In order to encourage research in low back pain, the
Volvo Company of Göteborg, Sweden, has also this
year sponsored three prizes of USD 3,000 each. Awards
will be made competitively on the basis of scientific
merit in one or more of the following three areas:
1. Clinical studies
2. Biomechanical studies
3. Studies in other basic science areas
Papers submitted for the contest must contain original
material, not previously published or submitted for
publication. A multiple authorship is acceptable. The
manuscripts, in the English language, should be in
the form of a complete report, including original illus-
trations (please note: marked with raised); not exceeding
30 typewritten pages—references and tables included;
double-spaced, typed text should not be smaller than
10 pica; and in a form suitable for submission as an
original paper (not thesis) to a scientific journal. Ethics
committee approval is necessary for all animal studies as
well as controlled clinical studies. One original and
3 copies of each paper in full—including illustrations—
must reach the address given below not later than
December 1, 1995. Accordingly, articles sent by Fax
will not be accepted. Do not forget to give complete
address with telephone number and Fax number.
One of the authors should be prepared, at his/her own
cost, to come to Burlington, VT, USA at the time of
the meeting of the International Society for the Study
of the Lumbar Spine, June 25-29, 1996, to present the
paper and to receive the award.
The board of referees will be chaired by the under-
signed and will contain members from the fields of
clinical medicine, biomechanics and biochemistry.
Please direct all correspondence to:
Professor Alf Nachemson
Department of Orthopedics
Sahlgrens Hospital
S-413 45 Göteborg
Sweden

The Vienna Physical Award 1995
Eligibility: All academic scientists working in Physical
Medicine or in related fields.
Conditions: Regulations of the Vienna Physical Medi-
cine Award.
Deadline: 1 August 1995.
Price: Yearly scientific award of 10,000 DM (6000 US$)
plus travel subsidy of maximum 1000 DM.
Sponsor: Zimmer Elektromedizin GmbH, Neu-Ulm,
Germany.
Institution: Chair of Physical Medicine and Rehabili-
tation, University of Vienna, Austria.
Submission: Unpublished original scientific papers from all
aspects of Physical Medicine, in English (maximum length:
20 typed pages). Papers are automatically submitted for
publication in the "European Journal of Physical Medi-
cine and Rehabilitation". All manuscripts must be anonymous and include:
a) name and address of author(s)
b) short C.V.
(c) statement that participant is author
d) statement confirming that the participant is
entitled to publish the manuscript and agreeing to
its publication.
Ceremony: in Vienna, date to be announced.
Correspondence: Dr. V. Faltas, Dept. Phys. Med.
Rehab., Wilhrenger Gürtel 18-20, AKH, 1090 Vienna,
Austria.

ABSTRACT. We studied 15 subjects with intermittent
classification, classed as stage II according to Leriche-
Fontaine. The patients were subjected to laser Doppler
flowmetry, strain gauge plethysmography, Doppler
velocity, and blood sampling, in basal conditions
and after one month of physical training. Symptom-free
walking distance at the end of the training period
showed a significant increase, while there was no
major change in maximal walking distance or the
Windsor index. Laser Doppler flowmetry showed no
significant change in cutaneous blood flow at rest, after
the mouth of physical training. On the other hand,
strain gauge plethysmography showed a significant
decrease in rest flow at the end of the training period,
while peak flow of postischemic hyperemia did not
change appreciably. Biochemical evaluations showed a
significant decrease of white blood cell count, triglyc-
rides and uric acid. Platelet count, prothrombin time,
APTT and plasminogen were unchanged. On the other
hand, we recorded a small, but significant, rise of
thrombomodulin. Our study confirmed the importance
of scheduled physical activity in the patient with intermit-
tent claudication, showing that clinical improvement is
not accompanied by an increase in the circulatory
reserve. The unchanged levels of plasminogen suggest
that the fibrinolytic activity does not vary significantly
after a course of physical exercise.
Key words: intermittent claudication, physical exercise,
laser Doppler flowmetry, strain gauge plethysmography,
thrombomodulin.

INTRODUCTION
Obliterating disease of the arteries in the lower
limbs classed as second stage according to Leriche-
Fontaine is managed conservatively, except in a
certain percentage of cases characterized by brief
isolated stenosis. Such cases can be treated by the
more recent endovascular surgical methods.

