40th and 1/20th of the standard more than doubled. The maximal 
ed longer. There was nevertheless 
o doses of oxymorphone.
phone than that of morphine is in 
d mice (2,5,7). With higher doses 
section were similar to those ob 
observed with morphine. Panting 
aggering to hind legs which was 
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Animal Laboratories Pharmaceuticals Inc., 
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orphan (14-hydroxydihydromorphine), hine and relative side action liability of 
em of the narcotic analgesics. J. Sci. 
its antagonist, N-Allynoroxymorphone in 
t to anaesthesia. Br. J. Anesth., 33 :

SHORT COMMUNICATION:

CORONARY CIRCULATION RESPONSE TO ALTITUDE

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Summary: Coronary haemodynamics were studied in 19 low landers (LL) at sea level and first four 
days at high altitude (HA) (12,000 feet above sea level) and 8 high landers (HL) at HA. The coronary 
flow and myocardial oxygen consumption decreased at HA both in LL and HL. The calculated 
external mechanical efficiency index of the left ventricle was increased. The myocardial lactate extrac- 
tion was reduced inspite of high arterial values. These findings suggest the possibility of anaerobic 
cardiac metabolism at high altitude.

Key words: coronary blood flow myocardial oxygen consumption 
high altitude hypoxia anaerobic myocardial metabolism

Among numerous intrinsic and extrinsic factors regulating coronary blood flow, hypoxia 
is one of the strongest stimuli affecting coronary flow (1). Whereas hypoxia of short duration 
has been shown to increase coronary blood flow in the experimental animals (2, 10) and man 
(11, 12), the response of prolonged hypoxia is controversial. For example, prolonged hypoxia 
has been reported to show no effect (15, 16) no effect or increase (6) or decrease (9, 17, 22) 
of coronary blood flow. The present study was designed to determine the response of 
coronary circulation to prolonged high altitude hypoxia in man.

MATERIALS AND METHODS

19 young male low landers and 8 male high landers (permanent residents at 12,000 feet 
itude) of comparable age formed the clinical material for this study. The low landers were 
 studied at sea level and again at high altitude (12,000) feet above sea level within 24-96 hours 
of arrival by air. The high landers were studied only at high altitude. All were studied in 
a fasting state without any premedication by standard right heart catheterization technique. 
Coronary blood flow was measured by the nitrous oxide desaturation method (7). The lactate 
content in the arterial and the coronary sinus blood was estimated by the enzymatic technique.* 
Other parameters were measured by the standard formulae (3).

RESULTS

The coronary blood flow and myocardial oxygen consumption per 100 g of left ventricle 
were significantly less in the high landers and the lowlanders at high altitude as compared to

*Kits supplied by M/s Boehringer Mannheim GMBH, Germany.
the lowlanders at sea level. The myocardial oxygen extraction coefficient was, however, not altered. The calculated external mechanical efficiency index of the left ventricle was increased at high altitude. Though the arterial lactate values increased significantly at high altitude in both in low landers and high-landers, the myocardial extraction coefficient of lactae decreased (Table I).

### TABLE I: Coronary circulation at high altitude.

<table>
<thead>
<tr>
<th>No.</th>
<th>Parameter</th>
<th>Low-landers</th>
<th></th>
<th>High landers</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Sea level</td>
<td>H.A. data</td>
<td>H.A. data</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>m, S.D.</td>
<td>m, S.D.</td>
<td>m, S.D.</td>
<td></td>
</tr>
<tr>
<td>(1)</td>
<td></td>
<td>(2)</td>
<td></td>
<td>(3)</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>No. of subjects</td>
<td>19</td>
<td>19</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>C.B.F.</td>
<td>83.6±7.6</td>
<td>75.6±7.5</td>
<td>71.9±7.5</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>MVO₂</td>
<td>9.08±1.93</td>
<td>6.77±2.08</td>
<td>6.13±2.43</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>MO₂EC</td>
<td>0.59±0.09</td>
<td>0.58±0.11</td>
<td>0.57±0.10</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>LVWi</td>
<td>4.56±1.14</td>
<td>5.19±1.11</td>
<td>4.44±0.57</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>MEILV</td>
<td>26.0±8.3</td>
<td>39.0±16.7</td>
<td>41.0±18.8</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>AL</td>
<td>8.00±1.70</td>
<td>13.97±3.14</td>
<td>11.56±2.10</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>CSL</td>
<td>5.01±1.84</td>
<td>11.34±3.57</td>
<td>9.10±2.79</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>MECL</td>
<td>0.37±0.18</td>
<td>0.21±0.16</td>
<td>0.24±0.23</td>
<td></td>
</tr>
</tbody>
</table>

