FLOW RATE MEASUREMENTS IN THE COMMON FEMORAL VEIN DURING ACTIVITIES OF THE MUSCLES IN THE LOWER LIMB

Jean-Thomas AUBERT (1), Michel CHAUVEAU (2), Christian RIBREAU (3)

(1) : Innothera, Serv. Biophysique, 7-9 Av. François Vincent Raspail, BP 35, 94111 Arcueil.
(2) : Service de Physiologie et d’explorations fonctionnelles, Hôpital Cochin, Paris.
(3) : IUT de Cachan, 9 Av. de la Division Leclerc, BP 140, 94234 Cachan Cedex.

Introduction

It is well known that venous flow rate is highly affected by the venous environment. But, the influence of movement, either accelerations or muscular contractions, on venous flow rate is not precisely quantified. This initial study proposes first answers about flow rate measurements in the Common Femoral Vein (CFV) aiming at quantify the effects of muscular contractions on veins in the lower limb.

Methods

The venous return velocity was measured with a Doppler echo-velocimeter (ATL HDI 5000) in the CFV. Venous return velocity is calculated from the average blood cells velocity on the cross section of the vein and in time. This flowmeter gave also the image and the size of the cross-section of the vein. The flow rate through CFV stands for a boundary condition as an output of the venous network in the lower limb. Flow rate was recorded on healthy subjects at rest and during specified movements.

The biomechanical parameters of movements that made explicit the activities of muscles were controlled by means of goniometers (Biometrics XM 110 & XM 180), accelerometers (Entran EGAS) and a force plate (Satel) for making sure of the repeatability of situations as well as possible. All the biomechanical parameters were synchronised by the mean of the DataLINK© acquisition platform (Biometrics Ltd). In future experiments, EMG should attest the actual activation of muscles.

Through the activation of explicit muscles and for a given posture of the body, the specified movements of the lower limb acted on the filling and emptying of veins. For such an analysis, two reference conditions were defined and differentiated two states of compliance of the venous network, which is when the subject was standing or lying supine. Furthermore, distinct explorations were produced in loaded and unloaded limbs (with or without foot support).

The movements involving loaded limbs were: (figure 1)
(i) voluntary contraction of the thigh (mainly the femoral quadriceps) in standing position;
(ii) leaning forward from standing position with straight legs (the only ankle angle was changing);
(iii) loading of the limb from standing position on one foot, the “recorded” second leg was free, towards standing position on two feet;
(iv) tip-toe.
Observation:
Common Femoral Vein

Voluntary contraction of the thigh

Leaning forward

Loading

Tip Toe

Figure 1: Movements involving loaded limbs

The movements involving unloaded limbs were: (figure 2)
(i) voluntary contraction of the thigh (mainly the femoral quadriceps) in lying supine position;
(ii) flexion/extension of the leg on the thigh in the standing position, for about 45° inclination of the thigh on the trunk.

Observation:
Common Femoral Vein

45°

Flexion / Extension of the leg on the thigh (foot relaxed)

Voluntary contraction of the thigh

Figure 2: Movements involving unloaded limbs

Results & discussion

This communication presents the variations of flow rate by comparison to the flow rate at rest for each specified movement (table 1). These results were obtained on ten subjects with no pathology.

It shows the huge dependence on the venous return of the activation of not only the calf muscles (which is known as the "calf pump") (Winter et al., 2000) but the entire lower limb muscles of the lower limb. For instance, in the CFV the venous mean velocity peaks were drastically different, from 1 cm.s⁻¹ to more than 180 cm.s⁻¹.
<table>
<thead>
<tr>
<th>Standing position</th>
<th>Unloaded Limb</th>
<th>Loaded Limb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexion / Extension of the knee</td>
<td>2.4</td>
<td>-</td>
</tr>
<tr>
<td>Voluntary contraction of the thigh</td>
<td>4.5</td>
<td>32</td>
</tr>
<tr>
<td>Leaning forward</td>
<td>-</td>
<td>13.3</td>
</tr>
<tr>
<td>Lower limb loading</td>
<td>-</td>
<td>13.7</td>
</tr>
<tr>
<td>Tip-toe</td>
<td>-</td>
<td>7.9</td>
</tr>
</tbody>
</table>

Table 1: Flow rate variations in the Common Femoral Vein $\times 100\%$

Before all, this study shows the great variability of the cross section size of the vein with the different postures (table 2) and consequently confirms the importance of the venous network compliance (Bassez et al. 2001).

Table 2: CFV diameter and posture

Such global information about the CFV flow rate and geometry are first importance to identify the main sources of hemodynamics unsteadiness in the network and hence for any modelisation of unsteady flow in collapsible tubes (Dai et al., 1999) (Thiriet et al., 2000). Future experiments would correlate venous return flow rate and the different biomechanical parameters.

References