MATERIALS AND METHODS
We studied 15 subjects (12 men and 3 women; mean age 66 years) with claudication on the lower limbs, classified as stage II according to Leriche-Foix classification. Hematological and antithrombotic treatments had been discontinued 15 days beforehand. Ten patients were smokers, but two of these had not smoked for over a year. One of the subjects who had continued to smoke had stopped at the time of the first visit 15 days before the commencement of the study. The other risk factors were represented by hypertension (33%), dyslipidemia (93%) and diabetes mellitus (33%). Of the eight hypertensive patients, six had been receiving calcium antagonist treatment for over a year (in four cases nisoldipine and, in two, nitrendipine) and two were taking meclozine. This treatment was not changed, since it could reasonably be considered that the patients had gained a stabilized hemodynamic condition.

Patients were subjected to laser Doppler flowmetry (PF, Permed, Stockholm, Sweden) and subsequently to strain gauge plethysmography (PeriQuat 3800, Gutmann, Euraurburg, Germany). Instrumental evaluations were performed after at least 20 minutes' stabilization in a supine position at a constant room temperature (21 ± 1°C). The last Doppler recording was continued for three minutes to afford an overall evaluation of spontaneous oscillations of the signal, which was recorded with a microcomputer (Olivetti M2908) and a dedicated software package (Pietrofig, Gutmann, Ltd, U.K.). Doppler velocity in the lower limbs was then performed with a 5-MHz probe (Vingmed SD-50, Vingmed, Horten, Norway) and the Windso index was calculated as the ratio of ankle systolic pressure to brachial systolic pressure (28). This is the most useful indirect measurement of ankle systolic blood pressure; it relates the pressure drop across an arterial segment to resistance and volumetric flow. Fasting venous blood samples were collected between 8 a.m. and 9 a.m. after at least a 15-minute resting period in a supine position at the beginning of the study and after one month of physical training.

After instrumental evaluations, both symptom-free walking distance (SWFD) and maximal walking distance (MWD) after the onset of symptoms were evaluated. These measurements were performed on a treadmill at 0° inclination and a speed of 4 km/h.

After these basal measurements, the informed consent of patients, according to Helsinki declaration, was obtained prior to commencing an exercise schedule of two half-hour sessions per day. Exercise consisted of cycling or treadmill, with even resistance. After 30 days, the basal instrumental evaluations and blood sampling were repeated.

Data were subjected to statistical analysis by Student's t-test for paired data allowing for Bonferroni's correction, and levels of probability less than 5% were considered statistically significant.

RESULTS
All patients completed the protocol. Symptom-free walking distance at the end of the training period showed a significant increase, while there was no major change in maximal walking distance (Fig. 1). Similarly, local blood pressure measurements showed no appreciable variation in the Windso index (0.665 ± 0.048 vs. 0.589 ± 0.051; mean ± s.e., n.s.).

Cutaneous blood flow, measured by laser Doppler flowmetry, showed no significant change after one month of physical training (3.07 ± 1.154 vs. 3.134 ± 0.567 perfusion units; n.s.). In terms of macrocirculation, strain gauge plethysmography showed a significant decrease in rest flow at the end of the training. Peak flow did not change appreciably (Fig. 2). Biochemical evaluations showed a significant decrease of white blood cells count (6880 ± 385 vs 7466 ± 429 WBC/mm³; p < 0.05), triglycerides (170 ± 16 vs 227 ± 32 mg/dl; p < 0.01), and uric acid (6.16 ± 0.37 vs 6.11 ± 0.33 mg/dl; p < 0.01). Platelet count, prothrombin time, aPTT, plasmogenolysis, and total cholesterol were unchanged; on the other hand we found a small, but significant, rise of fibrinogen (Table 1).

DISCUSSION
Scheduled physical exercise for a patient with intermittent claudication is now widely recognized as an important therapeutic factor for purposes of satisfactory functional autonomy (16, 17). Various studies underline the indication can also be extended to claudicant subjects with associated ischemic heart disease, excluding only those patients in whom exercise would aggravate stenocardic symptoms. Not even diabetes mellitus gives grounds for considering that the benefits of exercise would not meet expectations (9, 14).