CBF = Coronary blood flow/100gLV/min., MVO₂ = Myocardial oxygen consumption ml/100gLV/min.; MO₂EC = Myocardial oxygen extraction coefficient; LVWi = Left ventricular work index kg.M/min/m²; MEILV = Calculated external mechanical efficiency index of the left ventricle. AL = Arterial lactate content mg%/CSL = Coronary sinus lactate content mg%/ MECL = Myocardial extraction coefficient of lactate.

### DISCUSSION

It is apparent from the data obtained that coronary blood flow and myocardial oxygen consumption decreased during high altitude hypoxia of 24 to 96 hours duration and after long stay at altitude. This response may appear paradoxical because hypoxia has been shown to be a potent coronary vasodilator (1). Whereas hypoxia of a few minutes duration has been shown to increase coronary blood flow (2, 10, 12), data on prolonged response of hypoxia is scanty. In chronic hypoxemia due to chronic obstructive lung disease, coronary blood flow is reported to be normal (15, 16) or slightly increased (6). This is in spite of hypercapnia which has been shown to increase coronary blood flow (5). It may, therefore, be presumed that chronic hypoxia decreases or does not alter the coronary blood flow. Other factors present during high altitude hypoxia like hypercapnia due to hyperventilation, polycythemia and alkalosis (20, 21) may also modify coronary blood flow. Whereas alkalosis increases the coronary blood flow (8), polycythemia (18) and hypocapnia (19) have been shown to decrease the coronary blood flow. It is interesting and Moret et al. (17) flow at high altitude.

Because the calculated external mechanical efficiency index of the left ventricle was increased at high altitude (2). The calculated external mechanical efficiency index of the left ventricle was increased at high altitude because of high values if anaerobic metabolism at high altitude (20).

The authors are M.S. Boparai, DM; M. S. Wahi, Director-General who cheerfully volunteered for this study successful.

The cardiac output and the systemic arterial pressures do not change significantly at high altitude (20, 21), the external work of the left ventricle does not alter at the altitude. The calculated external mechanical efficiency index of the left ventricle, which is a ratio of the left ventricular external work done and the myocardial oxygen consumption, increased at high altitude because of decrease in the latter parameter. This index will obviously give high values if anaerobic cardiac metabolism is present. The presence of anaerobic cardiac metabolism at high altitude is also indicated by the decreased myocardial extraction-coefficient of lactate in spite of high arterial values. Normally heart is an aerobic organ and anaerobic metabolism is said to play an insignificant role except in few situations like asphyxia (13), coronary artery disease during exercise (14) and anaemia (4). High altitude hypoxia seems to be another condition where anaerobic myocardial metabolism is present.

**ACKNOWLEDGEMENT**

The authors are indebted to the Lt. General S.N. Chatterjee, DGAFMS, Major-General M.S. Boparai, DMR for their ungrudging support for this work. They also thank Prof. P.N. Wahi, Director-General, ICMR for the financial help. The jawans from the Armed Forces who cheerfully volunteered for this work, need a special word of gratitude for making this study successful.

**REFERENCES**


### SHORT COMMUNICATION

**SPASMOLYTIC ACY**

R.K. **J College of**

**College of**

Summary: The antispasmodic drug (SK & F 21,000), a new compound, was tested and by charcoal inhibition. The ID$	extsubscript{50}$ test was 3.4 mg/kg and 2.56 mg/kg. The inhibition test was 3.4 times that of atropine.

Key words: spasm

Atropine the well-known compound such as mydriasis, dry mouth, has been synthesised with antispasmodic activity. The ID$	extsubscript{50}$ test was 3.4 times that of atropine.

Mice of either sex were used. 

**Acute toxicity:** atropine sulphate was found to have 24 hr mortality. Group 1 had an LD$	extsubscript{50}$ of 1.69 mg/kg and 1.256 mg/kg. Group 2 had an LD$	extsubscript{50}$ of 1.256 mg/kg.

The faecal pellets were counted on the second day, when