1983, *Salbutamol and treadmill performance in non-atopic athletes*. Med Sci Sports Exerc. 15(6):520-522.

MEEUWISSE, W.H., MCKENZIE, D.C., HOPKINS, S.R., ROAD, D.J., 1992, *The effect of salbutamol on performance in elite nonasthmatic athletes*. Med. Sci. Sports. Exerc. 24:1161-1166.

RODRIGO, G., RODRIGO, C., 2005, *Elevated plasma lactate level associated with high dose inhaled albuterol therapy in acute severe asthma*. Emerg Med J. 22(6): 404-408.

SANDSUND, M., SUE-CHU, M., REINERTSEN, R.E., HELGERUD, J., HOLAND, B., BJERMER, L., 2000, *Treatment with inhaled beta 2-agonists or oral leukotriene antagonists do not enhance physical performance in nonasthmatic highly trained athletes exposed to -15°C*. J. Thermal Biol. 25:181-185.

SIGNORILE, J.F., KAPLAN, T.A., APPLEGATE, B., PERRY, A.C., 1992, *Effects of Short-Term Salbutamol Ingestion During a Wingate Tes*t. Med Sci Sports Exerc.24 (6): 638-642.

SPORER, B.C., SHEEL, A.W., MCKENZIE, D.C., 2008, *Dose Response of Inhaled Salbutamol on Exercise Performance and Urine Concentrations.* Med Sci Sports Exerc. 40 (1): 149-157.

STEWART, I.B., LABRECHE, J.M., MCKENZIE, D.C., 2002, *Acute formoterol administration has no ergogenic effect in nonasthmatic athletes*. Medicine & Science in Sports & Exercise: 34 (2): 213-217.

STRATAKOS, G., KALOMENIDIS, J., ROUTSI, C., PAPIRIS, S., ROUSSOS, C., 2002, *Transient Lactic Acidosis as a Side Effect of Inhaled Salbutamol*. Chest. 122: 385-386.

VAN BAAK, M.A., MAYER, L.H., KEMPINSKI, R.E., HARTGENS, F., 2000, *Effect of Salbutamol on muscle strength and endurance performance in nonasthmatic men*. Med Sci Sports Exerc. 32(7): 1300-1306.

WALLIN, A., SANDSTROM, T., ROSEHALL, L., 1993, *Time course and duration of bronchodilatation with formoterol dry powder in patients with stable asthma*. Thorax. 48:611-614.

ZACHAROGIANNIS, E., Paradisis, G., Tziortzis, S., 2004, an evaluation of tests of anaerobic power and capacity. Med. Sci. Sports Exerc. 36: 116.