Our study shows first and foremost that macrocirculatory flow, measured by laser Doppler flowmetry, was not affected by physical training.

CONCLUSION

Intermittent claudication and physical exercise

There is no general agreement regarding this finding, and many authors have observed their patients to be free of the peripheral pressure changes which would be expected in the presence of an increased ankle-brachial index (10, 20). An excellent study by Johnson et al. (15) showed no significant changes in maximal blood flow in the common femoral arteries after 5 months' training. In our study, there were no variations in peak flow or the Windso index, suggesting that the circulatory reserve as a whole remains unchanged, hence the absence of significant changes in MWD. This result is consistent with the findings of other authors, who have not found changes in blood flow in the lower limbs of claudicant patients undergoing physical exercise (3, 5, 23). In the study by Johnson and coworkers, after the third month of exercise, there was a statistically significant increase in MWD in comparison with the basal value for the parameter. In our study, possibly the absence of significant effects on MWD is attributable to the far briefer period of training involved, though the protocol was not the same and the difference in overall workload was thus not proportional to the different duration.

The increase in fibrinogen at the end of the training period is consistent with the observations of other authors (13, 26), although some references report that fibrinogen does not change after exercise (19) or even decreases (25). The varying results might be due to the different study populations. In our study the results do not show an increase in clotting tendency as confirmed by unchanged PT, aPTT, and platelet count.

Fibriiolytic activity has not significantly varied with regard to the levels of plasmogenolysis. Some authors have reported an increase in fibrinolytic activity mainly by an elevation of tissue plasmogen activator (8, 21). Moreover, Stratton et al. emphasized a decreasing PAI-1 activity (24).

Other authors report a significant increase in plasmogen levels after a course of physical training, but in their study the blood sampling was carried out at peak exercise (6), thus in a different hemodynamic and functional condition than for our subjects.

We studied the importance of scheduled physical activity in the patient with intermittent claudication, showing that clinical improvement is not accompanied by an increase in the circulatory reserve. On the other hand, plasmogenolysis levels as well as parameters of coagulation did not show significant changes. The findings for blood flow were considered to be related, albeit indirectly, to the improvement in

Fig. 1. Changes in symptom free walking distance (SWFD) and maximal walking distance (MWD) before (open column) and after (hatched column) the period of physical training (M ± SE).

Fig. 2. Changes in rest flow (RF), peak flow (PF) and PF/RF ratio before (open column) and after (hatched column) the period of physical training (M ± SE): *p < 0.01; **p < 0.001.

Table 1. Changes in biohematic parameters after physical training (M ± SE)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Before training</th>
<th>After training</th>
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<tbody>
<tr>
<td>WBC (cells/µl)</td>
<td>7466 ± 429</td>
<td>6880 ± 385**</td>
</tr>
<tr>
<td>Platelets (10³/µl)</td>
<td>251 ± 13</td>
<td>290 ± 411</td>
</tr>
<tr>
<td>Triglycerides (mg/dl)</td>
<td>227 ± 32</td>
<td>170 ± 16*</td>
</tr>
<tr>
<td>Cholesterol (mg/dl)</td>
<td>249 ± 41</td>
<td>240 ± 10</td>
</tr>
<tr>
<td>Uric acid (mg/dl)</td>
<td>6.11 ± 0.33</td>
<td>5.16 ± 0.57*</td>
</tr>
<tr>
<td>PT (ratio)</td>
<td>0.91 ± 0.01</td>
<td>0.99 ± 0.009</td>
</tr>
<tr>
<td>aPTT (ratio)</td>
<td>1.04 ± 0.04</td>
<td>1.06 ± 0.030</td>
</tr>
<tr>
<td>Fibrinogen (mg/dl)</td>
<td>340 ± 17</td>
<td>389 ± 20**</td>
</tr>
<tr>
<td>Plasmogenolysis (mg/dl)</td>
<td>180 ± 28</td>
<td>194 ± 32</td>
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</tbody>
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* p < 0.01; ** p < 0.001 vs values before physical training.
Cutaneous blood flow, measured by laser Doppler flowmetry, showed no significant change after one month of physical training (1.077 ± 1.58 vs. 1.314 ± 0.567 perfusion units; n.s.). In terms of macrocirculation, strain gauge plethysmography showed a significant decrease in rest flow at the end of the training. Biochemical evaluations showed a significant decrease of white blood cell counts (8680 ± 385 vs 7466 ± 429 WBC/mm³, p < 0.05), triglycerides (170 ± 1.6 vs 227 ± 3.32 mg/dL, p < 0.01), and uric acid (5.16 ± 0.37 vs 6.11 ± 0.33 mg/dL, p < 0.01). Platelet count, prothrombin time, aPTT, plasminogen, and total cholesterol were unchanged; on the other hand we found a small, but significant, rise of fibrinogen (Table I).

DISCUSSION

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Our study shows first and foremost that microcirculatory flow, measured by laser Doppler flowmetry, showed no significant change after one month of physical training (1.077 ± 1.58 vs. 1.314 ± 0.567 perfusion units; n.s.). In terms of macrocirculation, strain gauge plethysmography showed a significant decrease in rest flow at the end of the training. Biochemical evaluations showed a significant decrease of white blood cell counts (8680 ± 385 vs 7466 ± 429 WBC/mm³, p < 0.05), triglycerides (170 ± 1.6 vs 227 ± 3.32 mg/dL, p < 0.01), and uric acid (5.16 ± 0.37 vs 6.11 ± 0.33 mg/dL, p < 0.01). Platelet count, prothrombin time, aPTT, plasminogen, and total cholesterol were unchanged; on the other hand we found a small, but significant, rise of fibrinogen (Table I).

Fig. 2. Changes in mean flow (BF, peak flow (PF) and PF/BF ratio before (open column) and after (hatched column) the period of physical training (M ± SE): *p < 0.01; **p < 0.001.

m 1000

P < 0.001

400

300

200

100

0

0 200 400 600 800 1000

Fig. 1. Changes in symptom free walking distance (SFWD) and maximal walking distance (MWD) before (open column) and after (hatched column) the period of physical training (M ± SE).

there is no general agreement regarding this finding, and many authors have observed their patients to be free of pain after 4 weeks of physical exercise which would be expected in the presence of an increased ankle-brachial index (10, 20). An excellent study by Johnson et al. (15) showed no significant changes in maximal blood flow in the common femoral arteries after 5 months' training. In our study, there were no variations in peak flow or the Windsor index, suggesting that the circulatory reserve as a whole remains unchanged, hence the absence of significant changes in MWD. This result is consistent with the findings of other authors, who have not found changes in blood flow in the lower limbs of claudicant patients undergoing physical exercise (5, 13, 23).

In measuring overall blood flow in the limb, we observed a statistically significant decrease in rest flow. The factors that may be related to the metabolic changes: higher oxygen uptake and better “energy yield”.

Muscular effort in conditions of relative ischemia is an important stimulus for the development of new capillaries and collateral circulation (27). In these studies, this is considered to be related to an increase in the Windsor index, and thus to decreased resistances downstream from the stenosis (22). However, there is no general agreement regarding this finding, and many authors have observed their patients to be free of pain after 4 weeks of physical exercise which would be expected in the presence of an increased ankle-brachial index (10, 20). An excellent study by Johnson et al. (15) showed no significant changes in maximal blood flow in the common femoral arteries after 5 months' training. In our study, there were no variations in peak flow or the Windsor index, suggesting that the circulatory reserve as a whole remains unchanged, hence the absence of significant changes in MWD. This result is consistent with the findings of other authors, who have not found changes in blood flow in the lower limbs of claudicant patients undergoing physical exercise (5, 13, 23). In the study by Johnson and coworkers, after the third month of exercise, there was a statistically significant increase in MWD in comparison with the basal value for the parameter. In our study, possibly the absence of significant effects on MWD is attributable to the far briefer period of training involved, though the protocol was not the same and the difference in overall workload was thus not proportional to the different duration.

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mucosal metabolic function. In this respect, the decrease in overall rest flow indicates that physical exercise is accompanied by increased tolerance of exercise, probably due to a redistribution of flow within the muscles to ensure a more efficient blood supply to the active component (27).